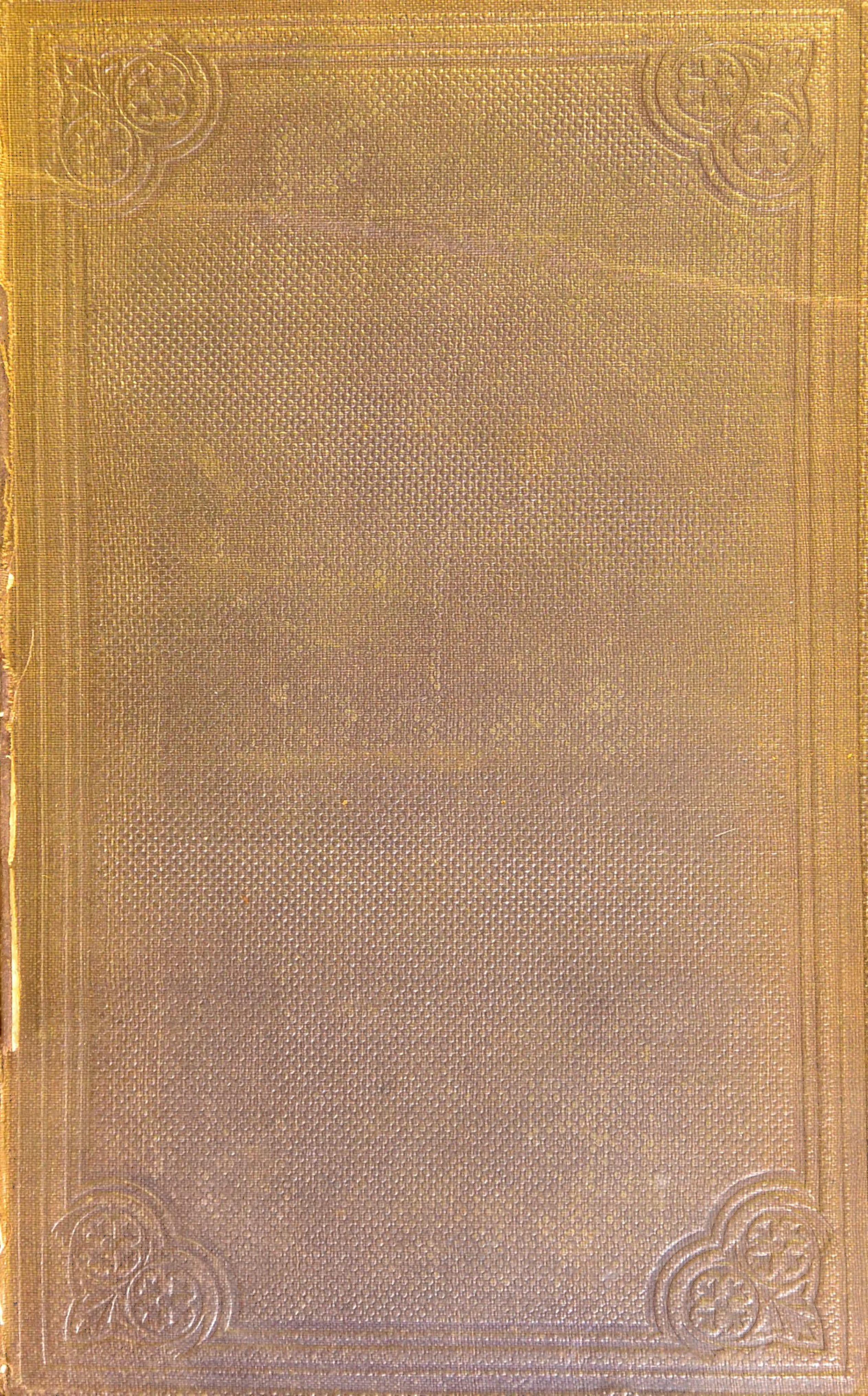

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COOPER'S DICTIONARY

OF

PRACTICAL SURGERY

VOL. I.

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COOPER'S DICTIONARY

OF

PRACTICAL SURGERY

AND

ENCYCLOPÆDIA OF SURGICAL SCIENCE

NEW EDITION

BROUGHT DOWN TO THE PRESENT TIME

BY SAMUEL A. LANE

Surgeon to St. Mary's, and Consulting Surgeon to the Lock Hospitals: Lecturer on Surgery at St. Mary's Hospital

ASSISTED BY VARIOUS EMINENT SURGEONS

IN TWO VOLUMES

VOL. I.

LONDON
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PREFACE

TO THE

EIGHTH EDITION.

THE last edition of COOPER'S SURGICAL DICTIONARY appeared under the auspices of its laborious and talented author, who devoted, with unprecedented ardour, a whole life to the production and perfection of his favourite work. His great abilities and untiring energy enabled him, in seven successive editions, spread over a period of nine-and-twenty years, to present to the world an epitome of surgical science unrivalled, as the production of one man, for its accuracy, for its great research, and for the amount of information it has been the means of accumulating and disseminating for the last half century, amongst surgeons in this country, and throughout the civilised world. In the preface to his seventh and last edition, Mr. Cooper thus writes of himself and his labours: —

"The utility of this Dictionary to students and all classes of medical practitioners, has obtained for it in this country a larger share of patronage than perhaps was ever conferred upon any other book of Surgery; while its translation into the French, German, and Italian languages, and several republications of it in America, may be taken as proofs of its being deemed worthy of considerable notice in various parts of the world."

"In preparing this edition, which comprehends an account of all the principal modern improvements in Surgery, I have conscientiously endeavoured to deal fairly and impartially with every individual whose name I have had occasion to mention, or whose suggestions form subjects of consideration, in the ensuing pages. My aim has been Truth, wherever I could find her; and in every situation where any glimpse of her beautiful figure presented itself, I have ardently courted her, regardless of the name, school, or country on which she might deign to shed her glory. By steadily adhering to this principle; by zealously marking what the book of nature and the field of experience unfolded; by renouncing all obsequious submission to every other kind of authority; and by taking the liberty of sometimes thinking and judging for myself; I trust that the most likely plan has been adopted of maintaining the character of this book, and raising my own reputation."

Mr. Cooper adds the following quotation from the preface of Dr. Reese's American edition of the Dictionary: —

"As in every species of human science, our highest attainments are but an approximation towards perfection; so in the science of Surgery, each succeeding year demonstrates that all that is known of the principles or practice of our art, is but the prelude to still higher exhibitions of science and skill, alike honourable to the profession, and valuable to the cause of humanity. To condense and arrange all the novel and interesting facts which clinical experience is furnishing, and upon which alone the edifice of true science can be erected, is a task worthy of the immense labour which Mr. Cooper has bestowed on each succeeding reprint of his Dictionary, and one to which he has proved himself entirely adequate. The extensive and multiplied resources to which he has access, furnish him with facilities possessed by few; and in availing himself of these, he has exhibited an industry, and, for the most part, an impartiality, worthy of all praise."

The task that has devolved upon the present Editor is to embody in the Eighth Edition of the work thus characterised by its illustrious author, all that has been subsequently achieved in the art and science of Surgery. Since the names of Liebig, Mulder, Robin, and Verdeil have appeared amongst us, chemistry, especially animal chemistry, has not only made rapid strides, but, as regards its influence on the study of morbid products of either a solid or fluid nature, may be considered almost a new science. The microscope, in the hands of Schwann and Schleiden, has led to the discovery of cell development, unveiling to us the important part played by the nucleated cell in the vital functions of secretion and excretion, and the further knowledge that the blood itself is composed of nucleated cells, movable in the liquor sanguinis, and conveyed by the circulation to every organ and tissue in the body. The vast improvements in histological and pathological anatomy, introduced by Rokitansky, Paget, and Virchow, have entirely altered our notions of healthy and morbid growths. The discovery of the laws of endosmosis and exosmosis, by Dutrochet, added to our improved knowledge of the peripheral terminations of the whole vascular system, have led to the subversion of the Hunterian doctrine of absorption and deposition by the open mouths of the absorbents and arteries. The gradual introduction of humoral pathology, and the equally gradual extinction of pure solidism; and lastly, the new views in the treatment of inflammatory diseases by stimulants, as advocated by the late Dr. Todd and others, perhaps too readily received and adopted by many of the rising generation of medical men, to the exclusion of the heroic remedies of repeated bleedings and salivations, — hitherto too zealously and too indiscriminately had recourse to,—have all had a powerful influence in modifying the opinions held by surgeons of the present day with regard to the nature and treatment of most surgical diseases.

The necessity that these new lights should be made to pervade more or less the pages of this dictionary, and that the prolific and teeming professional literature of the last quarter of a century should be consulted on every branch of Surgery, rendered it physically impossible that the Editor should himself revise each separate article. He has accordingly associated with him in his editorial labours many eminent and able writers, for the most part already distinguished in the department of Surgery which they have undertaken, as will be at once recognised in the following list of subjects and contributors:—

Mr. J. Adams	Head, Injuries of.
Mr. W. Adams	Orthopædic Surgery.
Mr. Ancell	Articles on Blood; Tuberculosis.
Dr. Bader	Ophthalmic Surgery.
Mr. Busk	Scurvy.
Mr. Blenkins	Gun-shot Wounds.
Mr. White Cooper	Cataract.
Mr. Coulson	Lithotomy and Lithotrity.
Mr. Druitt	Inflammation and its Terminations.
Mr. Erichsen	Aneurism
Mr. Fergusson	Staphyloraphe.
Dr. Hanfield Jones	Cancer and Malignant Diseases.
Mr. E. Hart	Hydrophobia; Tetanus.
Mr. J. R. Lane	Amputation; Fractures and Dislocations; Diseases of the Rectum.
Dr. McLeod	Varix.
Mr. Spencer Smith	Bones, Diseases of.
Dr. Snow	Anæsthesia.
Dr. Tyler Smith	Articles on Obstetric Surgery.
Mr. H. Thompson	Urethral and Prostatic Diseases.
Mr. Thos. Wakley	Joints, Excision of; Joints, Diseases of; Hydrocele, &c.
Mr. Spencer Wells	Plastic Surgery; Burns, &c.
Mr. Erasmus Wilson	Skin, Diseases of.
Mr. Ure	Caustics; Mamma, Diseases of.

The pathology of the blood will be found a very important addition which has contributed to augment the pages of the work. This subject in its entirety has been undertaken by Mr. Ancell, whose competency to the task is well established by the publication in the year 1841-42 of his "Lectures on the Physiology and Pathology of the Blood," which with the contemporaneous writings of Andral, Stevens, Piorry, Copland, and others, unquestionably influenced the progress of Medical and Surgical Science and the direction it subsequently took. At the period of the publication of the last edition, but slight account had been taken by surgeons of the blood as a vital constituent of the animal frame, or the seat of either the material elements, or the dynamic actions which enter into morbid processes. But at the present day, in every department of surgical practice, the question of the actual state of the blood must be entertained before any case can be fully compassed or rational indications of treatment, whether by operation or otherwise, can be laid down. Under these circumstances, the duty of the editor would appear to be to present to the surgical practitioner and the student a fair summary of all that is known on the subject. The accomplishment of this has been attempted in the Articles—*Blood, Pathology of — Cholæmia — Hydræmia—Hyperinosis—Hypinosis — Heterochymeusis — Hyperæmia— Oxalæmia —Necræmia — Pyæmia — Toxæmia — Spanæmia, Uræmia, &c.* Some of the articles have been through the press for a considerable period, but the writer has contrived so to arrange the materials that, under the various headings above specified, will be found comprised a sufficiently complete view of the actual state of our knowledge of the pathology of the blood.

The plan adopted in conducting the present edition through the press has been, to retain as much as possible of the original matter, whether historical or strictly professional; to erase only that which by lapse of time had become obsolete, or which the accumulated experience and the advance of the collateral sciences had shown to be at variance with the improved knowledge of the day. The addition of new matter has been restricted, as much as possible, to the space rendered available by the erasures, in order to keep the work within the compass of a dictionary of convenient reference. In many instances this has not been found possible, and a considerable extension of certain articles has been unavoidable. A few have been entirely re-written. New ones have also of necessity been added. Orthopædic surgery— Ovariotomy—Excision of Joints—the treatment of Vesico-vaginal Fistula and of Ruptured Perinæum, &c.—have assumed the position of new branches of Surgery since the last edition of this Dictionary, and have consequently demanded much additional space. The result has been, that with every desire and every effort to exceed as little as possible the bulk of the last edition, the present—notwithstanding the space gained by the numerous erasures, which have been unsparingly had recourse to—will contain at least 500 additional pages of new matter.

The reader will at once understand who is responsible for the revision or authorship of any article by observing the presence or absence of a name at the end of the article. In the latter instance the Editor himself is answerable; in the former the writer whose name is attached. Throughout the work the new matter is distinguished from the original of Mr. Cooper by being enclosed in brackets; that which has been erased could not be indicated.

The unavoidable increase in bulk of the present edition has induced the Publishers to divide the work into two volumes. The First is now presented to the professional public. The Editor, however imperfectly he may have thus far performed his task, has endeavoured, to the best of his abilities, to follow, *haud passibus æquis*, in the footsteps of Mr. Cooper; actuated by similar aspirations for the advancement of our noble and beneficent science, his aim has been to carry out the declared intentions of the author with the same independence of thought, the same devotion to truth wherever found, and to adopt the same spirit of fairness and impartiality in recording the discoveries and opinions of cotemporary surgeons.

To the Second Volume, which will appear as speedily as possible, will be added an Appendix, in which will be embodied the latest discoveries and improvements. This plan, which was adopted in former editions by the late author, is rendered absolutely necessary—especially as regards the articles belonging to the earlier letters of the Alphabet—by the rapid progress of Surgical Science, and by the long period unavoidably occupied by a work of this magnitude in passing through the press.

A
DICTIONARY
OF
PRACTICAL SURGERY.

Abdomen. The **Belly.** If the pelvis be reckoned as part of the abdomen, the latter may be said to extend from the diaphragm, which forms its upper boundary, down to the levatores ani, and, from the transversales muscles in front, to the spine, quadrati lumborum, and iliaci behind. Thus comprehensively viewed, the abdomen appears to contain and protect all the organs of digestion situated below the œsophagus, together with the urinary and internal organs of generation. Anatomists divide the abdomen into different *regions*, the terms allotted to which are so frequent in the language of surgery, that some account of them in this Dictionary seems indispensable. In fact, without the knowledge of them, the pathologist can neither direct his inquiries with precision, nor communicate clearly the results of his investigations to others. The abdomen has been divided into as many as nine compartments or regions. by four lines drawn arbitrarily between certain points, readily distinguishable on the surface, two of these lines are imagined to pass on either side from the cartilage of the eighth rib down to the centre of Poupart's ligament,—thus dividing the anterior surface of the abdominal paries into three longitudinal compartments, a central and two lateral. Each of these is again subdivided into three others by two lines extended transversely, the one between the lowest level of the costal cartilages, the other between the highest level of the iliac crests of opposite sides, cutting the former perpendicular lines at right angles. Partitions corresponding with these four lines are supposed to pass through the abdomen from its anterior to its posterior boundary, marking out the positions of the nine conventional compartments or regions into which the abdominal cavity is supposed to be divided. Enumerating from above downwards the three central of these regions are named the Epigastric, the Umbilical, and the Hypogastric; the lateral are termed the Hypochondriac, the Lumbar, and the Iliac. The *epigastric region* contains the middle part and the pyloric extremity of the stomach, the left lobe of the liver, the hepatic vessels, the lobulus spigelii, the pancreas, the cœliac axis, the semilunar ganglia, the aorta, the vena cava, and the crura of the diaphragm. The *left hypochondrium* contains the large end of the stomach, the spleen and narrow extremity of the pancreas, part of the colon, the renal capsule, and the upper portion of the kidney. The *right hypochondrium* contains the right lobe of the liver, the gall-bladder, part of the duodenum, some of the ascending colon, the renal capsule, and upper portion of the kidney. In the umbilical region are situated the transverse colon, the transverse portion of the duodenum, the aorta, the vena cava, and the convolutions of the jejunum. The *right lumbar region* contains the ascending colon, the lower half of the kidney, and part of the duodenum. The *left* contains the descending colon, and the lower half the kidney. In the *hypogastric region* are the convolutions of the ilium, the bladder in children, and, in adults, both the bladder and the uterus, if distended. The *right iliac* contains the cœcum, the ureter, and spermatic vessels, and the *left iliac*, the sigmoid flexure of the colon, the ureter, and the spermatic vessels.

Although the upper boundaries of the abdomen are completely determined internally by the diaphragm, they remain quite undefined externally. The diaphragm being a movable partition between the chest and the abdomen, alternately ascending and descending in respiration, must by such changes have the effect of occasioning a correspondent enlargement or diminution of one of these cavities at the expense of the other. Without attention to this fact, mistakes in diagnosis would be very frequent. A sword, entering at the same point, and in the same direction, may penetrate the thorax, or the abdomen, or both cavities, according to the position of the diaphragm at the moment of the injury.

The functions of the abdomen essentially require that its capacity should be continually varying; and had its cavity been circumscribed by an osseous case, like that of the cranium, or by a construction like that of the parietes of the chest, such an arrangement would have been totally incompatible with the offices of the abdominal viscera. So convinced is Cruveilhier of the facility with which the abdomen accommodates itself to the varying quantity of its contents, that he regards the doctrine as perfectly erroneous which refers the irreducible state of some herniæ to insufficiency of space within the peritoneum. "What!" says he, "can we suppose a cavity incapable of receiving the bowels again, which will allow of eight or ten pounds of victuals and drink being suddenly introduced into it? and which, in tympanitis, often becomes distended in a short time to twice or thrice its natural dimensions?" According to the judgment of this distinguished pathologist, the obstacle to reduction depends either upon adhesions, or a disproportion between the viscera and the passage through which they protrude, arising from hypertrophy of the omentum, or mesentery; or the altered relations of the peritoneum, drawn down by the displaced intestines. But though this explanation, so far as it goes, seems correct with reference to the causes of the impossibility of reduction, Cruveilhier's view should not lead us to forget, that certain cases every now and then present themselves where the viscera admit of reduction; but their return into the abdomen is followed by so much pain and indisposition, that the plan of keeping them there is unavoidably renounced.

In the treatment of several diseases and injuries of the abdomen, the surgeon cannot proceed one step with safety to his patient without the light of anatomy. Hernia, wounds, paracentesis, abscesses, are all so many cases where a surgeon deficient in anatomical knowledge would be likely to adopt very inefficient measures, or commit the most fatal mistakes. A surgeon, acquainted with the structure and extent of the sheath of the rectus, would have no difficulty in selecting the most advantageous place for the puncture, when matter collects within that investment of the muscle; and the practitioner, aware of the exact course of the epigastric artery, would never run any risk of wounding it either in tapping a dropsical patient, attempting to take up the external iliac artery, or dividing the stricture in inguinal and crural herniæ.

On being first consulted, surgeons, as well as physicians, too often neglect to institute a careful examination of the external parts of the body. Thus, either from carelessness or mistaken delicacy, they deprive themselves of the most simple, ready, and sure means of recognising the nature of the patient's complaint. Some diseases of the chest and abdomen are strikingly expressed on the surface; either in a permanent change of configuration, or in a temporary alteration of the natural movements, or both. (*Forbes, in Cyclop. of Pract. Med.* art. *Abdomen, Exploration of.*) When obstinate constipation, great pain, nausea, and vomiting occur, let the surgeon always be sure that these symptoms are not dependent upon hernia, the usual situations of which should be carefully explored. The methods of exploring the abdominal regions are three, viz. *inspection*, *manual examination*, or *palpation*, as it is termed, and *percussion*. The assistance of the sight and touch alone is not what the practitioner should always be content with; for as there is more or less gas within the alimentary canal, and considerable arterial trunks pervade the abdomen, the sense of hearing may be exerted with as much success in the investigation of diseases of this part of the body, as in that of diseases of the chest. The parietes of the abdomen being capable of relaxation, the viscera may be felt directly through them; and, as Cruveilhier justly remarks, this is the only visceral cavity admitting of such exploration. Frequently, by means of palpation, tender, enlarged, or indurated points may be detected. In the first instance, however, a careful inspection of the surface of the abdomen should always be made. The practitioner should consider whether it is more bulky, or of less size, than natural. Swelling and tension, combined with pain, and a small frequent pulse, characterise acute peritonitis. In some cases, a circumscribed swelling points out the seat of the disease,—the organ affected. How essential the knowledge of the various regions of the abdomen, and of the contents of each of them, will be for the formation of a correct opinion, must be sufficiently manifest. In pregnancy, retention of urine, and encysted dropsy, the swelling has an oval, or protuberant form; in ascites, a broader, more expanded shape. In lead colic, the parietes of the abdomen seem retracted, or drawn inwards. When palpation is instituted, the abdominal muscles should be relaxed, and the patient's mind diverted from his case. The pressure should be made gently and gradually; for when it is too forcible and abrupt, the examiner's touch is confused, the patient is put to pain, and his muscles contract. According to Cruveilhier, it has even been known to occasion the death of children by lacerating the liver, or the spleen in a state of enlargement. In fact, this rude mode of palpation conveys to the surgeon no information which can be relied upon; for the uneasiness, or pain experienced, or the change of countenance, may be more owing to the roughness or force of the pressure than to any disease in the region of the abdomen subjected to examination. In certain cases, like ascites, the exploration should be made, if possible, while the patient is standing up, because, in this position, the fluid gravitates and renders the parietes of the abdomen tense, so that the fluid is more plainly distinguished.

The presence of gas, or liquids, may be detected by percussion; that of liquids, or any foreign body, being made manifest by the dull dead sound, and the perception of fluctuation by the hand applied to the point opposite that which receives the percussion.

In diseases and injuries of the abdomen, the diagnosis is often attended with considerable obscurity. It might be supposed, that as the soft and yielding parietes of this cavity facilitate the manual examination of its viscera, the detection of any painful point about them, and the slightest change of their shape or volume, nothing would be more easy than to trace disease in this part of the body through its different stages with great precision. But, as Cruveilhier remarks, this is far from being the fact. The vast number of organs contained in the abdomen, their great moveableness, the frequency of their displacement, the multitude of their diseases, the particular character of their vitality, which sometimes lets them attain a very serious state of disease, unattended by any urgent pain; and lastly, the difference of thickness of the parietes of the abdomen in different individuals, are undoubtedly the circumstances accounting for the frequent difficulty in the diagnosis. In surgical, as well as in medical cases, the same uncertainty is experienced. Thus punctured wounds of the abdomen are treated on general principles, because the practitioner seldom knows exactly what viscera are injured. The same observation is applicable to contusions of the abdomen. A man who had a hernia received the kick of a mule on the belly : severe colic and vomiting ensued ; several surgeons believed that these symptoms arose from the hernia being strangulated, and recommended an operation. Cruveilhier objected to this proposal, which, however, was carried into execution: the patient died, and on opening the body, the small intestine was found torn completely across. In the North London Hospital a young man died this spring (1836), from the kick of a horse on the abdomen. During the four or five days which he lived after the accident, he frequently vomited, and the belly became considerably swollen. Effusion of blood, or of the intestinal contents, was foretold ; but, until the *post mortem* examination took place, the exact nature of the injury remained doubtful. A laceration of the small intestine was then detected, attended with effusion of its contents. The man died of peritoneal inflammation.

Abdomen, Abscesses of the, may take place either in its cavity or its parietes, and may be acute or chronic. In fatal examples of peritonitis, a seropurulent fluid is often found in the cavity of the abdomen. In some instances, the pus is circumscribed by adhesions, which are produced by coagulable lymph, and separate the abscess from the rest of the general cavity of the peritoneum. In other cases purulent effusion in the abdomen is the consequence of the bursting of an abscess of some of the viscera, or of perforation of the small intestine by ulceration.

Chronic tumours of the mesentery, which, in scrofulous children, sometimes terminate in suppuration, diseases of the ovary, and other abdominal viscera, bringing on the formation of matter, may be followed by purulent extravasation. Dr. Seymour in his work on *Diseases of the Ovaries*, relates the case of a young woman, who, after suffering hectic fever, the cause of which was not apparent, suddenly complained of acute pain in the abdomen, and in a few hours expired. On opening the body, a large quantity of pus was found effused in the peritoneal cavity from an abscess of the right ovary. Dr. Tweedie met with an ovarian abscess of the size of an orange, where the prominent symptoms were incontrollable vomiting and sympathetic fever. (*Cyclop. of Pract. Med.* art. *Abscess.*) I have seen several instances of ovarian cysts, which had become inflamed after tapping, and secreted a puriform fluid. A woman had an ovarial tumour, supposed to be an ovarian dropsy. After death, the cyst was found to contain twenty pints of well-formed pus. (*North Amer. Med. Journ.* 1826.)

Occasionally, however, salutary adhesions are produced between the viscera, and ulceration taking place, an outlet is obtained for the matter through the bladder, anus, or vagina. Thus in the case of a woman, who had had for a long while pains in the right lumbar region, supposed to proceed from suppuration of the kidney, because pus was voided with the urine, the right kidney was found after death in the natural state ; but there was an abscess in the right ovary, which was adherent to the bladder, into which the pus had passed through an ulcerated communication. In another patient, who had voided pus by the anus, the right kidney suppurated, and became adherent to the colon, with which it communicated by a preternatural aperture. For many years, a woman had a hard tumour of considerable size in the abdomen : at length, the pain of it became intolerable ; and just at the moment when her death was apprehended, an immense quantity of pus was suddenly discharged from the vagina. The pain abated ; the swelling of the belly subsided ; merely the remains of the induration were now perceptible ; and the woman's health was perfectly re-established. (See *Lassus, Pathologie Chir.* t. i. p. 138.)

In one case, an abscess communicated with the cœcum, to which and the parietes of the abdomen, the omentum had become firmly adherent. In this manner, a circumscribed cavity was formed, containing ill-conditioned pus, and three or four seeds of fruit, covered by earthy incrustation. (*Abercrombie on Dis. of the Stomach, &c.* p. 338.)

Abscesses of the liver are more common in hot than temperate climates. Frequently, the liver becomes adherent to the neighbouring parts, and then the matter may be discharged through the parietes of the abdomen, or into the colon, stomach, duodenum, or gall-bladder ; from which latter the pus may descend by the biliary duct into the bowels, and be discharged *per anum*, an instance of which is recorded by Malpighi. Abscesses of the liver have been known to make their way through the diaphragm into the pleura, or into the air cells of the lungs, so that the pus was coughed up. Andral refers to one case, where an abscess of the liver communicated with the vena cava, and to another, where it burst into the pericardium. (*Anat. Pathol.* t. ii. p. 601.) At the request of the late Dr. Pinckard, I examined the body of a woman, in whose liver there were nearly three pints of pus ; the case was remarkable on account of the gall-bladder having been annihilated, with the exception of a trivial portion of its fundus, which is now in my possession.

The kidney may be the seat of acute or chronic abscess. Sometimes the quantity of matter is small, and the texture of the organ but little changed. In other examples, the suppuration may be so copious that none of the original structure of the kidney is left, excepting its capsular investment, which is expanded into a cyst of considerable size, and filled with pus. I attended with Mr. Baker, of Staines, an old man who had symptoms somewhat like those of stone, and one of whose kidneys was found after death converted into a cyst containing about a pint of purulent fluid. As Andral observes, renal abscesses are sometimes so large, that they may be felt through the parietes of the abdomen. (*Anat. Pathol.* t. ii. p. 633.)

Abscesses of the kidney may burst in the loins, or make their way into the peritoneum, the ureter, or the colon.

Abscesses between the peritoneum and abdominal muscles, or between the layers of these muscles, or under the integuments of the abdomen, are attended with considerable variety, according as they happen to be chronic, or acute ; circumscribed, or diffused ; small, or extensive. Those of the acute or phlegmonous kind, from stabs and contusions, are noticed in the article Wounds. As for chronic abscesses of the parietes of the abdomen, they should be opened in an early stage.

Hard indigestible substances, after being swallowed, are not unfrequently discharged from abscesses in some of the abdominal regions. (See *De La Grange, in Museum der Heilkunde*, b. iv. p. 154 : *a fish-bone, which had been swallowed,* *found in the abscess; Petit, Traité de Mal. Chir.* t. ii. p. 226; *an awl, without a handle, extracted from an abscess of the abdomen; and many other analogous cases.*)

Encysted tumours are occasionally formed between the peritoneum and abdominal muscles, and attain an immense size before they burst; a remarkable specimen of which is described by Gooch, (*Chir. Works,* vol. ii. p. 144, &c. 8vo. Lond. 1792.) In this case, the spontaneous opening in the navel was enlarged with caustic, and the cyst extracted; but, before a cure could be effected, it became necessary to make a depending opening, and introduce a seton.

Abdomen, Pulsations in the.—From the article *Aneurism,* the reader will understand that, though it be the common nature of this disease to be attended with throbbing, it is not every pulsating tumour that is an aneurism. The cases, usually called *abdominal* or *epigastric pulsations,* often furnish a proof of the correctness of the preceding remark. The authors, who have treated of the latter affection with the greatest discrimination, are Dr. Albers, of Bremen, and Mr. Allan Burns, of Glasgow, two gentlemen, whose high reputation and useful labours will long survive the termination of their meritorious lives. Some of the pulsations here referred to are the consequence of organic disease, and capable of demonstration by dissection; while the rest are not attended with any such appearance, and have therefore been regarded as nervous. The pulsation is not always produced by the impulse communicated to a solid tumour, or substance between the hand and the artery, but was conceived by Mr. Burns to be sometimes dependent on a nervous affection of the vessel itself. (*On Diseases of the Heart,* p. 263.) Hippocrates refers to three patients affected with extraordinary pulsations in the abdomen. As one of these cases seemed to depend upon obstructed menses, it was probably not the result of any organic disease. (*Hippocratis Opera Omnia. ex edit. Fœsii Francof.* 1621, lib. v. sect. 7, p. 1144.) In order to remove a difficulty in believing how an artery, not affected with aneurismal enlargement, can communicate to the superincumbent parts such movements as are frequently remarked in cases of abdominal pulsations, a fact pointed out by Mr. Hunter should be remembered: in speaking of the actual dilatation of an artery, he says, that when the vessel is "covered by the integuments, the apparent effect is much greater than it really is in the artery itself; for, in laying such an artery bare, the nearer we come to it, the less visible is its pulsation: and when laid bare, its motion is hardly either to be felt or seen." (*On the Blood, &c.* p. 175, 4to. Lond. 1794.) And this observation will apply to all tumours and indurations situated over a large artery. In the epigastric region of a certain patient, Taberranus felt not only a pulsation, but a tumour as large as the fist, with all the other usual symptoms of an aneurism. On opening the body after death, he was therefore surprised to find, instead of this disease, a considerable scirrhous tumour in the middle of the mesentery, so closely connected to the large vessels as to compress the aorta, by the pulsations of which it had been lifted up. (*Obs. Anat.* ed. 2, No. 9.)

Mr. Loudon, of Leamington, sent me the particulars of a case, where the pulsations of the aorta against a diseased liver, extending across the epigastrium, and occasioning a well-defined tumour at the pit of the stomach, had been mistaken by several practitioners for an aneurism of the aorta, which vessel was found after death perfectly sound.

I once visited with Mr. Miller, of Keppell Street, a thin old man for retention of urine, where the tumour, formed by distended bladder above the pubes, was attended with regular and strong pulsations, corresponding to those of the arteries. I am not aware that any similar case is upon record.

In an example recorded by Störk, the symptoms arose from disease of the pancreas, which weighed thirteen pounds, and contained a large cyst filled with lamellated blood. (*Annus Medicus,* Vindob. 1760, p. 245.)

A man, aged 60, complained of pain in the left side, midway between the umbilicus and crista of the ilium, followed by emaciation, weakness, distress of countenance, anorexia, and constipation. At length, a large pulsating tumour was discovered in the epigastric region. The case was now pronounced aneurism of the abdominal aorta. There was *no nausea nor vomiting,* except a few days before death, when a quantity of fetid blackish fluid was twice or thrice voided. *No fever.* The swelling caused a sense of constriction rather than pain, and the throbbing became more perceptible. The pulse was feeble, but *slow and regular.* After death, the stomach was found *adhering* to the liver, pancreas, and peritoneum; and a *cancerous tumour* occupied its internal surface from the duodenum to the insertion of the œsophagus, its coats being an inch thick. The surface of the pancreas was also diseased, and the pylorus, situated in the midst of the cancerous mass, was contracted by the thickening of the parietes of the stomach, and obstructed by numerous fungi. The liver was large, but apparently sound; the spleen small. *The aorta, the cœliac trunk, and its branches were quite natural.* (See *Journ. de Méd. par Leroux,* Oct. 1815.)

Abdominal pulsations are described by Zuliani, as a symptom of hypochondriasis and hysteria. (*De Apoplexia,* Lips. 1790, p. 79.) They also happen in certain febrile diseases. (*Versuch über den Pemphygus und das Blaienfieber, von C. G. C. Braune.* Leipz. 1795, s. 23; and *Dr. R. Jackson on the Fevers of Jamaica,* 8vo. Lond. 1791.)

Thilenius observed a flatulence of the stomach, which, in some patients, was attended with pulsations at the scrobiculus cordis. (*Med. Chir. Bemerk,* Frankf. 1789, s. 211—217.) My friend, Mr. Hodgson, in speaking of pulsations in the epigastrium, which are not the consequence of organic disease, and occur in irritable hypochondriac subjects, states his opinion, that, in some instances, these pulsations are a consequence of distension of the stomach with air, which is thrown against the abdominal muscles by the pulsation of the great blood vessels: and in such cases, the throbbing is diminished by the eructations. (*On the Diseases of Arteries and Veins,* p. 96.)

Dr. Albers detailed some cases which fell under his own notice. A young woman, whose menses were upon her, and who had been for some days constipated, was seized with frequent fainting fits and febrile symptoms, occasionally voiding from the bowels a quantity of dark matter, each evacuation of which was followed by a swoon. One morning at five o'clock Dr. Albers was sent for, as it was feared the patient was about to die. She was extremely exhausted, and the fainting fits followed each other with hardly any intervals. She could just say, "I feel a throbbing in the belly;" and when Dr. Albers applied his hand to the part, he felt a violent pulsation, extending from the ensiform cartilage down to about the bifurcation of the aorta. The action of the heart was weaker than natural; the pulse at the wrist very small, but not quicker than it had been on the preceding day, and not synchronous with the throbbing in the abdomen. Dr. Albers confesses that, at first, he took the case for an aneurism. Dr. Meyerhoff was of the same opinion. Another physician, however, Dr. Weinholt, entertained doubts of the complaint being aneurismal, saying, that he recollected having read similar cases in Morgagni. These gentlemen decided to persevere in the employment of opening medicines and clysters, combining opium with the former. Under this plan, the pulsations in the abdomen and tightness of the chest diminished in a few days. The stools were at first of the colour of chocolate, but afterwards resumed their natural appearance. The throbbings, in a weakened form, however, were perceptible for six weeks longer. The patient at length got quite well, and was remaining so four years afterwards.

A man, about 40, severely afflicted with hypochondriasis, great oppression of the chest, constipation, and tension of the abdomen, tendency to fainting, &c., complained to Dr. Albers that he felt as if his heart had fallen down into his belly, where he was annoyed with an incessant throbbing. Indeed, when Dr. Albers examined the abdominal parietes, he could feel a very strong pulsation, and what is curious, could trace it not only along the track of the aorta, but in the course of the left iliac artery. The pulse at the wrist, which was small, frequent, and hard, did not correspond with the abdominal pulsations. For several days, the evacuations from the bowels had been as black as pitch. After the employment of gentle purgatives all the complaints quickly abated, though the throbbings were feebly perceptible for nine months afterwards.

In any persons not very fat, and lying upon their backs, the pulse of the aorta can easily be felt, if strong pressure be made a little to the left of the median line, about half way between the navel and scrobiculus cordis. In certain instances, the pulsation is painfully felt by the patient himself. In many cases of this kind, particularly in nervous individuals, the sense of pulsation is merely the effect of preternatural action of the heart; while, in other examples, it is the effect of the pressure of some hard substance upon the descending aorta, determining a disproportionate quantity of blood to the head, "and giving to the hand placed on the abdomen, and sometimes even to the eye, the appearance of a beating so near the surface, as to lead inexperienced observers to conclude that the aorta is morbidly dilated." According to Dr. Parry, the most common causes are collections of fæces in the colon, requiring repeated and active purgatives, which must bring away almost incredible discharges of stercoraceous matter before the aortal pulsation subsides. (See *Parry's Elements of Pathology &c.*; and the *Medico-Chir. Journ. and Review*, vol. i. p. 157.)

I once attended, with the late Mr. Ramsden, a boy in Christ's Hospital, who had a considerable abscess in the lumbar region, attended with distinct and forcible pulsations, corresponding to those of the aorta.

Three or four years ago, I was also consulted by Mr. Gilbertson, of Egham, in a case where an enormous abscess in the epigastric region was accompanied by pulsations as strong and synchronous with those of the heart as the throbbings of an aortic aneurism.

According to Mr. Allan Burns, a beating is generally felt about the pit of the stomach, in the advanced stage of chronic inflammation of the heart: in this case, when the pericardium is closely adherent to the latter organ, it is corrugated at every contraction of the ventricles, and the diaphragm and liver are elevated. The ventricle, however, having completely emptied itself, is again distended, and, in proportion to the degree of dilatation, the liver and diaphragm descend, whereby an impulse is communicated in the epigastric region. (*On Diseases of the Heart*, p. 263.) This valuable writer cites the remark of Morgagni (Epist. 17, art. 28), that sometimes in hypertrophy of the heart, this organ descends so far as to push the diaphragm into the hypochondrium, and pulsate in that situation, so that the disease is mistaken for an aneurism of the cœliac artery. In Mr. Burns' work a memorable case of this description is related. An erroneous judgment is the more likely to be formed in such examples, because the pulsations of the heart and tumour are not exactly simultaneous; for it is not the heart which is felt directly beating, but the liver, which, by the action of the heart, is thrown forwards. Hence the palpable interval between the stroke of the heart and the movement of the liver.

Preternatural pulsation about the epigastrium is stated by Mr. A. Burns to be sometimes occasioned by encysted tumours, attached either to the lower surface of the diaphragm, or formed between the layers of the pericardium towards the diaphragm, as happened in an instance recorded by Lancisi.

Another cause specified by Mr. A. Burns, is enlargement of the vena cava, or of the right auricle of the heart. Senac describes a case, in which the vena cava was as large as the arm, and there had been a violent pulsation in the epigastrium.

The next cause, enumerated by the same gentleman, is increased solidity of the lungs, more especially of their lower acute margins, where they overlap the pericardium. In this case, the pulsation is about the scrobiculus cordis.

Mr. A. Burns notices several other causes of epigastric or abdominal pulsations, already spoken of in the foregoing part of this article, indurations of the pancreas, scirrhus of the pylorus, tumours in the mesentery, or any solid increase of substance about the abdominal aorta, or its principal branches; and, lastly, a peculiar affection of the vascular system itself.

The following observations by Dr. Albers on the criteria between various abdominal pulsations and those of aneurism, appear interesting: — An internal aneurism originates gradually, and the pulsations increase in strength by degrees. Other abdominal pulsations, on the contrary, begin suddenly, and are most violent in the beginning, abating after they have lasted some time.

In an aneurism, the pulsation is synchronous with the stroke of the artery at the wrist; but this is not regularly the case with other pulsations.

Should the patient be affected with melancholia, hypochondriasis, hysteria, or other nervous complaints, void blood from the stomach, or a black matter from the bowels; should there be any hardness or swelling of the abdominal viscera discoverable by the touch, the probability is that the pulsations are not owing to an internal aneurism.

With the exception of cases in which these pulsations are owing to mechanical impediments to the circulation, Dr. Albers believes that they are mostly a symptom of some nervous affection. He also thinks, that the surprise excited by these throbbings arises only from their strength and situation; other analogous, strong pulsations, as, for instance, those of the heart, or of the carotids, being common enough in hypochondriacal and hysterical persons. The same gentleman adverts to the increased action, which, in inflammation, and fevers, is often more conspicuous in some parts of the sanguiferous system than others.

See Ueber Pulsationem im Unterleibe. Bremen, 8vo. 1803. Obs. on some of the most frequent and important Diseases of the Heart; on Aneurism of the Thoracic Aorta; on Preternatural Pulsation in the Epigastric Region, &c. By *Allan Burns*, p. 262, &c. 8vo. Edinb. 1809.

ABSCESS is derived from the Latin *abscessus*, which signifies a loss or departure, or that something is *gone* (to use a homely English word) from some part of the body; *si quid in aliquâ parte corporis abscesserit*, as Celsus says. The word signifies a collection of pus or puriform fluid, in the substance of any part of the body, or in any of the cavities. Thus we speak of abscess of the areolar tissue, or bone, or brain; and of abscess of the pleura, or joints.

Abscess in the substance of a part is homologous with ulcer on the surface. Each results from the softening down of the natural tissues, and of exudations which have infiltrated them.

There is one question, which commonly is brought forward in discussing the general history of abscess, and that is, whether all abscesses of necessity arise from inflammation. This question will be amply discussed under the article INFLAMMATION; where we shall show that a dispute of this matter is one of words rather than of things. If all exudations are inflammatory, then all abscesses must be so; but until it be settled that the term inflammation shall include all exudation, with hyperæmia, or without it, it will be impossible to deny that abscesses may have no necessary connection with inflammation.

The subject of abscesses admits of a twofold division. In the first place, the peculiarities which they derive from the tissue or part of the body in which they are situated, will require to be discussed, and for this we must refer to separate articles; for instance those on the LYMPHATIC GLANDS, FEMALE BREAST, the BRAIN, BONE, the EYE, the JOINTS, the TESTIS, and the OVARY, in which abscess of those tissues and organs will be described. Abscess also connected with the vertebræ, or with the great muscles of the trunk, will be treated of in the articles on PSOAS or LUMBAR abscess; and the articles on the PERINÆUM, and the GENERATIVE ORGANS in either sex, and the RECTUM will contain an account of abscess in those situations. In the present article we take the other division of the subject, and treat of abscess generally.

Now, as we observe more at length in the article INFLAMMATION, the general characters of each variety of abscess depend on those of the exudation, of which it is the result. Every variety almost, therefore, of blood disorder, may have its own special abscess, and the same may be said of many kinds of local injury.

The first variety we will speak of is the commonest. It is that which arises from the common inflammatory exudation, and which may occur in any constitution, after the blood has been disordered, or overloaded, or the excretions insufficiently discharged; and more especially if some part of the body be in a state which renders it prone to disease. We speak here of the kind of abscess which may follow a bruise or puncture if inflamed; which may affect the female breast during lactation, or the alveoli, if a tooth be decayed. It may occur after fever, or after any other general constitutional disturbance; and in so doing often seems to be the mode in which something injurious may be eliminated from the blood, and the health be improved in consequence. Its course is commonly acute, hence it is often called *par excellence* the *acute abscess;* although sometimes the course of this abscess is chronic; and that of any other variety may be acute. As good a word as any is *phlegmon.*

A second variety, the *chronic abscess*, is marked by the almost entire absence of inflammation, and results from the degeneration of an exudation of a *low*, devitalised kind. The term *scrofulous* is commonly applied indiscriminately to chronic abscesses, although it is not the truth that every chronic abscess is scrofulous, nor that every scrofulous abscess is chronic.

We may remark that abscesses commencing with specific *scrofulous* exudation have characters of their own, which will be pointed out in the article SCROFULA. Chronic indeed they are sure to be in their duration, although their origin may be attended with signs of acute inflammation.

We will only allude to the varieties of abscess which are presented by *boil* and *carbuncle;* to the abscesses which occasionally result from gouty exudations, surcharged with the so called *chalky deposit*, and which also occasionally follow chronic rheumatic disease, if injury be superadded. We might speak of *cancerous* abscess to designate the hollows formed in masses by cancer before ulceration. We must allude to the venereal bubo as an instance of abscess in the lymphatic vessels or glands, or in the areolar tissue around them, produced by the action of a particular poison, through which the *behaviour* (as chemists would call it) of these abscesses has some peculiarities. (See SYPHILIS, CARBUNCLE, CANCER, &c.)

There is another kind, the *diffused abscess*, which has derived its name from its wide extent, and from the circumstance that the exudation is not limited to one centre, and that when suppuration has taken place, the puriform fluid is not contained in anything like a cyst, but is extravasated or diffused widely along the areolar tissue, into the interstices of muscles, and under the skin. This may arise from the nature of the injury which has caused the abscess; as, for example, when a limb has suffered compound fracture and blood has been widely extravasated, and offensive discharges penetrate the muscular interstices; or when urine is extravasated, or when some poison, as that of snakes, has been inserted into the areolar tissue. Some cases too of carbuncle, may really be called diffused abscesses, so widely are the unhealthy exudations spread in the areolar tissue. But the most frequent cause of diffused abscess is phlegmonous erysipelas, and the state known as pyæmia, in which it is probable that the blood is impregnated with some putrid poison. Not but that the same kind of abscess may follow any grave fever; thus during typhus, the areolar tissue of a whole limb, from the foot to the nates may be filled with pus.

Now whether we have regard to the nature of the exudations which produce abscess or not, we shall find that the threefold division into acute, chronic, and diffuse, will be a convenient one, as it will show the treatment applicable to the largest number of cases. Most acute abscesses arise from a common inflammatory tendency; most chronic abscesses from a state of debility allied to scrofula; and most diffused abscesses, from the presence of some wide contamination of the blood.

The most frequent situation of abscesses is the areolar tissue, especially the subcutaneous, or intermuscular. But there is no tissue which admits of unhealthy exudations into its interstices, which may not be the seat of the abscess.

It is to be remarked further that, the areolar tissue, just outside an irritated membrane, is often the seat of abscess. The commonest abscesses perhaps which occur, are those situated just external to lymphatic glands, when these glands are irritated by poisonous matter brought to them by their afferent vessels. In the common acne, the exudation and suppuration are usually just external to the sebaceous follicles. In phlebitis, and angeio leucitis, in mammary abscess, in erysipelas and eczema, the same thing occurs perpetually. A surface is bathed with unhealthy secretion, or vitiated liquor sanguinis, as the case may be; a portion of this is imbibed and creates abscess external to the membrane: or an unhealthy exudation may be directed both to the surface and to the tissues beneath. But whatever the explanation, the fact remains.

Of all situations of abscess perhaps, as we have just said, the lymphatic glands and the areolar tissue around them are the commonest. They are exposed to the passage of irritating matter through the lymphatics from every sore, abrasion, and interstitial exudation whatever. Hence the frequency of bubo of the groin in syphilis and gonorrhœa, of swelling above the elbow or in the axilla after punctures of the hands; and of the cervical glands from cutaneous disease of the face or scalp; moreover they are the chosen seat of exudation in scrofula, and in almost every state of weakness and cachexia, scrofulous or not. (See LYMPHATIC GLANDS, BUBO, &c.)

Acute Abscess in the Areolar Tissue or *Phlegmon* begins with the usual signs of acute inflammation. Let us suppose that such an abscess follows a local injury, such as bruise, or puncture; that the patient has not kept the injured part at rest, and has been living freely. Pain which gradually increases, and acquires a decidedly throbbing character; heat, swelling, and redness, most intense at the centre, will be the symptoms. The accession of these symptoms is marked by slight chills, which, as we remark elsewhere (see INFLAMMATION), are the earliest signs of derangement in the blood. These are followed by the usual feverish symptoms; headache, lassitude, quick pulse, hot skin, on which we need not dilate here. The swelling increases, and is exquisitely tender in the centre and œdematous around. During this time, which may vary from twenty-four hours to three days, the affected part is becoming enfiltered with increasing quantities of exudation;—with blood and liquor sanguinis and fibrine. Now comes the change from the œdematous and adhesive to the suppurative stage. The centre of the swelling becomes softer and more prominent; and tends, as is commonly said, to *point;* its colour becomes of a paler or yellower cast; and if gentle pressure be made with the fingers of each hand alternately a fluid may be felt within, to be impelled from side to side like a wave; hence the term fluctuation. And now, if the part were examined it would be found that the central mass of exudation was softening into pus, that there was a central cavity, containing blood, serum, pus ready formed, and flakes of lymph not quite softened, whilst the exudation around retaining its vital properties forms a pretty definite sac or cyst, by which the pus is circumscribed and prevented from being diffused into the areolar tissue. (See SUPPURATION.)

The abscess being thus fully formed, nature proceeds to get rid of the contents. The parts between the cavity and the skin gradually melt down, the quantity of matter increases, the coverings become thinner, and the pointing and fluctuation more decided. At last the skin becomes tense, portions of the centre look yellowish, and lose their cuticle; at last one or more apertures are formed, and the pus escapes.

Then is presented the spectacle so familiar in idea to the readers of Hunter, of the various effects of inflammation in concentric circles. At the circumference, where the inflammation is least intense, a ring of œdema; within this, a layer of adhesive matter forming the cyst; within that, suppuration; and in the centre, a process of ulceration — the natural surgeon — combined perhaps with some degree of sloughing, in order that the results of the inflammatory process may be got rid of.

In the case of abscess, throroughly idiopathic, that is, depending on some morbid state of the blood, and not preceded by local injury, uneasy constitutional symptoms may exist for a certain time previously. Perhaps the patient is recovering slowly from the effects of a fever; perhaps the case is one of a woman in imperfect health, taxing her digestive organs to supply material for nursing an infant; perhaps there have been headaches, or pains in the side, or wandering pains in bones or joints, but in such a case shivering is the first symptom; pain in the part affected follows; and these symptoms may come with the greatest suddenness. The writer has seen a case of a lady, rather out of health and weakly, who was seized with shivering, and became delirious in an hour: acute inflammation of one breast followed. In some cases, idiopathic abscess is preceded by a patch of eczema or by some other cutaneous eruption; but in many cases the suddenness of the first local pain is remarkable.

The constitutional symptoms during the suppuration are very variable. In most cases, so soon as suppuration has taken place, it seems as if the disease had done its worst, and was pacified; feverishness abates, and pain ceases or changes its character. This can only be if the abscess be seated in loose and extensible parts. If it be confined by tendinous or fascial structures, which do not bulge out before the matter, nor are softened and disintegrated (absorbed, as the older surgeons said) without great difficulty, then the pain increases continually in intensity till relief is obtained.

One other constitutional symptom there is which demands more examination than is often given to it. We have said before and elsewhere (see INFLAMMATION), that shivering appears to be one of the earliest signs that some grave alteration is taking place in the blood, that something is received into the veins which directly affects the composition of that fluid, or that some change is taking place by virtue of a deleterious substance previously received. For example, no matter when or how a man imbibes the poison of fever or erysipelas, he will feel a shivering when the mischief is beginning in good earnest; and, in like manner, the onset of the inflammation which precedes abscess is commonly marked by a shivering.

But there is another kind of shivering which may accompany suppuration, and which occurs when matter is pent up and cannot escape ; more especially if, as we may presume, that matter contains some noxious ingredient. It is often taught in surgical books and lectures, that rigors are a sign of suppuration; but this is not absolutely true, because, if we except the shivering which occurs at the commencement of the case, before any pus is formed at all, the subsequent stages of most abscesses are marked by no rigors whatever.

The fact is, that under certain circumstances, rigors occur after suppuration has occurred; and they show what, in the language of the students of the Hunterian epoch, would be called irritation of the constitution at a disease which cannot be overcome; and what, in the language of the humoralists of the present day, would be interpreted as absorption of deleterious matter from an abscess which has no vent.

The rigors of suppuration form the cold stage of true *hectic fever.* They generally come regularly at the same hour every day; they are followed by a hot stage, and afterwards by a profuse sweat of a disagreeable smell. The pulse becomes quick, the tongue red and raw-looking, and there is a tendency to diarrhœa.

Tho following case will show the true nature of these symptoms : — The writer was consulted by a lady for *ague.* She had had two fits, on two successive days, of rigors, in the evening, followed by great headache and heat, and by very great and offensive perspiration during the night. On further inquiry, one breast had been painful the preceding week, and was said to be somewhat swelled and painful now. The breast, on examination, presented an obscure indication of deep-seated suppuration ; a bistory was plunged in, a large quantity of pus escaped, and the rigors returned no more.

Rigors, therefore, do not indicate suppuration purely, nor is the absence of rigors a sign of the absence of suppuration; although, if present, they give strong ground for believing that matter is confined somewhere. (See HECTIC.)

After the abscess has burst or has been opened, if the patient is fortunate and of good constitution, the case is at an end. The walls of the cavity fall together, the chasm is filled with pale pink lymph, and cicatrisation may ensue in forty-eight hours. (See *Hunter on the Blood,* c. iv. § 3; *Macartney on Inflammation,* p. 55.)

In less fortunate cases, the discharge may continue, the aperture may enlarge, and the cure be completed by a more or less tedious process of GRANULATION. (q. v.) An unhealed abscess, contracted into a narrow passage, is called FISTULA, or SINUS. (q. v.) If it have a wide orifice, it becomes an ULCER. (q. v.)

There is one part of the history of abscesses which has degenerated into such a dreary commonplace, that it is with difficulty the writer can bring himself to allude to it at all. This is the alleged law, that inflammation is always most intense on the side nearest the surface of the body; that ulceration, or interstitial absorption, has always a tendency to spread most in that direction; in fact, that there resides in the animal body a kind of centrifugal eliminative law, by virtue of which all extraneous matters, including pus, are brought to the surface. "We have, therefore," says Hunter, "always extraneous bodies of every kind determined to the skin, and on that side to which the extraneous body is nearest, without having any effect or producing the least destruction of any of the other surrounding parts. From this cause we find abscesses, &c., whose seat is in or near the centre of a part, readily determined to the surface on the one side and not on the other; and wherever the lead is once taken, it immediately goes on." So far, Hunter affirms a universal law, to the effect that "one side only of the surrounding living parts is susceptible of this irritation, therefore one side only is absorbed; and this is always the side nearest to the external surface of the body." But, with characteristic carelessness, he immediately afterwards states, that "as some parts *from their structure* are more susceptible of this irritation than others, we find that those parts composed of such structure are often absorbed although they are *not in the shortest road to the skin ;* this structure is the cellular membrane, as will be taken notice of hereafter."

The most probable account of the matter is, that some tissues are more prone to be the seat of exudation than others, and, *par excellence,* the subcutaneous areolar tissue; that some tissues resist infiltration and subsequent softening — possibly by virtue of their mechanical properties, as fascia, muscle, artery, and vein; and, consequently, that an exudation will rather increase in the direction of the skin, amongst the tissues easily admitting of it, than through muscle.

The tissues which are most easily infiltrated and softened down in suppuration are those also which ulcerate most easily — skin, areolar tissue, and the mucous membrane, to which must be added bone and cartilage; but arteries, veins, glands, and muscles are comparatively unaffected, and often appear in abscesses and ulcers with their surfaces as if cleanly dissected. Yet there is no tissue whatever which may not suppurate under some circumstances.

The *chronic abscess* is the result of a very low degree of inflammation, or of none. It is a mere symptom ; a consequence of some slow disease of bone or of ulceration of mucous membrane, or of some other slow degeneration in a constitution marked by want of power.

The patient usually complains first, of a swelling, which is pale, free from tenderness, not adherent to the skin, evidently encysted. In various situations, such a swelling may be mistaken for a venous cyst, a ganglion, an aneurism, or a hernia. The patient probably can give no account of its origin, unless it arises from disease of the spine, or implicate some of the great muscles of the limb, when probably there will be an account of obscure pain and weakness for months or years; in most cases the presence of the tumor is discovered by accident.

The abscess is bounded by a cyst, pale grey or ash coloured, more or less vascular, composed of adhesive or fibrous exudation. The contents may embrace every variety of pus or puriform fluid, in every stage of degeneration. They may be merely an opaque serum, or serum with curdy flakes, with flakes of cheesy matter and cholesterine, or genuine pus. The contents may vary from time to time; they may be diminished by absorption; or increased by fresh exudation kept up by the original source of the disease, or supplied by the inner surface of the cyst;—and this additional exudation may consist of blood or pus, which were not present at first.

One character of chronic abscesses, is their tendency to almost indefinite enlargement before coming to the surface and bursting. An abscess originating in diseased bone may excavate all the areolar tissue of the hips and lower part of the back, and both thighs, and contain gallons of matter. They may also make their way along the interstices of muscles, and point in the most unexpected situations at a distance from the focus of mischief.

As regards local history, the usual course is, that so soon as the chronic abscess has become sufficiently large to stretch the skin and interfere with its nourishment, the distended part reddens, and soon ulcerates at one or more points, just as in the case of an acute abscess, and the matter is discharged.

But this process admits of very many varieties in its circumstances and results and in the constitutional symptoms attending it; the chief of which are the following:—

In the first place, if the abscess result from an insignificant exudation into the areolar tissue, and if the state of health which gave rise to that exudation be repaired by proper alteratives and tonics, then, as we observe in the article Absorption, both the original exudation, and any puriform fluid to which it has given rise by its presence may be taken into the veins again, and the case be cured by absorption.

Secondly, in the case of a small abscess in the subcutaneous or intermuscular areolar tissue, it may burst, or be opened, the pus escape, and then under favourable circumstances, the opposite sides of the cyst may at once contract and adhere, and the aperture heal. But far more frequently there is a want of plastic energy in the lining cyst, so that it requires a long time to contract, during which, as in the acute abscess, the orifice may enlarge into an ulcer, and considerable drain take place from the internal surface. (See also Sinus.)

Thirdly, in the case of a large abscess, there are other and very grave conditions which may be added. One of these is, that from certain changes in the quality of the matter contained in the sac, the same series of phenomena may occur which we spoke of under the head of acute abscess,—viz. rigors, occurring daily, followed by a hot stage, and profuse perspirations; in fact, the symptoms of acute hectic which we have before detailed. This is not the place to enter fully into the subject of hectic. Well may Hunter's words be taken in their true sense, that "the constitution has become conscious of a local disease or irritation which it cannot remove nor cure." True also was his observation that hectic does not usually come on till after large chronic abscesses are opened; and likewise his opinion that absorption of pus alone cannot be the cause of hectic. But in truth, the word *pus* embraces an immense variety of morbid products, which again may be intermixed with products of decay; and these if absorbed, may be capable of causing hectic. We may observe, as we have before said, that rigors and the other signs of hectic may exist without suppuration; and that suppuration to an enormous extent may exist without them: further that pus may be and daily is absorbed without producing hectic; yet that pus in certain stages of decay or varieties of admixture may if absorbed cause these symptoms, and does actually produce them under certain circumstances. Some modern surgeons have copied Hunter and fallen into the error of asserting that hectic *never* occurs till after an abscess is opened. But this is absurd.

The symptoms then of hectic, rigors, heat, perspirations, red tongue, thirst, loss of appetite, diarrhœa, aphthæ, pink sediment in the urine, loss of hair and rapid emaciation may occur before an abscess has been opened. But after a large abscess has been opened a worse train of circumstances arises, which renders hectic in its severest form still more likely to come on. The surface of an extensive cyst, endowed with very feeble vitality, is deprived of the support heretofore rendered to it by the liquid which it contained. Hence its surface becomes loaded with blood; and its feeble vessels giving way, exude more or less blood or serum. The injury thus occasioned sets up some degree of inflammation and feverishness. Air probably gains access to the interior of the sac, and the pus, a liquid not easily putrefiable by itself, is rendered eminently so, by being mixed with small quantities of serum and blood. Hence there is a large internal absorptive surface, bathed in putrescent fluid. And now follows a more grave set of symptoms. The patient up to the very day of the opening of the abscess, may, with the exception of debility, have been in a comfortable state of health; he may have escaped all hectic hitherto, for, as we have said, that condition appears to be incidental to abscess, and not essential, to arise from the absorption of pus in particular conditions, and not from absorption of pus *pure* and *simple*. But let the interior of a large sac be bathed with putrid matter, and then comes on shivering, picking of the bedclothes, dry brown tongue, restlessness, possibly sickness, probably diarrhœa, which after two or three days will be followed by death.

Lastly, it must be noticed, that the drain from an extensive abscess may slowly bring on complete exhaustion, even though there be none of the signs of blood poisoning just related.

The *diffused abscess* now comes to be described, and if it be true that all other abscesses are but symptoms of some local or general morbid condition, more especially may the same be alleged of this. There are, as we observed before, two kinds; one produced by local injury, such as infiltration of the areolar tissue with urine, or with fetid exudation from a wound or some other poison; the other resulting from the action of the more violent blood poisons, which cause wide exudation of a matter difficult of absorption, prone to run into a state of liquefaction, and incapable of becoming organised, like healthy fibrine into a sac, which shall circumscribe the liquid part of the exudation and prevent its wide diffusion. (See INFLAMMATION.)

The points in which the diffused abscess differs from the common acute abscess, are these:—Swelling is flatter, more widely spread; not elevated in one centre;—redness also not most intense at the centre, and gradually vanishing, but extending in irregular patches; perhaps abruptly defined;—redness sometimes absent;—sometimes of a peculiar and unusual hue; heat and pain are generally intense; in some cases they may be absent. Want of tendency to point in one place; and a hard brawny, or a doughy, or œdematous, or obscurely fluctuating swelling are other characteristics.

The local progress of this kind of abscess is as follows:—First comes unhealthy exudation, which spreads and infiltrates the areolar tissue. It may be firm and brawny; or almost entirely liquid from the first, consisting of a turbid yellowish serum. It may occupy great space and extend great distances, filling the entire subcutaneous areolar tissue of a limb, or of one side of the trunk. It soon causes inflammation of the skin, whose vitality is seriously interfered with from the state of the subcutaneous tissue, and which exhibits vesicles filled with serum, straw coloured, or yellow, or livid. At these points the skin afterwards ulcerates or sloughs, giving exit to copious puriform discharge, with flakes of dead areolar tissue which come away often like masses of wet tow. Large tracts of skin may perish in this way, and all the areolar tissue may perish from the surface and interstices of the muscles, leaving them as though cleanly dissected. The work of granulation may succeed vigorously, but cicatrisation must of necessity be slow under such circumstances, and the muscles be left embarrassed and the joints permanently bent.

The constitutional symptoms which accompany such a state of things are those which are sometimes described as symptoms of *irritative fever*, or *pyæmia;* or of *typhoid symptomatic fever.* Rigors followed by intense excitement of the heart; palpitation and anxiety at the chest; rapid soft pulse; dry brown or glazed tongue; possibly bilious diarrhœa, or dysentery; possibly delirium; possibly a preternatural calmness and clearness of mind. If relief be not given, the patient sinks, and death is perhaps preceded by squinting and convulsive twitchings.

The great variety of causes which may give rise to diffused abscess must of necessity occasion great difference in the details. These may be learned by consulting the articles EXTRAVASATION OF URINE, COMPOUND FRACTURE, GUNSHOT WOUNDS, POISONED WOUNDS, and DISSECTION WOUNDS; whilst the details of cases arising from constitutional causes will appear in the articles PYÆMIA, ERYSIPELAS, and GLANDERS.

In cases in which the malady arises from a vitiated state of the blood, operating on parts which have received no injury, it is surprising how suddenly the whole process may be accomplished. A woman, for instance, whose womb has imbibed an erysipelatous poison after child-birth, and who has shivered, and is suffering from abdominal pain and tenderness, and suppressed milk and lochia, may be struck as it were with a sudden pain in one shoulder or elbow, which after a short time may vanish entirely, and be succeeded by pain in the calf of the leg, which speedily reddens, and in a few hours may be a bag of pus; and in some cases this is accomplished with little if any pain.

From cases of this kind the student may learn the purport of various terms which have been applied to abscesses. For example, a distinction may be made between abscess *in* a part, and abscess *of* a part. In the former, suppuration occurs in a part previously healthy, which is selected as the spot for accomplishing a work of elimination; in the latter, the suppuration is produced by a diseased state of the part itself. Abscesses by which the separation of a materies morbi was assumed to be effected were formerly often called *critical;* they have also been termed *consecutive*, and *metastatic;* although the last word, in its ordinary signification implies more than can quite be proved; that is, it implies that pus, in the form of pus, is taken up from one part and deposited in another, of which there is no proof. (See PYÆMIA, PHLEBITIS.)

One kind of abscess may improperly be called diffused; and that is abscess underneath hard fasciæ, and in the sheaths of tendons; the pus cannot get through these, and so spreads underneath them; and very serious cases they are; but their diffusion arises from anatomical peculiarities, and not from any thing special in the kind of exudation.

We have now described the three chief forms in which abscesses may present themselves, no matter from what cause they may arise. But it must be borne in mind that innumerable shades and gradations exist; for example, in the intensity of the inflammation which shall accompany the first stage of an abscess, and in the degree of blood contamination which shall be the cause of it; and that allowances must be made, in this as in other cases where things are treated of in a general way, for the difficulty of presenting one set of facts without seeming to ignore another. Every gradation may occur between a *healthy* acute abscess, concentrated to one point, rapidly suppurating, pointing, bursting, and healing up; and the *unhealthy* diffused abscess, with its imperfect limitation, and suppuration in patches here and there, and widespread destruction of the areolar tissues. So every variety may exist, in the degree of *healthy* sthenic feverishness, and of unhealthy *irritative fever;* and every variety between the acute and chronic abscess in the amount of vigour and rapidity with which the diseased processes are begun, carried on, and ended.

On the *causes* of abscess we need not dwell largely, as they embrace all the causes of local inflammation. Suffice it to say, they may be classified under these three heads:—1. Abscess resulting purely from the localisation of blood disorder, including all scrofulous, and cachectic, and critical, and eliminative abscesses; all abscesses resulting from pyæmia, glanders, and all the pustules of small-pox. 2. Abscess resulting from local injury; such as punctures and bruises; whether or not complicated with the presence of foreign bodies, or impregnated with poison. 3. Abscess resulting from pre-existing disease of another part, from disease of bone or joint, or from ulceration of mucous membrane of rectum, urethra, or the like.

Treatment of the Acute Abscess.—This may be divided into four branches:—1st. Measures which may be adopted to prevent suppuration, supposing it has not taken place, or to cause absorption of the matter, supposing it has. 2ndly. Measures intended to promote and hasten suppuration. 3rdly. The evacuation of the matter where formed. 4thly. The cure of the resisting cavity or ulcer.

In the first place, then, if any given case of inflammation is seen early, it will be fair to consider whether the patient may not be spared the pain and injury which would result from allowing it to go on to suppuration. Let us suppose, as before, an inflamed bruise or puncture, or other local injury. In this case the treatment of inflammation adapted to the case must be put in force. The part must be kept at rest, and elevated; leeches applied; warm poppy fomentations, or cold lotions be used; (and the patient, as stated elsewhere, may be safely left to make his choice;) and, above all, a dose or two of calomel, with colocynth or senna, or Epsom salts, must be administered. By these means, probably, the inflammation may abate; should it, however, still go on to suppuration, the case must be treated as described presently.

If the case be purely idiopathic, and be seen early, the practitioner must make it his duty to consider of what particular blood disorder the local inflammation is a sign, and whether he may not get rid of the materies morbi, through some of the great secreting organs. For example, a patient recovering from fever is seized with violent pain deep in the neck, with obscure swelling, intense tenderness, and utter inability to move, and with great feverishness. Another patient has the same symptoms on the lower and inner part of the thigh. Another is seized with pain and swelling of the gums near a carious tooth. These symptoms, we are certain from experience, if unchecked, will go on to abscess. But by attending to the common principles of the treatment of inflammation, by purifying the blood, and abating local irritation, they may be made to subside.

The first point is to produce a good discharge of bile and fæcal matter, by repeated doses of calomel, carried off by purgatives, till offensive, dark-coloured motions have ceased to pass. Meanwhile the patient should be in bed; the part raised, and covered with warm fomentations or poultices of bread, bran, linseed, or boiled chamomile flowers. No matter what theory may say, there is no doubt but that warmth and moisture are capable alike of facilitating the dispersion and the maturation of abscesses in the proper cases. The diet should be just what is requisite to keep the powers up to a healthy standard; it may require to be low, middle, or high. Leeches also may be applied if the pain and tenderness are intense.

By these means, supposing all active inflammation to have subsided, the pulse to be quiet, and the tongue clean, and the inflamed part slacker, œdematous, and much less tender, then, whether suppuration be conceived to have taken place or no, the matter will probably be absorbed, and the case do well. Moderate pressure by bandages, gentle stimulation of the surface with warm spirituous liniments, especially the compound camphor liniment; aperients, quinine, mineral acids, and other tonics, with and above all fresh air and sea-bathing, will most likely finish the cure.

We hear sometimes of specific remedies adopted to hasten absorption, such as the iodine paint, or iodine liniment; vesication with the cantharides or nitrate of silver, or the formation of pustules with tartar emetic ointment, and particularly emetics. The writer believes that if the principles laid down in the preceding paragraph are acted upon, these measures will be found unnecessary; in case of need, however, the surgeon can try them. We purposely avoid here the question of the *Venereal Bubo.*

The remedies adapted to prevent suppuration, may be used in all cases, because if they do not prevent, they will at least lessen the amount of it; except however two most decided repressing remedies: viz. cold applications and leeches, in the use of which the surgeon shows his discretion, or the want of it. As a general rule, leeches should not be used unless there is something like certainty of preventing suppuration; and cold should not be used in acute idiopathic inflammation generally, unless the patient particularly wishes it.

Our second branch of treatment consists in hastening suppuration, if inevitable. The means are simply abstaining from cold, leeches, and unnecessary purgation: and in the constant application of moist applications, as warm as they can be borne with comfort.

Our third point relates to the evacuation of the matter; and in most cases it is best to quicken the operations of nature, by opening the abscess. It is, or was commonly said, that abscesses may be opened by the knife, by caustic, or by seton. Setting aside the last as a barbarism, and observing that the caustic is of service in cases where the skin covering an abscess is thin and sure to ulcerate, as in some buboes and carbuncles, so that the surgeon does quickly by caustic what otherwise could be done more slowly and painfully without;—we may state that the best instrument is a small straight knife, which should be plunged in at the place where there is most pointing, till it has entered the cavity, and then be made to cut half an inch to an inch and a half, as it is being withdrawn. Then the swelling should be fomented, and covered with warm soft poultices, into which the matter may escape, solicited by gentle pressure.

The size of the aperture should be such that the matter may run out easily, and if the case admits of choice, it should be in a *depending* posture.

Fourthly. After the evacuation of the matter, poultices and fomentations may be continued for a day or two, until tenderness and pain cease; then lint, dry or dipped in zinc lotion, and bandage, are the best applications, and the health should be recruited with good diet and tonics.

Treatment of the Chronic Abscess.—In all cases, the constitutional treatment takes precedence, and it will be the practitioner's duty to prescribe sea-air, steel, cod-liver oil, iodide of iron or of potassium, and such other alteratives and tonics as may be best adapted to the circumstances of the case. He must further bear in mind the duty of looking for local disease, especially of bone, to which the origin of the abscess may probably be traced; and likewise the dangers which arise from the fact of the existence of a large abscess, no matter what its cause may be.

Speaking generally, we may say that in all cases, the sooner an abscess is opened the better. Many remedies, local and constitutional, are spoken of as capable of producing absorption, but the less the practitioner trusts to them, the less he will be disappointed. Galbanum plaster, iodine paint, and the like do little good.

So soon as the diagnosis is certain, especially if the tumour is enlarging, and has become adherent to the skin, and certainly before the skin is inflamed or rendered liable to ulcerate, an opening should be made.

If the abscess be superficial and small, not connected with deep-seated disease, it should be opened freely, so that it may be thoroughly emptied, and pressure be kept upon the sac by compresses, strips of plaster or bandages. The wound, after a day or two, may be bathed with zinc lotion, and the cavity be injected with it, if the discharge continues thin and copious; or a solution of nitrate of silver or of iodine, may be employed for the same purpose, to destroy the lining of the sac, and create fresh exudation and granulation with vigour. If the discharge continues to get less and less, and there is no particular inconvenience, the cavity may be left to shrink under the influence of moderate pressure.

There is an untoward event which sometimes occurs to chronic abscesses of scrofulous origin, and that is the deposit of additional scrofulous exudation outside the abscess, the ulceration of the orifice, and conversion of it into a scrofulous ulcer, which is always a most tedious affair.

If the abscess has already become perilously large, the great point is to make it smaller before it becomes permanently open, and to avoid the dangers of inflammation of the cyst, and absorption of putrid matter. For this purpose a small opening should be made with a trocar or bistoury: the greatest care should be taken to keep up gentle pressure during the operation, so as to keep out the air; a bandage should be put on so as to maintain equal pressure on the cyst, and the wound should be most accurately closed by plaster or collodion, or bloody lint moistened with a little perchloride of iron, and be made to heal. After a few days, another opening should be made with the same precautions, and it should be repeated at such times as will not allow the cyst to return to anything like a state of distention. By this process, it may be hoped that the sac will gradually contract, so that at last if a permanent sinus be established, it may do no harm.

If putrefaction of the contents of the sac should take place, not a moment should be lost in making free openings, so that there may be no retention, and in syringing out the cavity with weak solution of chloride of lime, and adopting every means of keeping the veins full of good wine and soup, so that absorption of the putrid matter may do less harm.

Treatment of the Diffused Abscess.—For the details of treatment we must refer to the Articles which we have referred to for details of symptoms. Here we may say briefly, that early and free incision into the infiltrated tissues, and the use of tonics and abundant diet with stimulants, and of small doses of mercury to provoke the eliminative organs (not to affect the mouth) in cases in which there is infection of the blood, are the leading measures.

The following aphorisms from the earlier edition of this dictionary, well deserve the attention of the surgeon.

OF THE TIME WHEN ABSCESSES SHOULD BE OPENED.

The following are generally regarded as cases in which an opening should be made, as soon as the slightest degree of fluctuation is perceptible, or sometimes even sooner.

1. Abscesses arising from extravasation or effusion of irritating fluids or matters into the cellular tissue. To this class especially belong urinary and fæcal abscesses. Here the incision is necessary, not only for the discharge of pus, but of the effused matter, or fluid, which is the cause of irritation and suppuration. I may add, that, under such circumstances, a very free incision is required to fulfil these two important indications.

2. Abscesses preceded by intense inflammation, and situated in parts abounding in adipose cellular tissue; as, for instance, the verge of the anus, the neighbourhood of the rectum, the sides of the neck, and the axillary, inguinal, and popliteal regions. In such cases, if an early opening be not made, the purulent matter spreads to a great extent in the cellular tissue, and an enormous denudation of parts, or separation of them from one another, is apt to ensue.

3. Daily experience teaches the surgeon, that abscesses are seriously retarded in their progress to the surface of the body by the intervention of a fascia, or an aponeurosis. These are cases, therefore, requiring an early opening to be made, in order to prevent the matter from spreading widely in the interstices of the muscles, from detaching the vessels and nerves from their connexions, and from forming numerous and extensive sinuses in various directions. Abscesses under the fasciæ of the thigh, arm, forearm, and leg, come under the rule here specified, as well as collections of matter under the palmar and plantar fasciæ, and in the sheaths of tendons. Here, as Dupuytren observes, the practice of an incision is warranted as soon as the practitioner perceives œdema of the parts, a broad and undefined swelling of them, the phenomena attending the progress of internal abscesses, and a deep obscure fluctuation, following the ordinary symptoms of inflammation.

4. Abscesses in the parietes of the chest, or abdomen, in the vicinity of a serous membrane, should be opened without delay, in order to prevent with certainty the effusion of pus inwardly, an occurrence which, though rare, has sometimes happened. Certain abscesses of the neck, formed under the sterno-cleido mastoid muscle, call for an early opening; because they not only cause a considerable and very painful swelling, but the matter may easily descend towards the clavicle and chest, in the course of the vessels and nerves.

5. Abscesses in parts abundantly supplied with nerves and capillary blood-vessels, and which, when inflamed, are accompanied by excessive pain or close confinement or strangulation of the textures, as whitlows, large painful boils, carbuncles, &c.

6. All abscesses producing serious disturbance, or interruption, of the functions of very important organs, and thereby endangering life ; as abscesses of the throat, or near the larynx, or pharynx ; abscesses compressing the jugular veins, and threatening the patient with apoplexy or suffocation, &c. In such cases, if the practitioner were to defer making an opening until the swelling had softened, and the abscess had been perfectly formed, the patient would be in great danger of perishing ere such changes had taken place.

7. The generality of chronic abscesses should be opened early, more especially if the means usually resorted to for promoting the absorption of the matter, present no prospect of success. By omitting to make an outlet for the matter, we allow the accumulation of it to increase, and sometimes the abscess then becomes dangerous from its mere size; the inner surface of it, or the cyst, acquiring vast magnitude. With respect to chronic abscesses, connected with diseased bone or diseased joints, and collections of purulent fluid in the synovial membranes, some directions will be found in other parts of this work. (See JOINTS ; LUMBAR ABSCESSES ; VERTEBRÆ.)

"Those abscesses ought to be opened early (says Professor Thomson) that are situated in parts through which the matter is liable to become widely diffused. This is particularly the case with abscesses that are situated on the fore part of the neck, or in the cavity of the axilla, or by the side of the rectum. When matter is formed in the cavity of the axilla, if it does not speedily obtain an external outlet, it is very liable to pass up towards the clavicle in the course of the axillary plexus of nerves and vessels, or forwards under the pectoral muscle. I have repeatedly seen axillary abscess take both of these directions at the same time, forming one of the most painful and difficult cases to treat, which occurs in the management of abscesses." Dr. Thomson also considers an early opening proper and necessary, when the matter is lodged, as in some cases of whitlow, in the sheaths of the tendons ; when matter is formed under the periosteum ; when it collects under fasciæ, or in the vicinity of large arteries, joints, or the greater cavities of the body ; and also when the abscess is deep-seated. (See *On Inflammation*, p. 336—338.)

With respect to making an early opening into abscesses situated near large arteries, I am not aware that any danger of the artery ulcerating in consequence of the nearness of the pus, really exists. Therefore, some doubts may reasonably be entertained of the soundness of Professor Thomson's advice in this particular case, as the general rule of opening abscesses near large blood-vessels, in an early stage of the disease, would be objectionable on the ground of the practice exposing the vessels themselves to injury. Indeed, this well-informed writer distinctly mentions, in considering the subject in question, that the arteries are not very susceptible of ulcerative absorption (p. 337).

It is now a well-established fact, that arteries, and veins likewise, may ulcerate into the sac of an abscess, particularly if of the scrofulous kind. (For examples, see the *Med-Chir. Trans.* vol. xxvi. xxix.; South's Edition of Chelius, I. 191.) Moreover abscesses may burst into any serous or mucous surface that happens to be near ; lung, bowels, pleura, or peritoneum.

The making of an opening in certain abscesses should be deferred longer than in common instances. Such are collections of purulent matter, situated in internal organs, as the liver, spleen, kidney, and lungs, and producing an outward swelling. Dupuytren deems it most prudent not to open such tumor until the skin is inflamed, the only circumstance which can be depended upon as denoting the formation of those adhesions, by which alone the insinuation of the pus into the great serous cavities will be prevented. — [*R. Druitt.*]

ABSORPTION. This word signifies the process by which any substance whatever, solid, liquid, or gaseous, passes into the blood-vessels of a living animal. It is used, also, by writers of the past generation, as synonymous with atrophy, emaciation, or wasting.

The idea of absorption is so associated in the minds of most surgeons, with the name of John Hunter, that we will commence by giving an account of the very elaborate doctrines which this great man taught, although they are now quite superseded by the more simple and truthful views of the present generation.

The leading idea, which runs through all Hunter's speculations on this matter, is, that absorption is an active process, an operation, or action, performed by the *mouths* of the lymphatics, or, as he calls them, the *absorbent* vessels. "My conception," he says, "is that the whole operation of absorption is performed by an action in the mouths of the absorbents." "Physiologists," he says, "have supposed that the action of these vessels was similar to that of capillary tubes. But capillary tubes can only imbibe liquids, whereas solid matters, such as scirrhous tumors, and bones, may be removed by the absorbents. "Therefore," he continues, "unless we assume the existence of some solvent, to reduce these solid parts to a liquid state, such as would enable them to be imbibed by capillary tubes (which we have no proof of), we must suppose some action in the mouths of the absorbent vessels, capable of effecting the same purpose." "Consider," he says, "the mouths of different animals, and I will venture to say that the mouths of all the different animals have not a greater variety of substances to work upon than the absorbents have ; and we may observe that with all the variety of mouths in different animals, this variety is only for the purpose of enabling them to absorb solids, which admit of every variety of form, texture, &c., every one being capable of absorbing fluid matter, which admits of no variety."

Such, in Hunter's own language, were his ideas of the mechanism of absorption, and the action of what he called the *absorbent* vessels.

Respecting the uses and operations of these vessels, he considered them (to use his own words) "in two views ; first, as they absorb matter which is no part of the machine ; secondly, as they absorb the machine itself.

"The first of these is the well-known use, the absorption of matter which is no part of the machine. This is of two kinds ; one, exterior matter, in which may be reckoned everything applied to the skin, as also the chylé ; and the other, interior, such as many of the secreted juices, such as fat, and the earth of bones, &c. These are principally with a view of nourishment, and also answer many other purposes ; so that the action of absorbing foreign matter is extremely extensive, for, besides its salutary effects, it is often the cause of a thousand diseases, especially from poisons.

"In the second of these views we are to consider them as removing parts of the body itself, in which they may be viewed in two lights. The first is, where only a wasting is produced in the whole machine or part, such as the wasting of the whole body from an atrophy; or of a part, as the wasting of the muscles of the leg, &c. from severe injury done to some nerve, tendinous part, or joint, all of which I call interstitial absorption, because it is removing parts of the body out of the interstices of the part which remains, leaving the part still as a perfect whole. But this mode is often carried farther than simply wasting of the part; it is often continued till not a vestige is left, such as the total decay of a testicle, so that the interstitial absorption might be understood in two senses.

"The second is, where they are removing whole parts of the body. This may be divided into the natural and the diseased. In the natural, they are to be considered as the modellers of the original construction of the body; and if we were to consider them fully in this view we should find that no alteration can take place in the original formation of many of the parts, either in the natural growth, or that formation arising from disease, in which the absorbents are not in action and take not a considerable part; this absorption I shall call modelling absorption. If I were to consider their powers in this light, it would lead me into a vast variety of effects, as extensive as any principle in the animal economy, for a bone cannot be formed without it, nor probably many other parts. A part which was of use in one stage of life, but which becomes entirely useless in another, is thus removed. This is evident in many animals; the thymus gland is removed, the ductus arteriosus and the membrana pupillaris are removed.

"Absorption, in consequence of disease, is the power of removing complete parts of the body, and is in its operation somewhat similar to the first of this division, or modelling process, but very different in the interstitial, and therefore in its ultimate effects. This process of removing whole parts in consequence of disease, in some cases produces effects which are not similar to one another; one of these is a sore or ulcer, and I therefore call it ulcerative; in other cases, no ulcer is produced, whole parts are removed, and for this I have not been able to find a term; but both may be denominated progressive absorption.

"This process of the removal of a whole solid part of the body, or that power which the animal economy has of taking part of itself into the circulation, by means of the absorbing vessels, whenever it was necessary, is a fact that has not in the least been attended to, nor was it even supposed; and, having now been noticed, I mean to give a general idea of it. I may just be allowed once more to observe, that the oil or fat of animals, and the earth of bones, have always been considered as liable to absorption; and some other parts of the body being liable to wasting have been supposed to suffer this by absorption; but that any solid part should totally be absorbed is a new doctrine. This use of the absorbents I have long been able to demonstrate; and the first hints I received of it were in the waste of the sockets of the teeth, as also in the fangs of the shedding teeth.

"It may be difficult at first to conceive how a part of the body can be removed by itself, but it is just as difficult to conceive how a body can form itself, which we see daily taking place; they are both equally facts, and the knowledge of their mode of action would answer perhaps very little purpose; but this I may assert, that whenever any solid part of our bodies undergoes a diminution, or is broken in upon, in consequence of any disease, it is the absorbing system which does it."

Thus, according to the views of Hunter, all absorption whatever, and all processes of diminution of bulk or loss of substance, are due to the action of the mouths of lymphatic or absorbent vessels. They were believed to absorb chyle for nourishment, as well as poisons and medicines; they were the causes of emaciation of the whole body under illness, and of wasting of any part of the body from disease; they acted as the pruning knife, to check exuberance of growth; they were the means through which bones or other parts were wasted before an encroaching aneurism or tumor, and by means of which abscesses were brought to the surface; lastly, they were the agents by which ulceration was produced; "a process which," says Hunter, "answers very material purposes in the machine, without which many local diseases could not be removed, and which, if allowed to remain, would destroy the person. It may be called in such cases *the natural surgeon.*

"It is by the progressive absorption that matter, or pus, and extraneous bodies of all kinds whatever, in consequence of or producing inflammation and suppuration, are brought to the external surface; it is by means of this that bones exfoliate; it is this operation which separates sloughs; it is the absorbents which are removing whole bones, while the arteries are supplying new ones; and although, in these last cases of bones, it arises from disease, yet it is somewhat similar to the modelling process of this system in the natural formation of bone; it is this operation that removes useless parts, as the alveolar processes when the teeth depart or when they are removed by art, as also the fangs of the shedding teeth, which allow them to drop off; and it is by these means ulcers are formed." (*Hunter on the Blood,* chap. vi.; Palmer's edition, vol. iii. p. 463.)

In order to make our account of the Hunterian doctrine complete, we must add a few lines on his doctrine of the causes of absorption and disposition thereto.

The *final* cause or purpose of absorption is, he says, the removal of that which is useless or injurious; anything therefore which renders parts useless, or which so disturbs the vitality of parts as to render them unable to support themselves, are efficient or remote causes.

"The most simple object or intention of nature seems to be the removal of a useless part, as the thymus gland, membrana pupillaris, ductus arteriosus, the alveoli when the teeth drop; as the crystalline humour after couching, and probably the wasting of the body from fever, either acute or hectic. These parts are removed by the absorbents, either as useless parts, or (in the latter case) in consequence of strength being unnecessary while under disease, or such as not to accord with disease.

"It might be asked, as a question, whether the waste of the constitution in disease arises from the body becoming useless when under such treatment, as may be observed of muscles when their joint, tendon, &c., is diseased, or whether it accords better with the diseased state, and may even tend to a natural cure.

"From the above account of the final cause of the absorption of whole parts from disease, it would appear that they are capable of being absorbed from five causes. First, from parts being pressed; secondly, from parts being considerably irritated by irritating substances; thirdly, from parts being weakened; fourthly, from parts being rendered useless; fifthly, from parts becoming dead.

"The dispositions of the two parts of the living body," continues Hunter, "which absorb and are absorbed, must be of two kinds respecting the parts, one passive and the other active. The first of these is an irritated state of the part to be absorbed, which renders it unfit to remain under such circumstances, the action excited by this irritation being incompatible with the natural actions and existence of the parts, whatever these are, which therefore become ready for removal, or yield to it with ease. The second is, the absorbents being stimulated to action by such a state of parts, so that both conspire to the same end."

We have thus, at some length, and in his own language, detailed Hunter's doctrines of absorption, because, as we have before intimated, they form, as it were, part of the very basis, of the very substratum of principles which have been accepted by members of the profession, whose studies were carried on before the modern chemical and microscopic era. They form a great fact in the history of medicine, and even though now superseded, they deserve to be recorded, partly as an element of the progress of opinion, partly because amidst their error they present a certain grandeur of conception, and because they illustrate the mode in which one false step in reasoning may be the parent of infinite confusion.

We may pass over that incessant attempt to demonstrate final causes, which is so characteristic of Hunter, and in which he is sedulously imitated by a crowd of writers, who deceive themselves with the idea that they can penetrate the purposes and intentions of the Creator, although it is hardly possible to suppress a smile at the extravagant notion of an elaborate machinery being provided to effect the emaciation of illness, on the ground, that "strength is unnecessary while under disease." We may pass over also the extravagant *solidism*, which refers every change to the *action* of organs, and takes no account of their composition. Suffice it to say, that the very foundation of the doctrine is a mistake. The universal existence and agency of absorbent vessels, with or without mouths, is neither proved nor probable, and all the hypotheses of their various effects are so many dreams.

In fact, as Mr. Lane observed (in his article on the Lympathics, *Cyclop. Anat. and Phys.* 1841), we may "confine the functions of the lymphatic system within the bounds ascribed to the lacteal vessels during the process of digestion, viz. to select and prepare nutritious materials for the purpose of sanguification." Moreover, as Mr. Lane says, "we are going too far in attributing to the lymphatics the important and universal function of interstitial absorption in the process of growth and nutrition; and it is without sufficient proof that we admit the ulcerative process to be carried on solely by the lymphatic system." And it is curious to observe, that in the midst of Hunter's strong assertions of the fact of their operation, and his claims of being the first to announce it, he never once seems to feel it necessary to bring forward any proof whatever of the truth of what he asserts.

Let us now rapidly enumerate the various processes in the human body, which may be denominated by the term absorption; after which we shall make a few observations on the manner in which foreign substances may be introduced into the circulation, and the manner in which that introduction may be prevented; and then on the cases in which the surgeon is interested in the absorption of parts of the body, or of fluids infiltrating these, and on the medicines most calculated to produce that kind of absorption.

And in the first place let us remark, that *absorption may be considered in two lights, an active and a passive.* It may be considered, as Hunter considered it, an action, an operation, a work done by the agency of some instrument; or, on the other hand, as a mere passive or negative process; as a thing suffered.

If, for example, we speak of the lacteals selecting certain materials from the contents of the intestine, taking them into their own tubes by a particular mechanism, and passing them onwards, we speak of an active process, a work done by certain instruments.

When, on the other hand, we speak of the imbibition of any vapour by the lungs, or of any liquid by the skin, which those parts, by virtue of their physical conformation, cannot help imbibing if presented to them, any more than blotting-paper can help sucking up ink; or when we speak of loss of substance and *dépérissement*, which the whole body or any part of it suffers if deprived of its nourishment, it is evident that these processes are merely passive or negative. A poisonous vapour penetrates the substance of skin always, and this not by any action of those parts as living, but by virtue of their composition whether living or dead. To speak, too, of the wasting of illness as an absorption, when it is merely the negation of nourishment, is surely an abuse of the term.

Now most of the cases described under the title *absorption* are of the negative or passive kind.

In the first place there is the imbibition, which takes place through all surfaces, of matters presented to them, whether liquid, or gaseous, or solid if divided to a sufficient degree of minuteness. Physical imbibition, by virtue of porosity and of mutual attraction between the imbibing membrane and the gas or liquid imbibed, is the proper name of this form of absorption. The imbibition of oxygen by the skin and lungs; the imbibition of water, and of nutrient fluids by tongue, throat, stomach, and every part of the alimentary canal, are examples of this process under the ordinary conditions of health; whilst the absorption of chloroform and similar vapours by the lungs, of hydrocyanic acid by the mouth or skin, of mercury in the form of vapour or ointment, of nutrient or anodyne enemata by the rectum, are examples of the same process, owing either to accident or to the intention of the medical practitioner. But for this kind of absorption no special agents or set of vessels are required; it is a function performed by every animal tissue, by virtue of its physical properties.

In the second place, there is the emaciation of the whole body in illness; or the removal or shrinking of parts rendered useless in the course of nature, as the ductus arteriosus and membrana pupillaris; the formation in the fœtus of the apertures of the eyelids, mouth, and rectum; and the decay of certain organs under conditions of disease; as, for example, the withering of the muscles of a limb which is paralysed; or of certain sets of muscles whose nerve is diseased, as happens sometimes after sciatica. This class of instances ought rather to be designated instances of *atrophy* than of absorption. For it does not happen that the withered parts are absorbed to an extraordinary degree, but that being wasted in the ordinary course of nature, they are not replaced. Just as a house may crumble away under the action of the elements, if never repaired, although no active steps be taken to pull it down. In this class, as in the preceding, there is no evidence that the lymphatic or *absorbent* vessels are in any way concerned.

As a third class of instances of absorption, we may take the cases in which, not a natural structure, but a deposit or exudation, liquid or solid, caused by disease, is removed. For example, the exudation which closes the pupil in iritis, or fills the pleura after inflammation; or a common extravasation of blood in consequence of a bruise. In the case of a morbid exudation, the first condition necessary for its absorption is, that the blood shall no longer be loaded with the materials out of which it is formed; that the gouty or syphilitic, or hyperinotic crasis, as the case may be, shall be extinguished. The second is, that the exudation be not of a sort endowed with independent vitality and power of growth; that it be not developed into permanent tissue. If those two conditions be obtained,—if, for example, the source of a pleuritic exudation be eliminated, before the exuded matter has passed into the permanent form of areolar tissue, the morbid deposit will most likely waste of its own accord. If, as in the case of cancer, both the blood continues to supply morbid material, and the morbid exudation, where deposited, grows and propagates itself of its own inherent forces, there will be little hope of disappearance by absorption.

The instance of extravasated blood ought rather to come under the head of absorption of foreign matters, for it follows the same laws. The serum is first absorbed; then the blood corpuscles are broken down, and the colouring matter dispersed in the interstices of the tissues, which imbibe it; and there it is gradually removed by means of the incessant interchange which is going on between the fluids in the blood-vessels, and those in the inter-vascular spaces, by which the blood is, as it were, after a short time washed out.

In this third class of cases, as in the preceding, there is no evidence that the lymphatic system takes any share in the absorption.

The fourth class of cases, is one of those which may be called active absorption, and includes the operations of the lacteals and lymphatics. As our purpose is surgical and not physiological, we cannot enter at length into the nature of their functions, or into the various disputations of which those functions have been the subject. Suffice it to say, that whilst every part of the alimentary canal has the power of absorbing some nutritive liquids—soup and wine for example, may be absorbed by mouth and rectum—the lacteal vessels seem to seek and absorb some special elements; that these are important, is evident from the ill effects which ensue if they are intercepted by disease.

What precise elements they are, which the lacteals select to the exclusion of others, we know not; neither do we know the earliest steps of the process. We do not exactly know, for instance, the mechanism by which they select chyle from the contents of the intestines.

The brothers Goodsir, in their very able and interesting *Anatomical and Pathological Observations* (Edinburgh, 1845, p. 8, et seq.), state that the terminal loops of the lacteals, in the villi of the intestines, are surrounded by a crowd of minute cells; and on this fact they built up a very ingenious theory, in reference to absorption in health and disease;—in which the enthusiasm with which the new cell-doctrines were embraced, is apparent.

They believe that these cells have the power of attracting certain matters from the contents of the intestines; and that when filled they burst and discharge their contents around the looped extremities of the lacteals, by which they are absorbed.

"Not only are cells," they say, "the germs of all the tissues, but they are also the immediate agents of secretion. A primitive cell absorbs from the blood in the capillaries, the matters necessary to enable it to form, in one set of instances, nerve, muscle, bone, if nutrition be its function; milk, bile, urine, in another set of instances, if secretion be the duty assigned to it. The only difference between the two functions being, that in the first, the cell dissolves, disappears *among the textures*, after having performed its part; in the other it dissolves, disappears, and throws out its contents *on a free surface*. Now, it will be perceived that before a cell can perform its function as a nutritive cell, or as a secreting cell, it must have acted as an absorbing cell. This absorption, too, must necessarily be of a peculiar and specific nature. It is in virtue of it, that the nutritive cell selects and absorbs from the liquor sanguinis, those parts of the latter necessary for building up the peculiar texture of which the cell is the germ. It is in virtue of this peculiar force, that the secreting cell not only detects and absorbs, but also in some instances elaborates from the same common material, the particular secretion of which it is the immediate organ. *And it is by the same force that the cell becomes the immediate agent of absorption in certain morbid processes.*"

From the foregoing passage, it will appear that the Goodsirs attributed to cells the power of absorbing materials from the intestines, which materials, by their bursting when ripe, they discharged into the interstices of the roots of the lacteals, whence absorption by the lacteals took place afterwards. They believed further, that this was not only a type of the usual office of cells in nutrition, secretion, and absorption, but that processes of diseased absorption were effected in the same way. To this last point we shall return presently—our present purpose is with the function of the lacteals and lymphatics, so far as they illustrate any part of surgical pathology.

Whatever may be the interpretation of the origin of the lacteal vessels, the nature of the lacteal and lymphatic glands is a perfect mystery. These consist of masses of nucleated cells, either disposed within or around (it is not certain which) a mesh of lacteal or lymphatic vessels. That they are often the seats of inflammatory exudation, in certain individuals when there is any injury, abrasion, ulceration, or other cachectic process at any part whence their radicles are derived, is familiar enough. What their functions are in health, what changes they produce on the liquid that filters through them, and what it is which makes them *take on* inflammation after some injuries, and not after others, are things quite inexplicable.

The lymphatic vessels (or *absorbents*) seem to have the office of absorbing everywhere any excess of liquor sanguinis which may be exuded in the process of nutrition. They may absorb, as we have just intimated, a liquid contaminated by unhealthy exudation; and such liquid may produce inflammation and abscess at any part of their course up to the nearest lymphatic ganglion, or beyond. They may also absorb, from certain morbid growths, as cancer, and epithelioma, and enchondroma, a liquid containing the germs of those growths, which may be developed at the nearest gland, but why this should be the case with some tumours and not with all, is another mystery.

Thus it will be evident, 'that the lymphatic vessels and glands, in their function as absorbents, present many points of interest to the surgeon. But there is one important morbid process which Hunter ascribed to their agency, which modern pathology compels us to deny, and that is *ulceration*. Not only is there not the shadow of a proof that this process is in any way or in any degree effected by the lymphatic vessels, but the eye affords the clearest evidence that it consists in the piecemeal liquefaction and destruction of the ulcerating tissue, which, before it ulcerates is most probably infiltrated with some unhealthy exudation. Ulceration is, in fact, a variety of mortification—a sloughing in detail. It ranks with other cases in which an exudation is melted down, and the tissues which are infiltrated share in the destruction. This is the case in every abscess; and this is the process by which abscesses are brought to the surface, but in this the lymphatics take no share.

We will now go on to a fifth class of cases; which may also, so far as proved, be considered cases of active absorption, and which may be comprehended under the idea, that rapidly growing cells may take into themselves the solid and liquid substances surrounding them, and grow at their expense. The facts of this class of cases and the history of the opinions which have been founded thereon, may be shortly expressed thus:—

During the Hunterian era of modern surgery, every morbid process was spoken of as an *action* of the parts concerned, and more especially of their vessels; for the fact was overlooked that many most important steps in organisation occur long previous to the appearance either of blood or blood-vessels. British surgeons considered it orthodox to state that it was the *action of the vessels* which was the cause of all growth, all secretion, and all disease; and in particular, as we have repeated in this article, all absorption, wasting, and ulceration whatever, were assumed to be the work of the lymphatic vessels.

In 1833, the established doctrines respecting ulceration received a rude shock from Mr. Aston Key (*Med. Chir. Trans.* vols. xviii. xix.), who asserted his belief that ulceration in general was a process of liquefaction, or disintegration, or disorganisation of the ulcerating tissue;—"a process," he calls it, "analogous to the softening attending suppuration; it is a degeneration of tissue; a change in the affinities existing between its component parts, by which it becomes changed from a solid texture into a fluid inorganic mass." But in addition to this form of ulceration, he described another, by which he believed bone and cartilage to be more frequently affected. And this other form of ulceration consists in this; in the existence of an *absorbing tissue* which grows upon and eats into the cartilage. This absorbing tissue, in some cases of ulceration of cartilage, he believed to be produced by a transformation of the synovial membrane, in other cases, to be developed as a fresh morbid production of the scrofulous order, from the articular extremity of the bone. We cannot here enter into any details on the subject of ulceration of cartilage, suffice it to say, that Key looked upon that pulpy and gelatinous membrane so often developed on the surface of diseased cartilages, and apparently fitting into every groove and inequality of the surface, as the agent by which their absorption was effected. In the same manner he believed bone to be absorbed by the agency of granulations, and ligament likewise.

"In ligamentous fibre," he says, "the process of ulceration appears to be accompanied with some peculiar circumstances. The ligament, instead of preserving its usual form and size, becomes distended and feels pulpy. When cut into, the fibres are found to be separated from each other by a vascular structure, which upon being injected, has a villous appearance. * * It is not improbable that *the ligamentous fibres themselves are passive in the ulcerative process*, which there is some reason for believing is performed entirely by the vascular tissue that surrounds them."

Thus far then, we have seen Mr. Key maintaining that one tissue can be absorbed by another actively growing tissue, on its surface, or in its interstices. This idea was attempted by the Goodsirs to be elaborated into a general law; applicable not only to the absorption of chyle by the lacteals (which we have already spoken of) but also to many other cases, including the absorption of nourishment by the placenta and including ulceration.

An ulcer, according to the Goodsirs, is not a chasm formed by the action of the absorbents, as Hunter said; nor yet resulting from the liquefaction and disintegration *pure et simple* of the diseased structure; but a chasm resulting from the action of a peculiar cell growth, which, as they allege, covers its surface, and grows at the expense of the tissue which it covers, and then immediately decays and disappears.

This view of ulceration, presents the strongest analogy to the growth of *dry rot*, and of other destructive fungi upon or within the substance of wood or stone; producing speedy ruin by first living upon the textures they invade, and then perishing themselves.

That it is probable that some tissues do actually disappear in this manner is shown by what takes place in the absorption of bone and teeth. This process was described as to all essential points, by the Goodsirs in their essays before quoted; but it was afterwards more fully detailed by Mr. Tomes and Mr. Campbell De Morgan, in a paper "*On the Structure and Development of Bone*," which was published in the *Philosophical Transactions* for 1853.

In the first place, these gentlemen show the well-known fact, that the solid block of cartilage, which is laid down as the precursor and substratum of bone, soon becomes tunnelled out into canals (called Haversian canals or spaces), in order to permit of the access of blood-vessels previous to the conversion of cartilage into bone. For, as we need scarcely say, whilst cartilage is non-vascular, true bone is always abundantly supplied with red blood.

In the next place they show that bone, once fully formed, is by no means a permanent substance, but that it is subject to incessant absorption and renewal. A section of a long bone displays the bony tissue arranged in concentric rings around the blood-vessels which occupy the Haversian spaces. But it is evident on inspection, that the Haversian systems of rings are by no means universally perfect and regular; on the contrary, they display a multitude of irregular patches of laminæ, looking like disjointed and *unconformable* patches of strata in a geological section, and testifying to the fact, that just as cartilage originally is tunnelled out for the formation of the first blood-vessels, and of the concentric rings of bone which are formed around those blood-vessels, so bone itself is incessantly undergoing a similar process. New longitudinal channels are continually being excavated, and continually being filled up with new bone; so that this tissue undergoes day by day change of material, the old portions being removed interstitially and new deposited.

As to the mechanism by which this absorption of bone is effected, the opinions of Mr. Tomes and Mr. De Morgan are almost identical with those of the Goodsirs. They believe that an active cell growth is the agent by which the bone is absorbed and passed into the circulating fluid, both normally in the healthy processes of absorption and nutritive renewal, and in disease. And they believe that it is by means of a similar cell growth that the fangs of the milk teeth are absorbed.

"When a portion of dead or dying bone," says Mr. Goodsir, "is about to be separated from the living, the process which occurs is essentially the same as that which has been described. The Haversian canals which immediately bound the dead or dying bone are enlarged contemporaneously with the filling of their cavities with a cellular growth. As this proceeds contiguous canals are thrown into one another. At last the dead or dying bone is connected to the living by the cellular mass alone. It is now loose, and has become so in consequence of the cellular layer which surrounds it presenting a free surface and throwing off pus."

In the same manner Messrs. Tomes and De Morgan describe the hollowing out of the medullary cavity of the end of a femur—exposed in a stump,—by a dense pale pink tissue, consisting of nucleated cells; which evidently increased as the bone decreased. "The cellular mass," they say, "was tolerably vascular, but the vessels did not reach the surface in contact with the bone; hence they could not be regarded as having any immediate action in the process of absorption."

"If," they continue, "we examine the fangs of temporary teeth when they are undergoing removal, similar states to those described in the portion of femur will be found to obtain. A similar cellular mass will be found closely applied to that surface of the tooth which is in process of removal." "It is difficult to resist the belief that the cells which lie in contact with wasting bone and dentine take up those tissues and use all or part of them for their own increase and multiplication, or else form a medium through which they are passed into the circulation."

These gentlemen believe that ivory pegs, such as are sometimes driven into bone, to excite the reparative processes of the fracture, may be absorbed by the cell growths of the Haversian spaces of the bone around. (See *Macartney, on Inflammation*, p. 46; and an article on *Bone*, in *Brit. and For. Med. Rev.* by *R. Druitt*, July, 1854.)

Now let us sum up the various facts and doctrines which relate to this, our fifth category of cases of absorption. It is alleged, as a sort of general law, that rapidly growing cells may absorb tissues with which they are in contact. Leaving out of question the supposed cell growths in the villi of the intestines, and in the lacteal and lymphatic glands, we find the facts brought forward in proof of the doctrine to be first, a supposed layer of cells on the surface of all ulcers. But this is purely hypothetical, and has never been demonstrated, and may be dismissed without further comment.

Secondly, there is the false membrane on the surface of cartilage, which was supposed by Key and Goodsir to erode that structure in ulceration. But it has been fully shown by Redfern that the changes in cartilage are intrinsic and original, and not mere consequence of the action of any membrane applied to the surface.

There remains then only the case of bone and teeth, in which it certainly is highly probable, if not proved to demonstration, that absorption in health and disease, for nutrition and for destruction, is effected by means of a cell growth.

But then it must be remarked, that the cells which absorb bone and tooth, do not appear to be invested with that function specially. On the contrary, the same cell growth which begins by tunnelling out a new Haversian space in bone, ends by being converted into new bone, to fill up the very void it had created. And the vascular growth which absorbs the fang of a milk tooth, when that tooth has dropped out, grows up to the level of the gum, becomes invested with epithelium, drops its absorbent function, and comports itself like ordinary gum.

Moreover it must be observed, that absorption is not the function of all rapidly increasing cell growths in contact with teeth, as, for example, in epulis the fangs of the teeth are not absorbed.

The writer has often made investigations of muscle infiltrated with cancer, to see whether in this case of a most vigorous cell growth intruding into another tissue, anything like absorption, such as that of bone under similar circumstances, could be detected. But it could not. In the case of a heart which presented several nodules of cancerous deposit, abruptly defined, it appeared as if the muscular fibres infiltrated with the new growth were gradually starved, atrophied, decolorised, and degenerate, but not as if they were for a long time bodily *absorbed* by the new growth.

There is yet another class of absorption; that which Hunter called the *progressive;* such as happens when the sternum or vertebræ perish before the progress of an aneurism. Why the presence of a growing tumour adjacent to a bone should cause it to waste, we cannot at present explain.

In the foregoing columns we have attempted a rapid review of all the various processes which have been formerly, or are now, denominated by the term absorption. We have seen that these processes are most various. There is the introduction of foreign matter into the blood; either as food or poison, whether specially through the lacteals or by imbibition of surfaces in general. There is the wasting of natural tissues, general or local, when nutrition is impeded either from natural causes, or from disease. There is the removal of morbid exudations and deposits. And to these instances, for some of which absoption is not a proper name, as not expressing the prominent condition concerned, there has been added ulceration, which has no title to the term absorption at all. We have also seen that, even in the instances which may pass under that term, the vessels called absorbent, are really not concerned, for the most part.

Now let us speak of the second branch of our subject, and give such particulars respecting the introduction of foreign matters into the veins as may interest the surgeon.

When there is any difficulty of swallowing, or of digesting food when swallowed, it is expedient to inject nourishing fluids into the rectum, or even to bathe the hands and feet with them, that they may be absorbed from thence. It is often desirable also, to introduce narcotic, or saline, or acid, or alkaline remedies, or mercury through the skin or bowels. The general principles with which the surgeon should be acquainted, seem briefly to be these: —

The first point is to cause the liquid, (or substance which is to be absorbed,) to be imbibed by the surface it is presented to. Now, there is no liquid from which the animal tissues universally have so much attraction as they have for water. This universal solvent forms by far the greater portion of their weight, and is imbibed with facility by them all; whilst saline solutions of all kinds are imbibed far less readily. It follows, therefore, as a general rule, that the more diluted solutions are the better. Alcohol, ether, oils and most other liquids, are imbibed to a certain degree; but not acids or corrosive solutions, strong enough to decompose the skin, and to coagulate the blood in the veins. If a narcotic substance is intended to be absorbed by the skin, it should be combined with a liquid which will not easily evaporate and so leave it dry, in which state it can scarcely be absorbed at all. For this reason glycerine is a better menstruum than either water or alcohol for liniments of belladonna, opium, and the like. If the matter to be imbibed is a semi-liquid, as the mercurial ointment, friction is of use in forcing it through the cuticle.

Nor must it be forgotten, that the cuticle is, as it were, an organic varnish; a layer of scales, specially designed by nature to limit the transmission of liquids, whether from within or from without. We need not recall to the memory of the surgeon how soon a subject for dissection dries up if the cuticle be removed; and it is equally certain that the penetration of all substances into the tissues is greatly promoted if the cuticle be removed. Hence, many substances which may be applied to the unbroken cuticle with safety, would be most dangerous if applied to a blistered surface, from the greater completeness and rapidity of their absorption; and the surgeon may often avail himself of very small blisters, in order to introduce morphia, or other narcotics near any painful part. Such medicines have also been introduced by inoculation or puncture; or even by injection of solutions into the areolar tissue; but these latter processes are painful and not often employed.

When the material to be absorbed has penetrated the tissues, the next object is, that it should enter the blood-vessels, and be carried away as rapidly as possible by the current of blood. This it is after all which is the truly efficient instrument of absorption, for the blood continually passing, carries off whatever is imbibed by the coats of the blood-vessels, and so keeps up a constant current towards itself. It must be evident, therefore, that everything which renders the circulation rapid promotes absorption; whilst everything which causes stagnation of blood has the contrary effect. Thus if the physical qualities of the material which is desired to be absorbed are such as to produce a *stasis* in the blood, as, for example, when saline or metallic solutions are used in too concentrated a form, and more especially if they are such as to cause coagulation, absorption will be greatly hindered. The density of saline solutions should theoretically be less than that of the liquor sanguinis. (*Liebig, on the Motion of the Juices*, Lond. 1848.)

It appears that the more empty the blood-vessels the more easily they absorb; whilst filling them even with warm water, as was done by Majendie, impedes absorption.

Some attention is expedient to the channels by which any given substance may be eliminated. Thus if it be deemed advisable to impregnate the blood with mercury, it should be introduced through the skin, or mucous membrane of the fauces, rather than through the stomach, from which it would pass to the liver and bowels, organs by which the elimination of the metal is most easily effected.

The principles on which the absorption of deleterious matters may be hindered, will be readily seen from what has gone before. Suppose any poison to have come into contact with the abraded cutis, the application of some powerful cauterant, as the nitric acid, nitrate of silver, or of mercury, actual cautery, alcohol, turpentine, &c., even if not capable of decomposing the poison before it is imbibed by the vessels, will produce a local inflammation, with stagnation of blood, and exudation, which will be unfavourable to absorption. The mode in which ligatures, exhausted cupping glasses, and suction of all sorts hinders absorption must be obvious.

It may be noticed too, that in cases in which there is a liability to infection from liquid or gaseous animal poisons; for instance, in the case of surgeons who dress erysipelatous wounds, or have to breathe a tainted atmosphere, the maintenance of a high state of health by good diet, stimulants, and exercise, if it does not render the veins less liable to imbibe a poison, will render the blood far less liable to be influenced by it.

In reference also to preventing the absorption of erysipelatous miasm by wounds and abrasions, we may point to the expediency of sealing up such injuries from the contact of hospital air, by means of Friar's balsam, collodion, or solution of the chloride of iron; which are far better adapted as applications to wounds, under such circumstances, than water dressing and other moist applications.

We now approach the third and last part of our subject, which is the consideration of the principles by which the surgeon is guided when he desires to promote the absorption of morbid exudations of various kinds, solid or liquid. Here we may claim the indulgence of our readers for the slightness of the sketch which we are able to give; but it must be remembered that almost half of the practice of physic is involved in these principles.

The exudations of which the surgeon may desire to promote the absorption may be of infinite variety;—pure blood; some of the elements of blood, either healthy, or combined with, as we may assume, various noxious substances, or in various states of decomposition; as the serum, fibrine, and pus, which are the products of various forms of inflammation:—again, they may consist of blood elements which have been developed into areolar tissue, or into bone, in consequence of common inflammation;—or of the various adventitious growths, which result from certain conditions of the blood, such as tubercular deposits, so called;—the bony and cartilaginous enlargements of gout, rheumatism, or syphilis:—the whole catalogue of tumours, fibroplastic, glandular, enchondromatous, epithelial, and cancerous; growths too, which come under the term hypertrophies, and tumours of which it is doubtful whether they result from some blood taint or some error in the original scheme of growth, such as wens, nævus, and the like. This list is tolerably extensive; but we desire to bring before the mind at one view, all the cases in which absorption of exudation in any stage of development is desirable. As we have said, it is general principles only that can be treated of here: details will be found in other articles.

In this matter, three things have to be considered:—1. The state of the blood; 2. the state of the exudation as to development and vitality, or the capacity therefor; 3. the state of the parts in which the exudation is situated.

The first point is, in most cases, the one important thing, as is shown more at length in the article Inflammation. Take exudations as a whole, and it will be found that by far the greater number vanish spontaneously, so soon as the blood is purified from the particular element which was the cause of the mischief.

But, in the second place, the condition of the exudation must be regarded. Some there are, which are in such a state from decomposition, that their absorption into the blood would scarcely be desirable if possible. Such are the fluids exuded in carbuncle and unhealthy suppurations, or in which pus has become putrid from admixture with secretions of the bowels, or with urine. For such cases, free evacuation and not absorption is the thing to be desired.

Some matters there are too, of which the absorption would seem to be clearly against nature. For example, cutaneous cysts filled with epithelium, and commonly called wens, can by no known means be made to absorb their contents; and it would seem manifestly contrary to reason to expect that excrementitious substances, such as cuticle and sebaceous matter should be taken into the blood again by the very organ whose function it is to eliminate them.

Dismissing then these cases, we have to pass in review the far more difficult and complex cases in which it is sought to cause the absorption of exudations which have acquired some degree of development, and have, as it were, made good their footing in the animal economy, and which persist, even though the condition of blood which originally caused them has ceased; or which when once existing have the power of propagating themselves and keeping up a blood infection.

It is certain that the organic elements, of which some parts of the body are composed, are not endowed with more than very transitory powers of life. Hair, cuticle, epithelium, and gland cells are incessantly being shed and renewed. The vital history of the milk teeth is obvious. What the processes of removal and renewal are in bone, we have learned from the before-quoted researches of Mr. Tomes and Mr. De Morgan. And it is *probable* that the other portions of the framework of the body, including skin, areolar tissue, ligament, basement membrane and sarcolemma of muscle are also subject to similar renewal, although the fact has never been demonstrated so completely as it has been with respect to bone. We speak here of the more inert portions of the body: not of active parts, such as muscle, whose rapid solution and replacement is morally certain. But regarding the time which any portion of the skin or ligament ought normally to last, before it is renewed, we know nothing. Beyond the *general* fact, too, that abundant nourishment and a brisk circulation are favourable to the maintenance of all tissues, and the converse, we know little, if anything, of *special* means for promoting the growth or the decay of any tissue. We can, by starving the whole body, or by robbing the food of essential nutritive elements, cause a general waste of fat, areolar tissue, muscle, and bone. We know further, that in cases of insufficient nourishment or mal-assimilation, some tissues are prone to degeneration: in one patient the hair falls, in another the teeth decay, in a third the nails cease to be regularly secreted, in another the callus uniting a fracture may disappear, in another the cornea or articular cartilages will ulcerate; but we know little of special means of effecting the increase or decay of any tissue in particular, beyond the general one of increasing or decreasing the supply of food, and the general waste by exercise, air, and excretion. We have no special means, besides, by which we can promote the growth, or cause decay specially, of hair, cuticle, bone, cartilage, or gland, or ligament.

The same is true with regard to adventitious and intrusive growths. We know little of the vital history of any of these; whether, for example, the mass, which is originally deposited as cancer or enchondroma, remains the same throughout its career, or whether it is subjected to a process of absorption and renewal, like normal tissues. We do not know how to eliminate the pabulum of these tumours in the blood, nor do we know what complementary substances are capable of neutralising it.

Exudations further may perish, and pass into a state of degeneration, in which they are quite harmless, and may exist during the whole of life in the interstices of tissues, but yet seem capable of very slow absorption, if any. For example, the common so-called "yellow cheesy tubercle" is a mass of decayed exudation, most generally of imperfect fibroplastic matter and epithelium in the lungs, or of some unhealthy fibrinous matter in a lymphatic gland; it is perfectly dead, and in a state of fatty or earthy degeneration, consisting of amorphous granular matter, oil globules, cholesterine, and earthy matter. Masses of this sort may remain harmlessly in the lymphatic glands for years. Portions of cancer or enchondroma, or of any other tumour may pass into the same state, undergoing the slowest possible absorption, first of the oil, then of the granular matter, and leaving a putty-like mass to the end of life.

In the third place, the state of the parts in which an exudation is situated may be an obstacle to its removal. A slow circulation generally; and of that of action of the veins in particular; relaxation and want of tone in the skin, muscles, and areolar tissues, are common causes. In acute hydrocephalus, the difficulty or impossibility of causing absorption of the effused serum are notorious; but death more probably results from the injury done to the structure of the brain, which renders absorption of the serum impossible, than from the mere presence of the serum. There are many surfaces which seem to lose the power of absorbing serous liquid, although such liquids may be readily enough taken up by the areolar tissue, as in the case of ganglion and hydrocele. In the case of cystic tumours, the mere absorption of the fluid contents of the cysts, is but a small part of the morbid conditions.

It remains for us shortly to enumerate the remedies which in various modes influence absorption, and the principles of their operation.

Air, abstinence, exercise, and purgative medicine may be said generally to promote absorption of the entire body. Copious libations of water, and diuretic medicines in general, especially the alkaline salts, have the same effects. It has been proved that both water and potass, in passing through the blood, cause an excess of solid matter to be excreted by the kidney. The solution of caustic potass is reputed to be of service in causing absorptive effect. (See TUMOURS.) The tincture of cantharides, it is said, has succeeded in removing the fluid in hydrocephalus. Amongst purgatives, the compound jalap powder and elaterium have the greatest virtue in cases of serous exudation, since they rob the blood so suddenly of large quantities of watery fluid that it more readily imbibes any serum that may be extravasated. Mercury, in its various preparations, is the medicine more universally relied on than any other for the power of causing absorption. And here it may be useful to remark, that it may be employed in two distinct modes, which should never be confounded. One is, when it is intended to abstract from the blood any redundant or morbid material, and to discharge it by means of abundant secretion from the liver. Another is, when it is intended to accumulate to a certain degree in the blood (the test of which is either slight ptyalism or dysentery), and to produce, as is believed, certain changes in the condition of an exudation which shall render it more easily absorbed. These two modes of operation, which ought always to be kept distinct in the mind of the practitioner, may yet to a certain degree be carried on together in some cases. The first, or evacuant operation, is to be effected by tolerably large doses, combined with drugs which shall cause purgation; and this is best adapted for early stages of disease, as a preventive of exudation, or to remove it soon after it is deposited. The other, or mercurial impregnation of the blood, is supposed to exert a *catalytic*, or (if we may discard the absurd use of new Greek words, which explain no more than terms already employed) a *dissolvent* action over exudations which are already undergoing development.

The cases in which this mercurial action is most beneficial are decidedly those in which there is a syphilitic taint; next, those of fibrinous interstitial deposit — thickenings of membranes, opacities of the cornea, and adhesions generally; but for inflammations of mucous membranes, erysipelatous, diphtheritic, and atonic exudations it is not adapted. (See INFLAMMATION.)

Next to mercury, the iodide of potassium is the most universal absorbefacient, especially in cases of exudation, or of bony deposit connected either with syphilitic, gouty, or rheumatic taint. Colchicum, especially the acetic extract in small doses, has considerable power over gouty exudations; and antimony over acute exudations in the lungs. Blisters and counter-irritants generally may be supposed to rob the blood, or the tissues near enough to be influenced by them, of certain elements which are abstracted from the seat of exudation. Friction and cold affusion promote a more rapid circulation, and so hasten the disappearance of exudations after the inflammatory stage has passed. Pressure operates in two ways — by preventing stagnation in the veins, and supplying the place of skin or muscle which have lost their tone, and cease to give normal support to the vessels. The leg, the scrotum, and abdomen are the parts to which pressure may be applied most beneficially with this intention. But pressure may be applied for another purpose, namely, to *starve* a tumour by limiting the supply of blood to it. Illustrations of this purpose of using pressure will be found in the articles on CANCER, TUMOURS, and OVARIAN DROPSY. To carry out the same intention most effectually, the arteries supplying a tumour are sometimes tied.

The remedies we have hitherto spoken of act by abstraction for the most part. But in the case of exudations arising from tenuity of the blood, the proper remedies are substances which supply the wanting elements, or which act complementarily to elements in excess. Hence, wine, good diet, cod-liver oil, and bark are of service in atonic effusions —and, above all, iron, which is almost a specific. The potassio-tartrate, and other combinations with diuretics, is of service at the close of inflammatory attacks that have left the lungs or other organs œdematous; the tincture of the sesquichloride, in doses of ten minims, combined with one-sixteenth of a grain of corrosive sublimate, is of great service in atonic engorgements of the womb. The corrosive sublimate, with tincture of bark, is a well-known remedy of analogous virtues.

There is one remaining mode of procuring absorption, which was idealised by Hunter when he spoke of "an action excited by irritation being incompatible with the natural actions and existence of the parts, which therefore become ready for removal;" or, in more modern phraseology, a part may waste and be atrophied if some of the conditions requisite for its life and health be interfered with. Thus the gums, if impregnated with mercury, may waste. So the testicle may waste if deposits have taken place in it, which first of all starve the natural tissue, and then undergo atrophy themselves. Such is sometimes the result of inflammation of muscle. This process may be imitated, and tumours caused to waste by exciting inflammation or a new interstitial deposit throughout their substance, either by setons, or by stimulating or astringent injections.—[*R. Druitt.*]

ACETATE OF LEAD. See Lead.

ACETATE OF MORPHIA. See Morphia.

ACETIC ACID. Strong acetic acid contains about 30 per cent. of absolute anhydrous acetic acid. The acidum aceticum dilutum of the present pharmacopœia contains about four and a half per cent of the same substance.

Acetum destilatum, or distilled vinegar, is of similar strength.

Distilled vinegar, mixed with farinaceous substances, is frequently applied to sprained joints, and, in conjunction with alcohol and water, makes an eligible lotion for many cases in which it is desirable to keep up an evaporation from the surface of inflamed parts. Vinegar was once considered useful in quickening exfoliations, which effect was ascribed to its property of dissolving phosphate of lime. Its good effects on burns and scalds were taken particular notice of by Mr. Cleghorn, a brewer in Edinburgh, whose observations were deemed by Mr. Hunter worthy of publication. (See *Med. Facts and Obs.* vol. ii.)

Diluted vinegar is alleged to be the best lotion for freeing the eye from any small particles of lime which happen to have fallen into, and become adherent to it, or the inside of the eye-lids. (See *A. T. Thomson's Dispensatory*, p. 8, ed. 2.)

Distilled vinegar is sometimes employed as a styptic for stopping hemorrhage from the nose. With this view, it may be used either as an injection, or a lotion, in which lint is dipped, and introduced up the nostril. It is often used to lessen the disagreeable smell of sick rooms. Strong acetic acid is a good application for the destruction of warts and corns, care being taken not to injure the surrounding skin with it. (*Brande's Manual of Pharmacy*, p. 9, 8vo. Lond. 1825.)

The pyroligneous acid, which is merely strong acetic acid impregnated with empyreumatic oil and bitumen, is commended by Mr. Buchanan, of Hull, as an ingredient in applications to the ear for the relief of certain cases of deafness. (See *Illustrations of Acoustic Surgery*, 8vo. Lond. 1825.)

ACHILLES, *Tendon of.* See Tendons.

ACTUAL CAUTERY. See Cautery.

ACUPUNCTURE (from *acus*, a needle, and *pungo*, to prick). The operation of making small punctures in certain parts of the body with a needle, for the purpose of relieving diseases, as is practised in Siam, Japan, and other oriental countries, for the cure of headaches, lethargies, convulsions, colics, &c. (See *Phil. Trans.* No. 148; and *Wilh. Ten. Rhyne, de Arthritide, Mantissa Schematica, &c.* 8vo. Lond. 1683.) Dr. Elliotson has tried acupuncture extensively, and his experience coincides with that of Mr. Churchill, confirming the fact that, as a remedy for chronic rheumatism, it answers best where the disorder is seated in fleshy parts. He also finds, that one needle, allowed to remain an hour or two in the part is more efficient than several used but for a few minutes. (See *Med. Chir. Trans.* vol. xiii. p. 467.) Neuralgia is a disease in which the practice may deserve trial. Local paralysis is another. In a modern French work, it has been highly commended: but the author sets so rash an example, and is so wild in his expectations of what may be done by the thrust of a needle, that the tenor of his observations will not meet with many approvers. For instance, in one case, he ventured to pierce the epigastric region so deeply that *the coats of the stomach were supposed to have been perforated: this was done for the cure of an obstinate cough, and is alleged to have effected a cure!* But if this be not enough to excite wonder, I am sure the author's suggestion *to run a long needle into the right ventricle of the heart*, in cases of asphyxia, must create that sensation.

See *Berlioz*, Mém. sur les Maladies Chroniques, et sur l'Acupuncture, p. 305—309. 8vo. Paris, 1816. *Churchill* on Acupuncture, 1824; *Dantu*, Traité de l'Acupuncture, 1826.

ADHESION. A term signifying the union of opposite surfaces. This is exemplified in the union of Wounds, of Fractured Bones and of Ruptured Tendons, to which articles, as well as to that on Repair, we may refer for the history of adhesion so far as it is related to the effect of injury.

The material by which adhesion is effected is the fibrine, or coagulable lymph of the blood, which may be exuded either without inflammation in the most favourable instances of repair, or, in consequence of inflammation, which, when it stops short with the production of fibrinous exudation, and does not cause suppuration, is erroneously called the Adhesive Inflammation. (q. v.)

The fibrine exuded either with or without inflammation is of three destinations. 1. It may be quickly absorbed (see Absorption). 2. It may undergo liquefaction into pus (see Suppuration); or may slowly waste and degenerate into a stuff looking like putty; or, 3. It may undergo development into areolar tissue, in the form of *cicatrix*, false membrane, bands of adhesion, and so forth.—[*R. Druitt.*]

AGARIC. A species of fungus, growing on the oak, and formerly celebrated for its efficacy in stopping bleeding. (See Hemorrhage.)

ALBUGO (from *albus*, white). A white opacity of the cornea, not of a superficial kind, but affecting the very substance of this membrane. (See Leucoma.)

ALUM, *Sulphate of alumina and potash.* Ten grains of alum, made into a bolus with conserve of roses, may be given thrice a day in internal hemorrhages, gleet, leucorrhœa, and other cases demanding astringent remedies. In a relaxed state of the urinary passages, or want of power of the sphincter vesicæ, small doses of alum are said to have been of service. Alum is employed as an ingredient in many astringent lotions, gargles, injections, and collyria. (See Lotio Aluminis.) Dr. Groshuis, a Dutch physician, first recommended its use in colica pictonum, and Dr. Perceval subsequently joined in the advice. The principle, on which it has been supposed to act, is that of decomposing the common preparations of lead, and converting them into sulphates, which are comparatively innoxious. Burnt alum is a principal ingredient in many styptic powders.

ALVINE CONCRETIONS. See INTESTINAL CONCRETIONS.

AMAUROSIS (from ἀμαυρόω, to darken) *Gutta serena. Suffusio nigra.* Germ. *Schwarzer Staar.* That diminution or total loss of sight which immediately depends upon the morbid state of the retina and optic nerve, whether this morbid state exist as the only defect, or be complicated with other mischief; whether it be a primary affection, or a secondary one, induced by previous disease of other parts of the eye. (*Beer.*) All those imperfections of vision which depend upon a morbid condition, *whether affecting structure or function,* of the sentient apparatus proper to the organ. (*Travers's Synopsis of the Dis. of the Eye*, p. 293.)

Obscurity of vision depending on a morbid condition of one or several portions of the optic nerve, its root, its course, or its termination. It is an effect therefore depending upon causes entirely different from those which prevent the rays of light from entering the eye or passing through it to the retina. (*Mackenzie on Dis. of the Eye*, p. 1015, ed. 4.) Any great imperfection or loss of vision existing independently of any change in the natural transparency of the parts anterior to the retina, or of any manifest varicose enlargement of the vessels of the choroid, or of any material alteration in the configuration of the eye-ball. (*R. Middlemore on Dis. of the Eye*, vol. ii. p. 242.)

The imperfection or loss of sight, which results from affection of the nervous apparatus belonging to the eye, whether that affection be seated in the retina, the optic nerve, or the sensoruium; whether it be idiopathic or primary, sympathetic or secondary: whether it consist in vascular congestion, or organic change, or simply in functional disturbance. (*Lawrence on Dis. of the Eye*, ed. 3, p. 506).

By the expression *gutta serena*, is usually signified the complete or fully developed form of amaurosis, that in which the patient has little or no power of distinguishing light from darkness. The term took its origin in the notion which formerly prevailed that the blindness was caused by the effusion of a humour or fluid at or behind the pupil, and as the latter opening retained its natural blackness in amaurosis the effused drop was said to be clear.

Amaurosis then does not uniformly take place as a single independent disorder; but not unfrequently presents itself as a symptomatic effect of some other disease of the eye: a fact exemplified in hydrophthalmia, cirsophthalmia, glaucoma, &c. And as Mr. Wardrop observes, amaurosis, in its usual acceptation, signifies a symptom of disease, as well as a distinct affection. (*Essays on the Morbid Anatomy of the Human Eye*, vol. ii. p. 165, 8vo. Lond. 1818.) With respect to the mere name of the kind of disease here implied by amaurosis its correctness will remain the same, whether the iris be moveable or immoveable; whether the pupil be preternaturally enlarged, or contracted, and whether it be perfectly clear and transparent, or more or less turbid; for the name only refers to the morbid state of the retina and optic nerve, and not to the condition of the sight in general. When the long established name of *amaurosis* is received with this precise meaning, there will be not the slightest danger of confounding the disease with other affections of the eye. However, when it is wished to make out the different forms and kinds of amaurosis, the appearances of the iris and pupil are considerations of great importance. (See *Beer's Lehre von den Augenkrankheiten*, b. ii. p. 420, &c. Wien, 1817.)

Amaurosis does not constantly attack both eyes at the same time; frequently one is attacked some time after the other, and it is not unusual even for one eye to remain sound during life, while the other is completely blind. This depends, in part upon the disposition to the disease in one eye being quite local, and in part upon the causes giving rise to the complaint extending their operation only to the eye affected. Where, also, the origin of amaurosis seems to depend altogether upon constitutional causes, one eye is not unfrequently attacked much sooner than the other; though in these examples it is more rare to find the eye which does not suffer at first continue perfectly unaffected. (*Beer*, b. ii. p. 422.)

Mr. Middlemore represents amaurosis as commonly attacking one eye first, and not commencing in the other until vision in the one first attacked is either much impaired or totally destroyed. "It is (says he) by no means an usual occurrence for amaurosis to take place in each eye at the same time, and to advance in both with an equal progress." Still, he admits, that this matter will be mainly determined by the nature of the cause producing the amaurotic affection. (*On Dis. of the Eye*, vol. ii. p. 251.) Indeed, since amaurosis may arise from affections of the sensorium, optic nerve, or retina, we can understand how it happens that it sometimes appears in both eyes at once; that it may be confined to one, or that, having taken place in one it may in the other also, after a longer or shorter interval. (*Lawrence*, op. cit. p. 507.)

Amaurosis may not completely hinder vision, a diminished power of seeing often remaining during life. Hence the division of cases into *perfect* and *imperfect;* which latter, however, sometimes attain a degree in which the patient is only just able to distinguish light, the direction of its rays, and its degree.

Amaurosis may take place in an instant, even so as to be attended with entire blindness; or it may come on quickly, that is, it may be complete in a few days or weeks; or, lastly, what is most frequently the case, it may be produced gradually, and several years elapse before it attains its utmost degree; circumstances of great moment in the diagnosis and treatment.

The type, which the disease assumes in its course and development, is also subject to great variety, and claims the utmost attention; for amaurosis may either be *permanent* or *temporary.* It is sometimes *intermittent*, making its appearance at regular or irregular intervals. In certain examples, it prevails at particular times, commonly all day, till a certain hour; or from one day till the next; or at a stated time every month.

Sometimes it is plainly a symptom of a confirmed ague, the patient being attacked with an ordinary intermittent, and blind during each paroxysm, but always regaining his sight as soon as each fit is over.

Sometimes the frequently recurring form of the disease confines itself to no determinate type; and, on account of its irregularity, it is then termed by Beer, *Amaurosis Vaga*, which, he says, is principally met with in persons liable to hysteria, hypochondriasis, convulsions, or epilepsy. Periodical amaurosis, after remaining uncured a certain time, often becomes *permanent.* (*Beer*, *Lehre*, *&c.* b. ii. p. 429.)

Day-blindness (*Cœcitas Diurna*; *Nyctalopia*) and *night blindness* (*Cœcitas Crepuscularis*; *Hemeralopia*) are nothing more than cases of periodical amaurosis.

Genuine uncomplicated amaurosis, consisting of a mere diminution or loss of sight, without the appearance of any other defect, is one of the most uncommon forms of the complaint. In it, merely the vital properties of the optic nerve and retina are affected, and, after death, nothing preternatural can be traced in these parts.

This simple unmixed form of amaurosis is subdivided by Beer into that amaurotic weakness of sight, or blindness, which depends upon the sensibility of the optic nerve and retina being too highly raised, and into another case, the proximate cause of which is peculiarly and entirely referrible to depression of such sensibility. The first example is much less common than the second. Mr. Lawrence conceives, however, that they who divide amaurosis into two kinds, *that with increased*, and *that with diminished sensibility of the retina*, enumerate as symptoms of the former various kinds of impaired vision, some of which rather denote the period of excitement in disease of the retina, than the more advanced stage, ordinarily designated as amaurosis. (*On Dis. of the Eye*, ed. 3, p. 525.) With reference to some amaurotic patients, who are annoyed by the bright light of day, Mr. Middlemore also observes, that it would seem as if the sensibility of the retina were increased, although the power of vision is greatly diminished; but, he adds, this is usually nothing more than an early symptom of only some few varieties of amaurosis; it does not continue so as to constitute one of its latter symptoms. (*On Dis. of the Eye*, vol. ii. p. 257.)

Amaurosis, then, either occurs in the form of a simple uncomplicated affection as we have described it above, or, which is more frequently the case, the disease is co-existent with other diseased appearances either in the eye, its vicinity, or some other organs at a distance from the eye, or in the general constitution. These appearances merit the most earnest consideration, because they are for the most part connected with the *cause* of amaurosis. According to this statement, then, there is a *genuine local amaurosis*, and a *complicated amaurosis*, which last may be either *local* or *general*, or of both descriptions together, and therefore named by Beer, *perfectly complicated.* (Vol. cit. p. 431.)

To the local complications, says Beer, belong cataract; glaucoma; a general varicose state of the eyeball (*cirsophthalmia*); exophthalmia; atrophy of the eye; spasms in the organ and surrounding parts; paralysis of one or more muscles of the eye (*ophthalmoplegia*); paralysis of the eyelids; ophthalmia in general, and internal ophthalmia in particular; a scorbutic bloodshot appearance of the eye (*Hyperœmia Scorbuticum*); and, finally, wounds or contusions of the eye, or adjacent parts. With these cases should also be mentioned that important disease, fungus hæmatodes of the eye. From this simple enumeration of local complications, one may see how frequently amaurosis is only a symptomatic effect of another disorder of the eye, with which it is conjoined, and how often it is connected with the same common causes, which pertain to another or several other diseases of the eye.

Amongst the general complications, Beer enumerates those which are purely nervous: impairment of the health in various forms by infection, contagion, or miasmata; a bad habit of body; typhoid fevers, the amaurotic effect of which upon the eye the author of this work has frequently noticed; asthma; hydrocephalus; organic defects of the abdominal viscera; worms; chlorosis; consumption; old ulcers of the legs; organic disease of the brain and skull; complaints arising from pregnancy; hemorrhage, &c. In these general complications, the casual connection between amaurosis and some remote disease of another organ, or of the whole constitution, cannot be mistaken; and we often see the disease of some other part distant from the eye suddenly or gradually diminish, and immediately appear again as a sympathetic action in the form of amaurosis, of which the most remarkable instance presents itself after the sudden healing of old ulcers of the legs. (*Beer*, *Lehre von den Augenkr.* b. ii. p. 433.)

Mr. Travers divides amaurotic affections into two classes, the *organic* and the *functional.* The first comprehends alterations, however induced, in the texture or position of the retina, optic nerve, or thalamus. The second includes suspension or loss of function of the retina and optic organ, depending upon a change either in the action of the vessels, or in the tone of the sentient apparatus.

As causes of *organic* amaurosis, this author enumerates: 1. Lesion, extravasation of blood, inflammatory deposition upon either of its surfaces, and loss of transparency of the retina. 2. Morbid growths within the eyeball, dropsy, atrophy, and all such disorganisations as directly press upon, or derange the texture of the retina. 3. Apoplexy, hydrocephalus, tumours or abscesses in the brain, or in or upon the optic nerve or its sheath, and thickening, atrophy, absorption, or ossification of the latter. As causes of *functional* amaurosis, Mr. Travers specifies: 1. Temporary determination; vascular congestion, or vacuity, as from visceral or cerebral irritation; suppressed, or deranged, or excessive secretions, as of the liver, kidneys, uterus, mammæ, and testes; various forms of injury and disease; and hidden translations of remote morbid actions. 2. Paralysis idiopathica, suspension or exhaustion of sensorial power from various constitutional and local causes; from undue excitement or exertion of the visual faculty; and from the deleterious action of poisons on the nervous system, as lead, mercury, &c. From this description, says Mr. Travers, it will be understood, that organic and many forms of functional amaurosis are incurable; and the functional, by continuance, lapses into the organic disease.

Functional amaurosis is subdivided by Mr. Travers into, 1st, the *Symptomatic*, or that which is only a symptom of some general disease, or disorder of the system; as, for example, plethora, or debility: 2ndly, the *Metastatic*, or that produced by the sudden translation of the morbid action from another organ of the body; as, for example, from the skin, the testicle, &c. 3rdly, the *Proper*, or that which depends upon a peculiar condition of the retina; as, for example, the visus nebulosus, muscæ volitantes. (*Synopsis*, p. 139—155.)

Mr. Lawrence does not consider the expression *functional* amaurosis to be of any practical utility;

he argues that the exact limits of the changes termed organic have not yet been determined. "We apply the epithet functional to those diseases which produce no changes recognisable after death. But we cannot infer from these cases that no alteration had existed during life. The state of an organ, necessary to the correct execution of its function is a living, not a dead condition; it requires, not merely a certain organisation as we find after death, but a supply of healthy blood in a certain quantity, a natural state of nervous influence and sympathy, and perhaps other circumstances, not clearly understood. If all these conditions are combined, can we consider it possible, that the function should be disordered, or interrupted? If one or more should be altered, or wanting, can the disease be properly regarded as simply functional? Vascular congestion is an obvious deviation from the normal state of a part. If the retina, or any other organ, be said to be functionally disordered when its vessels appear twice as numerous and large as in the normal condition, the expression must be employed too loosely to convey any clear information." (*On Diseases of the Eye*, ed. 3, p. 508.)

It seems to Dr. Mackenzie, that amaurosis always results from an *organic cause.* The notion of a *functional* amaurosis, he conceives, must have arisen from the facts, that this disease is sometimes sympathetic, or arises in consequence of derangement of some remote organ; and that it is occasionally sudden in its attack, and, on the other hand, instantaneous in its departure. In sympathetic amaurosis, Dr. Mackenzie considers it as indisputable, that the loss of sight must depend on some organic change in the optic apparatus. Take, for example (says he), the amaurosis which arises from the presence of worms in the bowels. This result is only occasional; the brain of perhaps not more than one out of a hundred affected with worms, is so susceptible of disease, that the irritation communicated to it from the bowels, through the great sympathetic nerve, is sufficient to excite it to that morbid condition which causes dilatation of the pupils and loss of vision; but that the amaurosis, in these cases, is the consequence of any thing else than a certain morbid condition of the optic apparatus, seems to Dr. Mackenzie a proposition which scarcely deserves a serious refutation. Neither does he admit, when amaurosis occurs suddenly as a disease of relation, that it is independent of organic derangement in the optic apparatus, however indubitable it may be, that the first link in the chain of causes has existed in some remote part of the body. (*On Diseases of the Eye,* ed. 4, p. 1019.) After all, however, with the qualifications and particulars annexed by Mr. Travers to his definition of the varieties of functional amaurosis, I see a perfect agreement between him and Mr. Lawrence in the pathological view of the subject: and the only question relates to the propriety of applying the term functional to particular forms of amaurosis. The least objectionable divisions of the amauroses seem to the latter surgeon to be three, according as the disease proceeds from *affection of the sensorium*, or of *the optic nerve*, or of *the retina*; though he acknowledges, that the evidence during life leaves us sometimes in doubt, whether the case ought to be referred to one or another of these heads. Amaurosis (says he) may be induced by causes acting immediately on the nervous apparatus of the eye, such as excessive exertion of the organ, or a stroke of lightning; it may arise secondarily from sympathy between the nervous structure of the eye and some other previously affected organ, as from irritation of the stomach, or of the nerve of the fifth pair; or it may be a symptom of affection of the sensorium, more or less general. Hence, the distinction of the complaint into *idiopathic*, *sympathetic*, and *symptomatic.* (See *Lawrence on Dis. of the Eye*, ed. 3, p. 510.)

SYMPTOMS OF AMAUROSIS.

One may consider as the only really inseparable symptom of amaurosis, that weakness of sight (*Amblyopia*), or that complete blindness, in which neither with the unassisted nor assisted eye the least defect can be perceived in the structure and shape of the affected organ. But how rarely this essential symptom is met with alone, and how frequently it is obscured by some other defect in the structure and form of the eye, is proved by daily experience.

Imperfect amaurosis, besides being characterised by considerable weakness of sight approaching to actual blindness, is mostly complicated with other morbid derangements of the visual function. Amongst the most important of these is a defective interrupted vision. (*Visus interruptus.*) For instance, when the patient is reading, single syllables, words, or lines cannot be seen, unless the eye be first directed to them by a movement of the whole head, and greater or lesser portions of other objects are in the same manner indistinguishable. Sometimes amaurotic patients can see only the upper or lower, or the left or the right half, of objects. (*Visus dimidiatus; Amaurosis dimidiata; Hemiopia; Hemiopsia.*) Or, when the patient shuts one eye, he can only distinguish the halves of objects; but, if he open both eyes, he sees everything in its natural form. In this case one eye is sound, and only some fibres of the nerve of sight are injured in the other. (See *Schmucker's Vermischte Chir. Schrift.* b. ii. p. 12.)

In some not very uncommon cases of imperfect amaurosis, the patient cannot see an object unless it be held in a particular direction before the eye; but, when the eye or head is moved in the least, he loses all view of the thing, and cannot easily get sight of it again. (*Beer*, *Lehre von den Augenkrankheiten*, b. ii. p. 424.) Patients who may be said to be entirely blind, sometimes have a small part of the retina which is still susceptible of the impression of light, and is usually situated towards one side of the eye. This obliquity of sight was long ago pointed out by the late Mr. Hey, as common in the present disease. (See *Med. Obs. and Inquiries*, vol. v.) Richter mentions, that in one man, who was, in other respects, entirely bereft of vision, this sensible point of the retina was situated obliquely over the nose, and so small, that it was always a considerable time before its situation could be discovered: he adds, that it was so sensible, as not only to discern the light, but even the spire of a distant steeple. The centre of the eye seems to be first and most seriously affected. Hence, the generality of patients, in the early stage of imperfect amaurosis, see objects which are laterally situated better than such as are immediately before them. (*Anfangsgr. der Wundarzn.* b. iii. kap. 14.)

One of the most common symptoms of incipient amaurosis, is an appearance in the patient's fancy, as if gnats or flies were flying about before his eyes. (*Visus Muscarum*, *Myodesopsia.*) Sometimes transparent, dark-streaked, circular, or serpentine diminutive bodies appear as if flying in greater or lesser numbers before the eyes, often suddenly ascending, and as quickly falling down again, and chiefly annoying the patient and confusing his sight when he looks at strongly illuminated or white objects. The substances, thus appearing to fly about before the patient's eyes, are termed *Muscæ volitantes; Mouches volantes.* (*Beer, Lehre, &c.* b. ii. p. 424.) If what obstructs the sight be a single black speck, it receives the name of *scotoma.*

Sometimes the muscæ are not moveable, but fixed and constant in their position, in which case they will indicate that certain definite portions of the retina have become insensible to light, while the floating or moveable muscæ are merely symptomatic and form no part of the disease itself.

This illusive perception of various substances being in rapid motion before the eye, gradually increases; the substances themselves become less and less transparent, and, at length, are so connected together that they form a kind of network, or gauze, by which all objects are more or less obscured. This is another symptom of amaurosis, technically called *visus reticulatus.* The network commonly has the peculiarity of being black in very light situations, or when white substances are before the eye; while, in dark places, it is quite shining, and, as it were, of a bluish white hue, like silver, though sometimes of a red-yellow, golden colour.

Sometimes, in the early stage of amaurosis, all objects seem covered with a dense mist (*visus nebulosus*), and this mist may appear for a day or two of a light gray colour, and then for another day or two very black, everything appearing as if looked at through a dense sooty smoke. (*Beer, Lehre von den Augenkrankheiten*, b. ii. pp. 422—426.)

A not uncommon symptom of imperfect amaurosis is the patient's seeing every object indistinctly in a rainbow-like, sometimes tremulous, and generally very dazzling light; while, in the dark especially, blue or yellow flashes, or fiery balls seem suddenly to pass before his eyes when the eyelids are shut, and excite considerable alarm. (*Visus lucidus; Marmoryge Hippocratis; Photopsia.*)

To an eye affected with imperfect amaurosis, all objects frequently appear indistinct, but double. (*Visus duplicatus; Diplopia.*) When the disease comes on gradually, the patient sometimes sees double, with both eyes.

In other cases, double vision only occurs when the patient looks at objects with both eyes, and it ceases as soon as he shuts either the diseased or the sound eye. In the last of these circumstances, double vision originates from the deviation of the unsound eye from the axis of sight; but, in the first instance, it arises from the morbid state of the retina itself of the diseased eye. A degree of squinting, *strabismus*, therefore, is a common symptom of incipient amaurosis, particularly when only one eye is affected; for this always deviates more or less from the axis of vision. It is owing to this loss of correspondence, that persons affected with an imperfect amaurosis of one eye, often mistake the relative distance of objects, and frequently see them reflected. (*Travers's Synopsis*, p. 170.)

Beer has often met with patients labouring under imperfect amaurosis, who could plainly distinguish all objects which were not very small; but saw them of a different colour from their real one; for instance, yellow, green, purple, &c. (*Visus coloratus*, *chrupsia.*) He had under his care an amaurotic woman, who at mid-day could discern even the smallest objects in a strong light, but they all appeared yellow, though no marks of jaundice were perceptible.

Sometimes in the early stage of amaurosis, all objects appear distorted, bent, shortened, and, in rarer instances, inverted. (*Visus disfiguratus; Metamorphosia.*) Thus the flame of a candle appears very long, but all awry. This is said by Beer to be constantly an unfavourable omen, as the cause of it lies in the brain itself.

Imperfect amaurosis is sometimes attended with considerable shortsightedness (*Myopia*), and sometimes with the opposite affection (*Presbyopia*).

Many patients, when first attacked with amaurosis, everywhere testify a partiality to a great quantity of light, employing several candles at night, and sitting in the day-time with their backs against a sunshiny window, in order to let whatever they are reading have a very strong light upon it. In some cases, however, the sensibility of the retina may be so augmented, that the patient shuns all light places, particularly those in which the light is strongly reflected into the eye, and, in order yet to discern in some measure large objects, he feels himself obliged always to seek shady, darkish situations, or to screen his eyes, out of doors, with a green shade or green glasses. This state is termed intolerance of light. (*Photophobia.*)

The amaurosis with morbid irritability of the retina and photophobia, is described by Beer as commencing with a peculiar sensation of fulness in the eyeball, joined with continually increasing, violent, and annoying luminous appearances, and a remarkable weakness of sight. These symptoms are soon followed by a stupifying, constantly increasing headache, during which the power of vision manifestly diminishes, without the slightest defect being perceptible, either in the eye itself or its surrounding parts. The patient, however, is always of an athletic constitution, or has symptoms of general or local plethora, or a phlogistic diathesis. This observation coincides with the view which I entertain of this part of the subject, namely, that the amaurosis beginning with irritability of the organ and photophobia, originates generally from an inflammatory affection of the retina.

In the amaurosis originating with symptoms of weakness and diminished irritability the sight is cloudy, and the patient finds that he can see better in a light than a dark situation. He feels as if some dirt, or dust, were upon his eyes, and is in the habit of frequently wiping them. His power of vision is greater after meals than at the time of fasting. His sight is always plainer, for a short time after the external use of tonic remedies, such as hartshorn, cold water, &c. Richter informs us of a person who was nearly blind, but constantly able to see very well, for the space of an hour after drinking champagne. He also mentions a woman entirely bereft of sight, who was in the habit of having it restored again, for half an hour, whenever she walked a quick pace up and down her garden.

When the disorder is accompanied with diminished sensibility in the eye in general, Beer coincides with Richter, respecting the temporary improvement of the sight after a nourishing meal, or drinking spirituous liquors; or when the patient's mind is elated with joy or anger, though such melioration of sight, it is true, is but of very short duration. (Also *Vetch on Dis. of the Eye*, p. 137.) On the other hand, it may be remarked, that every thing which tends to depress the passions and spirits, augments the imperfection of sight. Where marks of increased sensibility prevail, the above-mentioned circumstances exercise a transient disadvantageous operation; the patient carefully retires from every strong light, and frequently shelters his eye with his hand. (*Lehre von den Augenkr.* b. ii. p. 430.) Mr. Travers also knows patients, whose vision is benefited in a high degree, and others, in whom it is much deteriorated, by the quickened circulation of a full meal, and a few glasses of wine. The former, he says, are persons of spare and meagre habits; the latter plethoric. (*Synopsis of the Diseases of the Eye*, p. 157.)

According to Beer, this amaurosis, originating with diminished sensibility of the organ, usually comes on very slowly, and commences with the visus reticulatus, or nebulosus, without any alternation with a blinding glare of light; and the eyesight is sometimes considerably better, and sometimes weaker, which always depends upon the accidental operation of the above internal or external circumstances. The melioration of the eyesight never continues long, while the diminution of it not only remains, but gets worse and worse. It is not at all uncommon for this species of amaurosis to make its appearance as a night blindness, because common artificial light is much too feeble to make due impression upon the diminished sensibility of the optic nerve, and consequently these patients always show a partiality to a strong light. To such weak-sighted individuals, the flame of a candle, or the moon, appears as if covered by a dense veil, with an expanded halo round it of various colours. There is no complaint made of pain in the head or eyes; and no sensation of fulness or weight is experienced in the eyeball; much less are there any signs of the disease in the structure and form of the eye, or in the action of its irritable textures; but, when it has been long complete, it is usually conjoined with a debilitated habit.

In the simple uncomplicated species of amaurosis, all morbid appearances are absent, so that we are obliged to trust almost exclusively to the patient's assertion, that his sight is bad, or quite gone; and not unfrequently it is necessary, especially in judicial cases, to employ political artifices, in order to determine whether such assertion be true, particularly when the patient affirms that the blindness is restricted to one eye.

In this case we shall probably be assisted in our diagnosis by the slight degree of strabismus usually present, which arises from the patient being unable to fix the diseased eye steadily on any object. This degree of strabismus is noticed by Ackermann and Fischer as the surest sign of amaurosis. (See *Klinische Annalen von Jena*, st. i. p. 144.) And it is particularly pointed out by Richter as an invariable attendant upon amaurosis. The patient, says he, not only does not turn either eye towards any object, in such a manner that the object looked at is in the axis of vision, but he does not turn both his eyes towards the same thing. This was regarded by Richter as the only symptom which we can trust, where implicit confidence should not be put in the mere assurance of the patient that he cannot see, while all the coats and humours of the eyes present their natural appearance. (See *Anfangsgr. der Wundarzn.* b. iii. kap. 14.) This observation is interesting to the military surgeon, amaurosis being a common affliction of soldiers, many of whom, however, endeavour to avoid service by pretending to labour under a disqualification which they well know does not necessarily produce any very considerable alteration on the natural appearance of the eye. There is another symptom of great value, when only one eye is quite blind, and the eyesight on the other side is perfectly undisturbed, namely, *if the sound eye be very carefully covered, the pupil of the blind one immediately expands, and the iris becomes quite motionless, notwithstanding the diseased eye be exposed to the strongest light possible.* However, this criterion is frequently wanting, because the amaurosis, unattended with any perceptible defect, except loss of vision, is seldom confined to one eye, but usually affects both. (See *Lehre von den Augenkr.* b. ii. p. 481-82.)

The gait and the cast of the eye in an amaurotic patient form another important characteristic of the disease. He advances towards us with an air of doubt and uncertainty in his movements, from which the cataractous patient is generally exempt, and instead of converging his eyes in the natural way towards an object, it is evident that there is something vacant and unmeaning in his look, the result of the eyes being directed parallely, as if towards an object infinitely distant. In many cases there is oscillation, and in some the eyes stand completely fixed in the head. (*Mackenzie on Dis. of the Eye*, ed. 4, p. 1022.)

Imperfect movement in the lids also frequently accompanies amaurosis, and will usually indicate that the cause of the disease is such as to implicate the motor oculi and facial nerves also in the paralysis.

One of the most important incidental symptoms of amaurosis consists in the faulty size and shape and the imperfect movements of the pupil. When the amaurosis is complete, the most frequent state of the pupil is that of extreme dilatation, so that a mere ring of iris may be all that is visible, and its dimensions are not altered even when the strongest light is directed upon the retina. And in the incomplete cases, the movements of the iris are sluggish, and the pupil is larger than ordinary.

This is the state of numerous cases, but there are many exceptions. Sometimes, according to Richter, in the most complete and incurable cases, the pupil is of its proper size, and even capable of free motion (*Turbés, Recueil Périodique, &c.* t. ii. p. 319): and, occasionally, it is actually smaller and more contracted than natural. This aperture often continues extraordinarily large in the strongest light; but, in some instances, it is unusually small in every kind of light. (*Arrachard, Recueil Périod. &c.* t. i. p. 273; *Richter, Anfangsgr. &c.* b. iii. p. 424; *Beer, Lehre, &c.* b. ii. p. 435.) According to the latter writer, the pupillary edge of the iris rarely has its primitive shape, being generally more or less angular; either at some indeterminate point, or above and below, so as to resemble in some measure the pupil of the cat race; or towards the nose, or temple, so as to have some similitude in its form to the pupil of ruminating animals.

Frequently, not only the size and shape of the pupil are faulty, but its position is unnatural, being inclined either upwards or downwards, or outwards or inwards, but most commonly in a diagonal line between inwards and upwards; and in these cases the pupillary margin of the iris never describes a regular circle, but is more or less angular. (*Beer*, vol. cit. p. 436.)

We have also the authority of Richter for asserting that, in particular instances, the iris not only possesses the power of motion, but is capable of moving with uncommon activity, so that, in a moderate light, it will contract, and nearly close the pupil. (*Anfangsgr. der Wundarzn.* b. iii. p. 424, ed. 1795.)

Two or three remarkable instances of the active state of the iris, in cases of amaurosis, were some years ago shown to me by Dr. Albert, then staff surgeon at the York Hospital, Chelsea, and I have since seen other similar cases. Most of the patients in question had not the least power of distinguishing the difference between total darkness and the vivid light of the sun, or a candle placed just before their eyes. Janin sometimes found the pupil capable of active motion in this disease, and Schmucker twice noticed the same fact. An example of complete amaurosis, with perfect motion of the irides, is recorded by Mr. Lawrence. It was attended by violent pains in the head, and proved incurable. (*On Diseases of the Eye*, ed. 3, p. 512.)

Such cases, Mr. Travers thinks, can only be explained by concluding the organ to be sound, and the cause of the amaurosis remote, or external to it. Thus, says he, in a case of circumscribed tumor, compressing the left optic nerve, immediately behind the ganglion opticum, although the blindness was complete, the iris was active. In two young ladies, in whom the eyes, as in the former case, were perfect, and the blindness complete, the iris was even vivacious; and there was the strongest presumptive evidence, from the symptoms, that the amaurosis was in the cerebral portion of the nerve. (*Synopsis*, p. 188.) Sometimes, when the retina of each eye is equally insensible to light, and the amaurosis of both eyes complete, the iris of each eye will be differently acted upon by the light, so that one pupil will be larger and its motions more lively than those of the other. Mr. Middlemore has seen several persons, who had amaurosis in a decided form in one eye, and only in a very slight degree in the other, in whom the mobility of the pupil, as tested in various ways, was much more considerable in the most diseased eye. The irritability of the iris, and the sensibility of the retina to light, do not, therefore, always correspond. (See *R. Middlemore on Dis. of the Eye*, vol. ii. p. 255.)

In some anomalous cases, when the strength of the light is suddenly increased, the pupil expands with more or less celerity.

It is observed by Mr. Travers, that if the retina be opaque, compressed, or unsupported, the iris mechanically disordered, or the ciliary nerves palsied, the pupil is inactive, independently of the state of vision. In the first of these cases, it is evident that the sight will be lost; but we continually see useful vision combined with the second and third, as after operations, in which the iris has been half destroyed, or has become preternaturally adherent, or in malformations, where it is half wanting; and in paralysis of the ciliary nerves, accompanying ptosis. (*Synopsis*, p. 188.)

Frequently, in amaurosis, when the sight of only one eye is lost, and the other retains its full power of vision, not the slightest defect can be discovered as long as the patient keeps both of them open; but, the instant the sound eye is completely covered, the iris becomes perfectly motionless, its pupillary margin assumes an angular shape, and the pupil expands, being sometimes evidently drawn towards the edge of the cornea. (*Beer, Lehre von den Augenkrank.* b. ii. p. 438.) This demonstrates the difference between the independent and the associated action of the iris.

Dr. Mackenzie thinks that the activity of the pupils, which sometimes exists in cases of total blindness, may be accounted for in the following manner. He says, "It appears to be absolutely necessary for the ordinary motions of that membrane (viz. the iris), not only that the iridal or ciliary nerves, and one or other or both retinæ be sound, but that a certain degree of communication shall be kept up, between one or other or both retinæ and the brain on the one hand, and between the brain and the iridal nerves on the other. It becomes, then, a question whether the brain may not be so affected with disease as to be incapable of acting as the organ of visual perception, and yet retain the power of communicating to the third nerve the impulse necessary for the usual motions of the pupil. If we suppose that the function of vision is accomplished only after the optic nerves reach the corpora quadrigemina, and thus communicate with the posterior part of the medulla oblongata, but that the association which undoubtedly exists between the optic nerves and the third pair is effected farther forward on the basis of the brain, we shall be able to afford at least a plausible explanation of the fact of the lively mobility of the pupils in certain cases of complete amaurosis. The third pair makes its appearance immediately behind the tuber cinereum, a part of the brain with which the optic nerves have a manifest connection. The third pair does not, indeed, appear to take its origin from the tuber cinereum, but from the central cineritious substance of the crura cerebri, bearing an analogy, along with the sixth and ninth pairs, the portio dura of the seventh, and the portion of the fifth pair which escapes the Gasserian ganglion, to the anterior roots of the spinal nerves; but it is surely not an improbable supposition, that the optic nerves, either where they cross the crura cerebri or more probably where they communicate with the tuber cinereum, form that link of connection with the third pair which they are universally acknowledged to do in some part or other of their course. A disease, then, affecting the corpora quadrigemina, or, in other words, the origin of the optic nerves, or affecting any part of the tractus opticus between the corpora quadrigemina and the communication between the optic nerves and the third pair, wherever that communication is effected, will, according to this view of the subject, produce blindness, but may leave unimpaired the influence of the optic nerves upon the third pair; while the cases of amaurosis in which the pupils are fixed and dilated, are probably owing either to more extensive disease, or to disease so situated as to affect that part of the brain where the optic nerves communicate their influence to the third pair. Amaurosis with lively pupils has not unfrequently been found to depend on disease of the cerebellum."

He thinks the same theory "will also serve to account for the motions of the iris of an amaurotic eye, when the opposite sound eye is exposed to various gradations of light. Each optic nerve, dividing at the chiasma into two portions, one to the right and the other to the left side of the brain, is in communication with both nerves of the third pair, so that although the pupil of the diseased eye becomes expanded and fixed when the sound eye is kept shut, it instantly contracts when this eye is exposed to light, and so long as this is the case, performs exactly the same motions."

The pupil of an eye, affected with amaurosis, frequently does not exhibit the clear shining blackness which is seen in a healthy eye. When the disease is an effect of hydrocephalus, and occurs in a young subject, the pupil presents its natural black hue; but in elderly subjects, it is rarely the case that some degree of glaucoma does not accompany amaurosis. (*Mackenzie*, ed. 4, p. 1025.) In general, the pupil is of a dull glassy, hornlike blackness, which symptom alone is frequently enough to apprize a well-informed practitioner of the nature of the disease. It is, in the words of Mr. Travers, "little more than the healthy appearance of the humours in the eye of a horse." (*Synopsis*, p. 146.) Sometimes the colour of the pupil has an inclination to green; while, in other examples, this aperture seems to be dense, white, and cloudy, so that the complaint might easily be mistaken for the beginning of a cataract. This error, into which inexperienced surgeons are liable to fall, may generally be avoided by attention to the following circumstances. The misty appearance is not situated close behind the pupil, in the place of the crystalline lens, but more deeply in the eye. Nor is it in proportion to the impairment of sight, the patient being quite blind, while the misty appearance is so trivial, that, if it arose from the opacity of the crystalline lens, it could at most only occasion a slight weakness and obscurity of vision; at the same time, Richter acknowledges that it must be more difficult to avoid mistake when a beginning amaurosis is accompanied with this cloudiness of the eye, and, consequently, when the degree of blindness seems to bear some proportion to the degree of mistiness in the pupil. However, in this case, he maintains that the true nature of the disease may generally be known by comparing the ordinary symptoms of the two diseases. (*Anfangsgr.* b. iii. p. 14.) And, according to Beer, when the pupil is of a true dark gray, or greenish gray colour, a lateral inspection of the eye will show plainly enough that the cloudiness is in the vitreous humour or behind it. Sometimes the pupil appears reddish, quite red, or of a yellowish white colour (*Lehre von den Augenkr.* b. ii. p. 436); while, in other cases, the interior of the eye, a good way behind the pupil, seems white, and a concave light-coloured surface may be observed, upon which the ramifications of blood-vessels can be plainly seen. In particular instances, this white surface extends over the whole back part of the eye, while, in other cases, it only occupies a half or a small portion of it. This peculiar appearance has been ascribed to a loss of transparency in the retina itself, and a consequent reflection of the rays of light. (*Haller*, *Element. Physiol.* t. v. p. 409.) Mr. Travers inclines to the opinion, that it arises from a deficient secretion of the choroid pigment, a preternatural adhesion betwixt the choroid coat and the retina, and a discoloration or resplendent appearance of the latter from this cause. (*Synopsis*, p. 148.)

A whiteness behind the pupil sometimes originates from the diseased mass, which, in fungus hæmatodes of the eye, grows from the deeper part of this organ, and gradually makes its way forward to the iris, attended with total loss of sight. Putting out of present consideration the change of colour within the eye, produced by fungus hæmatodes, the other palish changes behind the pupil are not confined, as Kieser supposes, to very old cases of amaurosis, because the alteration is described by Schmucker as taking place especially in examples the formation of which was quite sudden (*Vermischte Chir. Schrift.* b. ii.); and Langenbeck has recorded cases in which the same appearance happened in the early stage of the disease. (*Neue Bibl.* b. i. p. 64, &c.)

One criterion between amaurosis and incipient cataract, is the different appearance which the flame of a candle exhibits to the patient in the two affections. In incipient cataract, it appears as if it were involved in a generally diffused thin mist, or white cloud, which increases with the distance of the light; but in amaurosis, a halo or iris appears to encircle or emanate from the mist, the flame seeming to be split when at a distance. (*Stevenson on the Nature, &c. of Amaurosis.* Lond. 1821.)

The Ophthalmoscope, a contrivance for directing concentrated light into the interior of the eyes, is sometimes employed for exploring the condition of the deeper seated tissues. On this subject, Dr. Mackenzie observes: — "It may be possible by concentrating the sun's rays, or the strong light of a lamp or gas flame, with a double convex lens, and letting the focus fall within the eye, to discover in some cases pigmentary depositions in the vitreous humour, effusions of blood or exudations of lymph on the surface or in the substance of the retina, or between it and the choroid, varicosity of the retinal vessels, partial removal of the pigment in patches, separation of the retina from the choroid in consequence of subchoroid dropsy, &c. The same may be accomplished by means of a beam of strong light reflected from a mirror, as is done by the ophthalmoscopes of Helmholtz, Coccius, and others. Such examinations may confirm us in an unfavourable prognosis, already pronounced on other grounds, but are not likely to be either satisfactory or safe in the early and curable stages of the disease." (See OPHTHALMOSCOPE.)

If the pupil is *very much* dilated, if its mobility is *nearly* destroyed, if scintillations are present, and if the patient has recently been exposed to the operation of circumstances calculated to induce atonic amaurosis; then the decision that the case is of the latter kind is free from difficulty. (See *R. Middlemore on Dis. of the Eye*, vol. ii. p. 270.) This gentleman is satisfied, that the only circumstances, which can render it difficult to distinguish cataract from amaurosis, are, when mere atony of the retina, or atrophy of the optic nerve, *commences*, and especially, when either of these morbid states supervenes upon a cloudy state of the pupil; and, in every such instance, where the slightest doubt exists, he recommends the eye not to be actively exerted.

For additional observations on the distinctions between incipient cataract and amaurosis, and glaucoma, see *Cataract* and *Glaucoma.*

Besides the above appearances of the pupil and iris, amaurosis is attended with other characteristic phenomena, which occur under certain circumstances, in the form, texture, and state of other parts of the eye, and adjoining organs. Thus, the patient oftens complains of a peculiar troublesome dryness of the eye, or of a sensation as if the eyeball were about to be pressed out of its socket; and, indeed, says Beer, one may sometimes hear a grating noise, and distinguish a fluctuation in the orbit behind the eyeball, when this organ is pressed upon by the finger, or moved in various directions, though neither its circumference be enlarged, nor any tendency to exophthalmia be really present. Nor is it very uncommon to find the affected eye preternaturally hard, soft, or even quite flaccid; but it is less common to find the dimensions of the globe of the eye increased, than the organ affected with atrophy. (*Beer,* vol. cit. p. 438.)

However, in organic amaurosis, a peculiar bluish gray tint of the sclerotic coat is frequently remarkable; and sometimes even a degree of bulging on one or more sides of the eye, or simply a loss of sphericity, its sides appearing flattened. A turgescence of the superficial vessels, especially of the long fasciculi of conjunctival veins, is likewise another symptom, frequently observed in organic amaurosis. (See *Travers's Synopsis,* p. 146.)

In this work are given the particulars of a dissection, in which a case of amaurosis was attended with a collapse of the retina from absorption of the vitreous humour.

Some of the principal morbid effects of amaurosis have been already described in speaking of the several defects of vision, which accompany an amaurotic weakness of sight. Besides these, however, there are others meriting attention. For instance, the patient feels in the eye and surrounding parts an irksome sensation, without any actual pain, and complains of a remarkable sense of fulness or weight in the organ. Amaurotic patients are also frequently attacked with sudden violent giddiness, usually ending in a considerable diminution of the eyesight, and sometimes in severe general headach. Occasionally they fancy that small atoms of dust are lodged under the eyelids, and are fearful of moving these parts, or the eye. It is also well known, that many persons become amaurotic while labouring under severe hemicrania, extending from, or to, the diseased eye; while, on other occasions, the most violent pains are confined, particularly to the region of the eyebrow, and have the appearance of being strictly periodical. In certain other cases, the pain is wandering, and shoots in every direction about the eyebrow. These painful feelings often precede the amaurotic blindness a considerable time, and often first take place when one or both eyes are already blind; but the pains and loss of sight are not unfrequently produced together. Lastly, some patients are met with, in whom the worst pains only last until the amaurosis is perfectly formed, when they gradually and permanently cease. In all these painful cases of amaurosis, the pain and the blindness chiefly depend upon the same cause, and one is seldom the occasion of the other. Sometimes amaurotic patients experience such violent pain, that they lose their senses, and grow delirious; but, in these cases, if we can credit the assertion of Beer, important morbid changes in the bones of the skull, or the brain itself, are invariably noticed after death. (See *Lehre von den Augenkr.* b. ii. p. 439.) In some amaurotic patients, lethargic symptoms may be remarked; in others, restlessness; and, more rarely, delirium in all its degrees, either as a transient or permanent affection.

According to the observations of Mr. Travers, pain in the forehead and temples is a precursory symptom of amaurosis, diminishing in proportion as the dimness increases. When the amaurosis is perfect, it usually ceases altogether, *if the disease has its seat in the eyeball.* But when the pain is severe, remits imperfectly, and is quickly rendered worse by exercise, it is usually connected with organic disease of the brain. In this case, derangement and torpor of the primæ viæ, loss of strength and flesh, disposition to stupor, occasional confusion of intellect, inaptitude to exertion, and paralysis of one or more muscles, will be concomitant symptoms. (*Synopsis, &c.* p. 167.)

Dr. Mackenzie observes that amaurosis without pain generally depends on atrophy of the optic nerves. If it be attended with pain either constant or intermittent, there is probably some organic affection of the brain, or cause of pressure within the cranium. From a careful investigation of the seat, extent, and nature of the pain, we may often arrive at a probable conclusion respecting the state of the cerebral circulation, or we may obtain evidence of the existence of some deposition or formation within the head causing pressure. (Ed. 4, p. 1028.)

Paralytic appearances may precede amaurosis, either in the vicinity of the eye, or in the muscles of the face, or in a distant situation, as the extremities. Sometimes they accompany the disease, and sometimes closely follow the weakness of sight, being not unfrequently the forerunners of a fatal attack of apoplexy.

In the same way, convulsive symptoms may be conjoined with amaurosis; and when they first occur in the complete stage of the latter disease, Beer pronounces them a very unfavourable omen for the patient's life.

Likewise, when in a case of perfect amaurosis, several of the other senses are affected; when the hearing and then the smell and taste are lost, and afterwards the memory and other intellectual powers fail, the patient's speedy dissolution may be expected. (See *Lehre von den Augenkrankh.* b. ii. p. 441, Wien. 1817.)

CAUSES OF AMAUROSIS.

In some cases, the cause is of a *local, direct,* and *mechanical* nature; such as the pressure of a tumour on the optic nerve. In others, it is of a *local,* but *vital* kind; such as a plethoric, or congested state of the blood-vessels of the brain or eye. In a third set of cases, the cause is *general* or *constitutional;* such as exhaustion, consequent to profuse or continued loss of some of the fluids of the body. (See *Mackenzie on Dis. of the Eye,* p. 901, ed. 2.)

The directions of Mr. Middlemore for tracing the cause of amaurosis deserve notice. The surgeon should first investigate the condition of the eye and the eyelids: he should observe whether the upper lid drooped, whether there was any degree of strabismus, and whether the sympathetic and associated movements of the eyes were unaltered; he should then notice the state of the cornea, its clearness and its form; the state of the pupil, its size, its figure, its degree of motion, and also the distance of the iris from the cornea, as well as its colour and the general appearance of its texture, and whether it be convex or concave, or preserve its natural place; the state of the humours in reference to their transparency, and particularly notice whether any deep-seated buffy or dusky cloudiness were present, and whether the eyeball were increased in vascularity, or changed in colour, figure, size, or consistence. Mr. Middlemore further recommends the effect of belladonna on the pupil to be noticed; and the eye to be examined under its influence, if any influence at all be produced by it, and in various degrees of light, and in connection with the pupil of the opposite eye. The state of the pupil is to be observed at the moment when the lids of both eyes are suddenly separated, and also when the lids of the sound eye are closed, and those of the diseased one separated. Each pupil is also to be examined separately, so as to ascertain its extent and facility of motion.

Mr. Middlemore advises inquiry to be made into the patient's habits, temperament, disposition, and state of mind; whether any visceral disease be present, and what its nature; whether there be any temporary disorder in the alimentary canal; whether the patient is suffering or has been recently suffering from gout, rheumatism, scrofula, or syphilis; whether he has passed through any severe mercurial treatment; whether he has suffered from apoplexy, epilepsy, paralysis, severe fever, inflammation, or concussion, or other injury of the brain; how long the disease has existed; what remedies have been tried, and what their effect. (See *R. Middlemore on Dis. of the Eye*, vol. ii. p. 255.)

Age cannot be considered a predisposing cause of amaurosis in the same degree that it is of cataract; for there are many more blind persons who have been deprived of their sight by amaurosis in their best days, than old persons thus attacked. Amaurosis spares no age — not even the new-born infant. Mr. Lawrence concurs in this statement, adding his belief, however, that amaurosis is most frequent at or after the middle period of life, especially about the cessation of menstruation in females, and the corresponding age in the male. (*On Diseases of the Eye*, p. 517.)

The following statement, in relation to this part of the subject, appears correct:—"There are certain ages at which, from particular circumstances, amaurosis is most commonly witnessed, and for the most part merely as a functional, or sympathetic affection. In the first place, it may be congenital, with or without being evinced by any defect in the form or the magnitude of the eye, or any of its parts, although the globe generally acquires under such circumstances a rolling or unsteady motion. Amaurosis may be produced by hydrocephalus, which disease occurs most frequently in children; by convulsions; and by the irritation connected with dentition, or by the presence of worms in the stomach or intestines. These are the circumstances associated with very early life, with which amaurosis is most commonly connected. At the period of puberty, it is sometimes induced by vitiated habits, and by certain conditions of, and changes in, the genital system. Again, the period of pregnancy and suckling are favourable to its origin; the former, by the pressure of the gravid uterus on the large venous trunks; and the latter, by enfeebling the system generally, and very probably also by over exciting and deranging that sympathy which exists between the uterus, the mammæ, and the retina, and with the precise nature of which we are not fully acquainted. The final cessation of menstruation is the next season at which amaurosis is most likely to take place; and, lastly, extreme age is a strong predisposing cause of amaurosis." (See *Middlemore on Dis. of the Eye*, p. 252.)

Four forms of *congenital* organic amaurosis are noticed by Mr. Travers. One, in which the eye is preternaturally small, soft, and even flaccid; the iris tremulous, and not influenced by belladonna; and the globe affected with tremour, and not subject to the control of the will. A second, depending on a deficiency of the pigmentum nigrum; the organ is tremulous, strong light produces uneasiness, and vision is dazzled and confused. The vessels of the choroid give the interior of the eye a deep red tinge. A third case is that in which the sclerotica so encroaches upon the cornea, that the latter is scarcely wider than the pupil. In the fourth kind of congenital amaurosis, described by Mr. Travers, the eyes move in concert, as if attracted by a faint perception of light; but the infant is blind: no marks of organic derangement can by seen; but the disease may be connected with a morbid state of the thalami, or optic nerve. (*Synopsis*, p. 153, 154.)

Neither do sex and race affect the frequency of the complaint; but dark eyes are sometimes alleged to be more disposed to amaurotic blindness than such as are light-coloured. According to Beer's experience, for every gray or blue eye affected with amaurosis, there are five and twenty or thirty brown or black ones thus diseased. L. Winslow, Weller, and Sanson likewise regard dark eyes as most subject to amaurosis. In this country, I believe, it is found that the mere colour of the eye has not the influence here represented in predisposing to amaurosis. (See *R. Middlemore on Diseases of the Eye*, vol. ii. p. 252.)

More frequently than cataract, amaurosis is found to be a true hereditary disease;—this is so much the case, that most of the members of a family, for more than one generation, may lose their sight from amaurosis at a certain period of life. Beer was acquainted with more than one family in which this happened; and, what merits attention, the women of one of these families, down to the third generation, became completely and permanently blind from amaurosis on the cessation of the menses, while all the others, who had had children, were unaffected. But the males of this unfortunate family, who, as well as the females, have very dark brown eyes, all seem to be weak-sighted, though none of them are yet blind. (*Lehre von den Augenkrankheiten*, b. ii. p. 443.)

In women, especially those with black eyes, the time when the menses stop is considered by Beer a likely period for the commencement of amaurosis.

One of the less common causes of amaurosis is an idiosyncrasy in relation to this or that sort of nutriment or medicine, or this or that particular state of the body. Here is to be reckoned the amaurotic weakness of sight, or the perfect amaurosis, which comes on at the very commencement of pregnancy, and subsides after delivery, but always attended with dyspepsia and insuperable vomiting. This species of amaurosis, however, should be carefully distinguished from that which sometimes first originates in the final months of pregnancy, and chiefly from strong and long-continued determination of blood to the head and eyes, particularly when the bowels are at the same time loaded, and the patient constipated. This latter case usually continues till after delivery; or, if the labour be tedious, difficult, and attended with considerable efforts, the blindness may first attain its complete form at the time of delivery, and not afterwards subside.

Beer saw a young Jewess, who, at the very beginning of her first three pregnancies, which followed each other quickly, regularly lost her sight, becoming completely amaurotic between the third and fourth months, and, on the two first occasions, she continued blind till after delivery; but, in the third instance, the power of vision never returned at all. (See also *Démours, Traité des Mal. des Yeux*, t. i. p. 380.) Beer twice had under his care another woman, who was attacked with amaurosis whenever she drank chocolate; but, upon leaving off that drink, she never afterwards had any complaint in her eyes.

According to Richter, the causes of amaurosis may be properly divided into three principal classes, the differences of which indicate three general methods of treatment.

The first class of causes depends upon an extraordinary plethora and turgidity of the blood-vessels of the brain, or of those of the optic nerves and retinæ, upon which last parts a degree of pressure is thereby supposed to be occasioned. A considerable plethora, especially when the patient heats himself or keeps his head in a depending position, will frequently excite the appearance of black specks before the eyes, and sometimes complete blindness. A plethoric person (says Richter), who held his breath, and looked at a white wall, was conscious of discerning a kind of network, which alternately appeared and disappeared with the diastole and systole of the arteries.

Richter thinks it likely, that the disease is thus produced, when it proceeds from the suppression of some habitual discharge of blood, from the neglect to be bled according to custom, the stoppage of the menses, and the cessation of hemorrhage from piles. In the same manner, the complaint may be brought on by great bodily exertions, which determine a more rapid current of blood to the head. Richter informs us of a man who became blind all on a sudden, while carrying a heavy burden up stairs. He tells us of another man, who laboured excessively hard for three days in succession, and became blind at the end of the third day. Pregnant women, in like manner are sometimes bereft of their sight during the time of labour. Schmucker has recorded a remarkable instance of this in a strong young woman thirty years old, and of a full habit. Whenever she was pregnant, she was troubled with violent sickness, till the time of delivery, so that nothing would stop in her stomach. She was bled, three or four times without effect. Towards the ninth month her sight grew weak, and for eight or ten days before parturition, she was quite blind. The pupil of the eye was greatly enlarged, but retained its shining black appearance. She recovered her sight immediately after delivery, and did not suffer any particular complaints. Schmucker assures us, that he has been three times a witness of this extraordinary circumstance. (*Vermischte Chir. Schriften*, band ii. p. 6, ed. 1786.) Richter speaks of a person, who lost his sight during a violent fit of vomiting. Schmucker acquaints us, that it is not uncommon for soldiers, who are performing forced marches in hot weather, to become suddenly blind.

Beer also coincides with Schmucker, Richter, and others, in regarding, as a frequent cause of amaurosis, repeated and long-continued determinations of blood to the head and eyes, produced by various circumstances, viz. by pregnancy; a tedious and difficult labour; lifting and carrying heavy burdens, especially with the arms raised up; all kinds of work in which the eyesight and intellectual faculties are intensely exerted, with the head bent forwards, and the abdomen compressed, as is the case with shoemakers, tailors, &c.; every sudden stoppage of natural, or preternatural long-established discharges of blood, as that of the menses lochia, or hemorrhoids; the omission of habitual venesection at some particular season of the year; severe and obstinate vomiting; forced marches in hot, dry weather; scrofulous and other swellings of considerable size in the neck, pressing upon the jugular veins, and obstructing the return of blood from the head; the use of a pediluvium, or warm bath, the water of which is of high temperature; hard drinking; violent gusts of passion; frequent and obstinate constipation; and hard straining at stool. These causes are more likely to occasion amaurosis, in proportion as the individual is young and plethoric. The causes of that amaurosis which is characterised in its first stage by increased sensibility of the eye, and intolerance of light, are referred by Professor Beer to circumstances which produce a long and repeated determination of blood to the head and eyes. (*Lehre von den Augenkr.* b. ii. p. 446 and 483, &c.)

Mr. Lawrence regards amaurosis, in its most frequent and important form, that which is seated in the eye itself, as generally the result of inflammation of the nervous structure; including under that phrase all degrees of increased vascular action, whether designated as fulness, turgescence, determination, congestion, or as inflammation in its more limited sense; and the usual consequence of inflammatory disturbance, that is, organic change, permanently destroying the function of the part. When, says he, we advert to the structure of the retina, we must suppose that it would be liable to such affections; we find it composed of minute ramifications of the arteria centralis retinæ, and on this network of vessels the nervous pulp is expanded. The state of the retinæ, when examined after death, in amaurotic eyes, accords with these views; it exhibits those changes which long-continued inflammatory disturbance would produce; it has been found thickened, opaque, spotted, buff-coloured, tough, and, in some cases, even ossified.

The preceding doctrine is, however, judiciously qualified by its restriction to the disease as seated in the eye itself. The retina and optic nerve, Mr. Lawrence admits, with other surgeons, may be disordered sympathetically, as the stomach may be disordered, without any change visible on dissection.

The second class of causes are supposed to operate, by weakening either the whole body, or the eye alone, and they indicate the general or topical use of tonic remedies. In the first case, the blindness appears as a symptom of considerable universal debility of the whole system; in the second case, it is altogether local. Every great general weakness of body, let it proceed from any cause whatsoever, may be followed by a loss of sight. Amaurosis is sometimes the consequence of a tedious diarrhœa, an attack of cholera, profuse hemorrhage, and immoderate salivations. (See *Travers's Synopsis,* p. 144.) Richter informs us of a dropsical woman who became blind on the water being let out of her abdomen. According to the same author, no general weakening causes operate upon the eyes, and occasion total blindness, so powerfully and often as premature and excessive indulgence in venereal pleasures. Mr. Lawrence does not coincide in some of the foregoing views. "Those," says he, "who have considered amaurosis to arise from debilitating causes, have considered that debility and atony of the nerve may be produced by all those circumstances which debilitate the system generally, such as loss of blood from profuse hemorrhage, diarrhœa, copious salivation, &c. I have never seen amaurosis produced by such causes. That great anxiety and grief may favour the occurrence of amaurosis, I am inclined to allow; for it is not improbable that severe impressions of that kind may produce inflammatory excitement in the brain or eyes; but I think we cannot, without more direct proofs, admit the influence of debilitating causes generally in the production of amaurosis. The most clear instance of any directly debilitating cause producing amaurosis, is that of protracted suckling."

The causes, which operate locally in weakening the eyes, are various. Nothing has a greater tendency to debilitate these organs than keeping them long and attentively fixed upon minute objects. But, however long and assiduously objects are viewed, if they are diversified, the eye suffers much less than when they are all of the same kind. A frequent change in the objects which are looked at, has a material effect in strengthening and refreshing the eye. The sight is particularly injured by looking at objects with only one eye at a time, as is done with telescopes and magnifying glasses; for, when one eye remains shut, the pupil of that which is open always becomes dilated beyond its natural diameter, and lets an extraordinary quantity of light into the organ. The eye is generally very much hurt by being employed in the close inspection of brilliant, light-coloured, shining objects. Amongst the occupations enumerated by Mr. Travers as particularly exposing persons to amaurosis, are those of needleworkers, writers, draughtsmen, inspectors of linen and scarlet cloths, and of new bank notes; money counters, smiths, stokers in iron-furnaces and glass-houses, tavern-cooks, watchmakers, engravers, philosophical instrument makers, sea officers, &c. (*Synopsis,* p. 144.) They are greatly mistaken, says Richter, who think that they save their eyes, when they illuminate the object which they wish to see in the evening with more lights, or with a lamp that intercepts and collects all the rays of light, and reflects them upon the body which is to be looked at. Richter mentions a man, who, in the middle of winter, went a journey on horseback, through a snowy country, while the sun was shining quite bright, and who was attacked with amaurosis. He speaks of another person, who lost his sight in consequence of the chamber in which he lay being suddenly illuminated by a vivid flash of lightning. A man was one night seized with blindness as his eyes were fixed on the moon. Richter also expresses his belief, that a concussion of the head, from external violence, may sometimes operate directly on the nerves, so as to weaken and render them completely paralytic.

Beer corroborates the foregoing statement; for, he says, amongst the most frequent causes is to be considered every abuse of the eyesight, especially in dark-eyed persons, as a long and close inspection of one object, particularly with a microscope, when the thing examined is very brilliant, or reflects back much light into the eye. Hence, the view of jewels at night, and long journeys through snowy countries, are conducive to the disease. In this respect, every kind of employment which strains the eyes much, and requires a strong reflected light, must be considered injurious. (See also *Travers's Synopsis,* p. 144.) Thus reverberating lamps, like Argand's; the view of a white wall illuminated with the sun's rays; and looking a long while at the moon, or more especially the sun, with the unassisted eye, are circumstances likely to bring on the disease. That a flash of lightning, especially when it suddenly wakes a person in the night-time out of a sound sleep, may produce an amaurotic amblyopia, in an irritable eye, or even perfect blindness, is a well known fact: and it is on the same principle, that going suddenly out of a dark bed-room, immediately after waking in the morning, into an apartment that commands an open extensive prospect, must be hurtful to an irritable eye, though the bad effects may only come on slowly. Here is also to be included every kind of over irritation of the eye by light, as happens to typhoid patients, when they lie with their eyes open all the day in a large sunny chamber.

In the weakness of vision (*asthenopia*) brought on by over exercise of the sight, there is some difference of opinion as to the precise nature of the changes in the optic apparatus. Dr. Mackenzie considers that the disorder depends in a great measure on a loss of power in the apparatus for the focal adjustment of the eye, and that the effort necessary for adjustment cannot be sustained; the focal length of the eye can no longer be shortened as it should be, the letters of a book necessarily fade from before the sight, and a feeling of fatigue creeps over the eye. It is probable that the cause of impotency resides not in the ciliary circle, nor in the ciliary nerves merely, but in the third nerve and other muscular nerves of the eye generally. The contraction of the recti and obliqui, then, so necessary for keeping the eye in a state of libration for directing it along the lines of a printed page, for converging the two eyes to the same point, and perhaps for compressing the globe of the eye so as to maintain an increased distance between the retina and the cornea, must in this case gradually give way under the effort demanded, so that these muscles fall into a state of minimum contraction. The consequence is, that at length the upper eyelid drops, and the patient is obliged to indulge in that cessation of visual exertion which experience has taught him will regenerate his exhausted powers of sight, and enable him by and bye to resume his labours. With reference to this statement of Dr. Mackenzie's, Mr. White Cooper thinks that "it is highly probable that in the earlier stages of this affection, and in the slighter cases, an enfeebled condition of the adjusting organs is the main fault; but has no doubt that congestion is speedily superadded, and that this local congestion is, in the majority of cases, in connection with general debility. In many cases the vessels of the eye have lost their tonicity; a trifling effort at reading visibly reddens the surface of the globe, and with a lens many small vessels may be seen distended with blood; from this, in connection with the symptoms, we may predicate the state of the deeper tissues. It is probable that the great advantage derived from cold applied to the eye itself, from iron, and from general invigorating measures, is referable to the effect produced by such remedies in restoring tone to the weakened vessels and imparting vigour to the nervous apparatus. When, however, the congestion has proceeded beyond a certain point, other treatment becomes necessary."

Mr. Dalrymple also is of opinion that the symptoms are produced by congestion, and the following quotation explains his view of the effect produced by over distention of the blood-vessels in the delicate structures of the eye: —

"When we recollect that in health the sclerotica and cornea are tough, inelastic, and resisting tissues, and that the fluids within the eye are so nicely balanced that no vacuity is left, and that no undue pressure is perceived, — when we remember also that the retina is interposed between the choroid and the incompressible vitreous body, — we shall readily perceive how increased bulk from congestion of the vascular tissue must exert a direct and injurious pressure upon the most delicate of nervous structures; how, in fact, this important organ becomes as it were benumbed by compression, and its functions and sensibilities to the pictured image presented by the rays of light interfered with, altered, or suppressed. While this effect is being produced on the special properties of the retina, we see also that the ciliary nerves that traverse the exterior of the choroid become in like manner compressed against the sclerotica, and as these are in part the channels of the common sensation of the globe, pain is induced; first of a sense of distention; secondly, of dull aching; and, lastly, pain in the brow or forehead, partaking somewhat of a neuralgic character induced by radiation to the frontal branches of the first division of the fifth pair.

The cause of amaurosis is often suspected to depend upon local or constitutional debility, proceeding from impairment of the nerves in general, or of the nerves of the head, especially those of the forehead and eyebrow; either in consequence of falls from a considerable height, or of concussion with the weight of the whole body upon the heels; blows on the head; concussions or contusions of the eyeball. Some of the cases of amaurosis from blows on the temple or the eye, observed by Mr. Travers, were attended with signs of disorganisation; some were superficially inflamed; and others presented no external appearance of injury. It is not always the eye on the struck side of the head that is affected. (*Synopsis, &c.* p. 152.) If we are to believe Beer, considerable direct weakness, leading to amaurosis, may arise from cholera, long-continued diarrhœa, salivation, and the incessant spitting of tobacco smokers; bleedings; injudicious tapping of the abdomen; excessive indulgence in venery, and the misemployment of issues. A general debility, which has the worst effect on the eyes, may also arise from long trouble, especially when the diet is poor and bad; also from a deficiency of proper food, long watching, or violent and sudden fright. The amaurosis following typhus, without any unusual irritation of the eye by light, Beer refers to general debility. (*Lehre von den Augenkr.* b. ii. p. 449.)

Like nervous deafness, amaurosis sometimes follows typhus and scarlet fever, and the various forms of acute constitutional disease. Mr. Travers has several times met with it as a consequence of infantile fevers. He observes, that it is also sometimes a consequence of chronic wasting diseases, in which organic changes interrupt the nutrition of the system. He has seen a rapid and severe salivation, instituted for a remote affection, and where no disease had previously affected the eyes, terminate in gutta serena of both. (*Synopsis*, p. 155.)

The susceptibility of the retina is conceived by Mr. Middlemore to be capable of being at once directly depressed, without going through the process of inflammation, in the same way as the nervous power of other parts of the system may be lowered or taken away by powerfully depressing and rapidly enervating agents. (*On Dis. of the Eye*, vol. ii. p. 247.)

With regard to the doctrine, that certain forms of amaurosis are diseases of debility, Mr. Lawrence expresses his disbelief in its correctness, and asserts that the only successful treatment of amaurotic affections is found, with few exceptions, to be variously modified antiphlogistic. (*On Diseases of the Eye*, ed. 3, p. 524.) Whether the amaurosis resulting from typhoid fevers, of which I have seen several instances, proceed from debility, or from too great a determination of blood to the head, may admit of dispute; but I conceive that, in many of such cases, tonic treatment is clearly indicated, if not for the eye itself, certainly for the generally enfeebled state of the health, with which the amaurosis is connected. Yet the doctrine, that fulness and congestion of the vessels originally lead to the amaurotic affection, may be more correct than the theory which refers the blindness simply to weakness. However, as the amaurosis generally does not show itself till an advanced stage of fever, or that of great debility, and as it only recedes as the patient regains strength, it can hardly be considered as a case in which any other treatment than tonic can be availing.

The third class of causes consists of irritations, most of which are asserted to lie in the abdominal viscera, whence they sympathetically operate upon the eyes. The observations of Richter, Scarpa, and Schmucker, all tend to support this doctrine. Many amaurotic patients are found to have suffered much trouble, and long grief, or been agitated by repeated vexations, anger, and other passions, which have great effect in disordering the bilious secretion, and the digestive functions in general. Richter tells us of a man, who lost his sight, a few hours after being in a violent passion, and recovered it again the next day, upon taking an emetic, by which a considerable quantity of bile was evacuated. A woman is also cited, who became blind whenever she was troubled with acidities of the stomach. (See *Anfangs. der Wundarzn.* b. iii. kap. 14.) However, according to Beer, if the case from worms be excepted, imperfect amaurosis seldom depends upon disorder of the gastric organs. (*Lehre von den Augenk.* b. ii. p. 456.); a very important difference from the statements of Schmucker, Richter, and Scarpa. The close sympathy between the stomach and the eyes is well illustrated by a case referred to by Mr. Lawrence, where an amaurosis, with fixed pain over the eyebrow in a child, was not relieved by purging and other depletive measures; an emetic was at last given; and, under its action, a bead was rejected from the stomach, and the amaurosis immediately disappeared.

Just as amaurosis is frequently a pure symptomatic effect of various disordered states of the constitution, so may different morbid changes, occasioned in the eye by those states of the health, become the proximate cause of amaurosis, as cirsophthalmia, fungus hæmatodes, dissolution of the vitreous humour, glaucoma, &c.

One case, very analogous to amblyopia senilis, is believed to depend upon a diminution of the pigmentum nigrum, which secretion, in some individuals earlier and more considerably, in others later and in a slighter degree, recedes with other secretions of a different nature. (See *Beer's Lehre von den Augenkr.* b. ii. p. 451, &c.) Mr. Middlemore is certain that he has met with cases in which a diminution in the quantity of the choroid pigment was the sole defect in the eye, and constituted the adequate and efficient cause of impaired vision. Cases of this description, he says, are for the most part attended by a contracted pupil and great intolerance of light; and vision, though seriously impaired, is seldom destroyed. (Op. et vol. cit. p. 273.)

I think with Mr. Travers, that the history and concomitant appearances of amaurosis will often denote whether the case is *organic* or *functional.* "For example, diseased changes in the situation or texture of the eyeball, or in the brain, a hemiplegia, or partial paralysis, with other signs of apoplectic or hydrocephalic pressure, whether resulting from an injury of the head, or otherwise, or an acute deep-seated inflammation, whether accompanied by a visible opacity or not, point out the organic nature of the affection. I have seen (continues Mr. Travers) such an amaurosis produced by abscess in the cerebral substance, and by medullary disease of the cerebrum. On the other hand, I have known the following distinct sources of irritation produce functional amaurosis, viz. a wound of the scalp, caries of the skull, abscess and caries of the antrum maxillare, with excessive œdema of the integuments of the lids and cheek, a large abscess under the masseter and muscles of the cheek, and an abscess at the extremity of a molar tooth, while the crown of the tooth was sound. In all these cases, it is to be understood that the eye was sound, and the orbit was untouched by the disease of the parts in the vicinity, to which the amaurosis was clearly attributable. In like manner, an excessive use, or rather abuse, of the visual faculty, the disordered functions of the stomach, liver, uterus, &c., sudden and alarming depletion, excessive or obstinately suppressed secretions, difficult dentition, the presence of worms in the intestinal canal, and the deleterious effects of noxious agents upon the organ, or the system, are sufficiently obvious causes of the functional amaurosis." (*Synopsis, &c.* p. 142.) In general, recent cases afford a greater prospect of cure than others of long standing; and the same may be said with respect to examples, in which the eyesight is merely lessened and not completely extinguished.

Amaurosis is occasionally caused by, or associated with, hysteria, hypochondriasis, epilepsy, or convulsions, but in these cases is rarely permanent, and usually subsides as soon as the spasmodic, epileptic, or convulsive attack is over. However, the complaint may begin at two periods, viz. either during such an attack, or (what is more uncommon) afterwards, and it never loses its symptomatic character. The pupil, which is much dilated, always remains perfectly clear and of a shining blackness, even when the disease has induced entire blindness; but a slight dull pain in the forehead, especially about the eyebrow, constantly preceding and accompanying the blindness, generally lasts a good while after the amaurosis has completely subsided.

As this amaurosis is merely a symptomatic effect of the above general disorders, its removal must entirely depend upon the success with which their treatment is conducted. (*Beer, Lehre von den Augenkr.* b. ii. p. 506—510.)

With respect to *rheumatic amaurosis*, we do not in this country recognise any distinct form of amaurosis entitled to the name of rheumatic, though Beer has minutely described such a case. No doubt a certain proportion of amaurotic patients suffer from rheumatism; but I agree with those pathologists who do not acknowledge rheumatism as having been clearly proved to be a cause of amaurosis.

Gouty Amaurosis.—According to Mr. Travers, gout attacks the eye through the medium of the stomach. Vomiting occurs, with pain in that organ, on the subsidence of an inflammation in the extremities, and is succeeded by violent pain in the head. The loss of sight, he adds, is sudden and permanent. (*Synopsis, &c.* p. 163.) The gouty amaurosis, described by Beer, is perhaps badly named: at all events, there are some circumstances in its history which must create doubts about its dependence upon gout. "We can admit," says Mr. Lawrence, "that the nervous structure of the eye may be diseased in the rheumatic and gouty, as well as in other persons; but it will require clearer evidence than we possess at present to show, that there are distinct gouty and rheumatic amauroses." (*Lawrence*, op. cit. p. 510.) When we find Beer describing one form of gouty amaurosis as taking place only in dark-eyed slender maiden ladies, who have suffered from scrofula in their childhood, or from other severe diseases at a later period, and whose menses are irregular, or have ceased, we must regard his evidences of gouty amaurosis as vague and fanciful.

When *amaurosis proceeds from disease of the optic nerves, or their sheaths,* it comes on slowly, and rarely attacks both eyes together. It commences with a black cloud, which grows more and more dense, and with a troublesome, alarming, perversion and disfigurement of every object, without the least painful sensation in the eye or head. The patient merely complains of a slight sensation of dull pressure at the bottom of the orbit, as if the eyeball were about to be forced from its socket, of which displacement, however, there is not yet the smallest appearance. In the very beginning of the disease, the pupil is already considerably dilated, and the pupillary edge of the motionless iris presents angles at several points, the pupil sometimes representing an irregular pentagon, or hexagon. By degrees, though very slowly, a glaucomatous change of the vitreous humour ensues, and afterwards of the lens itself; the only species of glaucoma which Beer has ever noticed quite unattended with a varicose affection of the blood-vessels of the eye. At last the globe of the eye becomes perceptibly smaller than natural; but a complete atrophy does not ensue.

The morbid changes which Beer had himself ascertained by dissection, consist in a real induration of the optic nerves, and an adhesion of them to their sheaths, while within the skull these ash-coloured, gray, very much diminished nerves, presented no vestige of medullary structure even as far as their origin from the brain. On the contrary, the optic thalamus presented externally its natural appearance. The retina seemed to have lost its pulpy matter, was tough, not easily torn, and appeared to consist but of a vascular membrane. In one example, although both eyes had been completely deprived of sight together, Beer found only the retina and optic nerve of the left side in this state of atrophy as far forwards as the point of union on the sella turcica. On the other hand, the optic nerve of the right eye was hard, without being in the least dwindled, and was closely adherent to its external coverings. Anteriorly to their decussation, nothing at all preternatural in either nerve could be discerned. But the left corpus striatum was so indurated, that a very sharp, strong scalpel was required for its division, though in colour and shape it was perfectly natural. On this side, also, the plexus choroides was entirely wanting. In three amaurotic patients of this kind, Beer found hydatids between the coverings of the optic nerve; and where such hydatids lay, the medullary matter seemed to have been displaced by their pressure. With the utmost care, he could not trace the ophthalmic ganglion.

Raw also found on the optic nerve a large hydatid, which had produced amaurosis. (*Obs. Anat. Rarior.* Obs. 2.) In Mr. Heaviside's museum there was a preparation of the optic nerve of an amaurotic eye, where a tumor of considerable bulk had grown from the neurilemma. (See *Wardrop's Essays on the Morbid Anatomy of the Human Eye,* vol. ii. p. 157.) In this work are specified examples of various other morbid changes of the optic nerve, especially calculous concretions within it, the presence of a viscid, muddy, gray, fluid, in the thickened neurilemma, instead of pulp, atrophy of the nerve, &c.

An instance is recorded by Haller (*Opusc. Pathol.* Obs. 65, p. 172.) in which a calcareous mass was found betwixt the membrane of Ruysch and the vitreous humour. According to Beer, there is preserved in the pathological and anatomical museum of the general hospital at Vienna, an eye distended with a similar osseous mass, without the capsule of the lens being at all affected.

Magendie states, that he has seen the retina transformed into a fibrous membrane; though Andral suspects that the change could not have happened in the nervous expansion itself, but rather in the very fine cellular substance between it and the choroid coat. (*Anat. Pathol.* t. i. p. 272.) An osseous capsule also, sometimes produced within the eye, and usually regarded as an ossification of the retina, he offers good reasons for setting down as really an ossification of the cellular tissue between the retina and choroid tunic. (Op. et vol. cit. p. 297.)

Various other swellings in the orbit, as, for instance, encysted tumours, &c., may and must gradually produce complete amaurosis by their pressure upon the optic nerves and retina. Some of these cases are usually characterised by a protrusion of the eye from its socket. (See EXOPHTHALMIA.) Cases depending upon atrophy of the optic nerves are recorded by Dr. Monteith. (See *Weller's Manual.*) Mr. Langstaff has some interesting specimens of enlargement in front of the third ventricle, the parietes of which bulge so as to press upon the optic nerves, and thus to account for the amaurosis under which the patients laboured.

In another instance, the macula lutea, which is naturally a yellow spot near the centre of the retina, was found black. (*Mém. de la Société Méd. d'Emulation,* an. 1798.)

When *amaurosis proceeds from disease of the skull or brain,* it usually attacks both eyes together, or at least one soon after the other, the blindness also commencing very slowly, with appearances as if every object looked at were perverted or disfigured. However, there is no black cloud, but rather an obscurity or confusion of every object. The disease in this stage is also accompanied with frequent giddiness, ugly luminous spectra, and, for the most part, with aversion to light, uncommonly lively motions of the iris, a contracted pupil, angles in the upper and lower portions of the pupillary margin of the iris; an evident turgescence of the blood-vessels of the eye, gradually augmenting with most violent headache into actual cirsophthalmia; frequent convulsive motions of the eyes and eyelids, and strabismus of one or both eyes, ending in a true deviation of one or both these organs from their natural positions. Under these symptoms, vision is afterwards entirely abolished; and the headache, though subject to remissions, grows so much worse, extending back to the spine, that the patient is often nearly frantic, and, indeed, after a time, a destruction of the external senses happens, followed by that of the intellectual faculties. The first of the external senses which is lost is always the hearing, which infirmity is next followed by loss of the smell or taste, or both these senses together; and then the memory and other intellectual powers decline. In this stage of the disorder, the eyeball not unfrequently protrudes from the orbit; a pathognomonic symptom, to which Beer attaches great importance, because it is an infallible criterion of a diseased state of the bones of the orbit, of the parts which invest this cavity, and of the optic nerve and dura mater, in the sella turcica. In such cases, complete mania now usually follows, and this sometimes in its most violent form, unless the patient happen to be first carried off by paralytic symptoms; life, under these circumstances, never lasting any considerable time.

The cause of both these forms of amaurosis lies in diseased alterations of the bones of the cranium, the dura mater, and the brain.

The morbid alterations of the bones of the skull mostly happen at its basis; and not only may caries take place, but still more frequently exostoses of various forms, which are sometimes so small that they are first detected by the bone giving the feel of a rough grater. At the same time they are so sharp, that if the finger be passed rudely over them, it will be painfully hurt. In these cases, the bones of the cavity of the skull are always found extremely thin; the diploe is almost entirely wanting, and the parietes of the orbit are preternaturally diaphanous, and, in some places, imperfect. Beer speaks of a lady's skull, who had been completely blind, and, for some weeks previously to her death, insensible; in which instance scarcely any part of the cavity of the skull could be touched without risk of the fingers being hurt by spicula. Once, in an amaurotic boy, who, for a short time before his death, was so insane that he used to devour his own excrement, Beer found at the side of the sella turcica a long considerable spiculum, which passed directly through the optic nerves at the place of their decussation. A case of amaurosis, produced by a spiculum of bone injuring the opposite side of the brain, is related by Anderson. (See *Trans. of the Society of Edinb.* vol. ii.) Sometimes the ethmoid bone has been found carious (*Ballonius, Paradigmata*, No. 7); sometimes other parts of the cranium. (*Mursinna, Beobacht.* b. i. No. 6; *Schmucker, Vermischte Schrift.* b. ii. p. 12.) Fractures of the skull at the anterior part of its basis may cause pressure on one or both optic nerves, or on their union, or may otherwise injure them. (See *Case in Sir B. Brodie's Paper on Inj. of the Brain*, in *Med. Chir. Trans.* vol. xiv.) These nerves may be variously affected by disease of the bone, or its membranous coverings, in the same situation; or, in the orbit, such disease may have a venereal origin, and be indicated by the simultaneous existence of other symptoms referrible to the same cause. (See *Lawrence on Dis. of the Eye*, ed. 3, p. 516; also *Case by Wilson*, in *Trans. of Soc. for Improvement of Med. and Chir. Knowledge*, vol. iii.) Sometimes the medullary substance of the brain itself is quite soft, while the cortical substance is full of blood-vessels, and unusually firm, the convolutions being hardly distinguishable.

Examples, in which the amaurotic blindness arose from abscesses in the brain, are reported by Ballonius (*Paradigmata Hist.* 7), by Pelargus (*Med. Jahrg.* b. iii. p. 198), Peyronie (*Mém. de l'Acad. Royale de Chir.* t. i. p. 212), Schaarschmid (*Berlin Nachrichte*, 1740, No. 26), Langenbeck (*Neue Bibl.* b. i. p. 61), and Mr. Travers (*Synopsis*, p. 143.) The latter author has recorded an instance in which a firm lardaceous tumour, of the size of a garden bean, situated on the same side as the blindness, compressed the optic ganglion and nerve at its origin from it. (*Synopsis*, p. 151.) I have seen a case of amaurosis, in which a medullary tumor as large as a middling-sized apple was found in the anterior lobe of the brain, attended with protrusion of the eye, and vast destruction of the bones. I was consulted in 1835, for a case of amaurosis in a young lady, 14 years of age, the daughter of a surgeon. The pupils were remarkably large, and of a clear black colour. She died suddenly, and a tumor, formed in the anterior lobe of the brain, was found to have been the cause of the blindness and of her death. Mr. Travers has seen amaurosis produced by a medullary fungus of the brain. A case, occasioned by disease of the thalamus, is related by Villeneuve (*Journ. de Méd. continué*, 1811, Févr. p. 98); another, of a tumor of the thalamus on the same side as the blindness, is recorded by Ford (*Med. Commun.* vol. i. No. 4); and other swellings in various parts of the brain are described in *Ephem. Nat. Cur.* Dec. 3, Ann. 9, and 10, Obs. 253; *De Haen's Ratio Medendi*, P. 6, p. 271; *Journ. des Savans*, 1697; *Muzell's Wahrnehm.* b. ii. No. 13; *Plater, Obs.* lib. i. p. 108; *Thomann, Annalen fur* 1800, p. 400, &c.; *Wardrop's Essays on the Morbid Anatomy of the Human Eye*, vol. ii. p. 174, &c.

Bonetus, in his *Sepulchretum Anatomicum*, lib. i. sect. 18, describes various cases which were quite incurable: after death the blindness in one instance was found to be occasioned by an encysted tumor, weighing fourteen drachms, situated in the substance of the cerebrum, and pressing on the optic nerves near their origin. In the second, the blindness was produced by a cyst, containing water, and lodged on the optic nerves, where they unite. In a third, it arose from a caries of the os frontis, and a consequent alteration in the figure of the optic foramina. In a fourth, the cause of the disease was a malformation of the optic nerves themselves. Mr. Lawrence refers to a specimen in Mr. Langstaff's museum, exhibiting the eyes, optic nerves, and part of the basis of the brain of a man, who had been amaurotic for twenty-eight years. The sclerotica, cornea, iris, pupil, choroid coat, and retina, are perfectly healthy. The optic nerves in their whole extent, from the globes backwards, are shrunk into white cords, not larger than a small crow-quill. At the point of union, they merely lie together without being joined, and each proceeds to its own side of the brain. Where they sweep round the crura cerebri, they are gradually confused and lost. (See *Lawrence on Dis. of the Eye*, ed. 3, p. 518.)

In some of the instances, in which no apparent alteration can be discovered in the optic nerve, the late Mr. Ware conjectured that a dilatation of the anterior portion of the circulus arteriosus of Willis may be the cause of the affection. The anterior part of the circulus arteriosus lies directly over, crosses, and is in contact with, the optic nerves; and just in the same way as the anterior part lies over the optic nerves, the posterior part lies over the nervi motores oculorum. Hence Mr. Ware attempted to refer the amaurosis itself, and the paralytic affection of the eyelids, and muscles of the eyes, sometimes attendant on the complaint, to a dilatation of the anterior and posterior branches of the circulus arteriosus. The frequently diseased state of the trunk, or small branches of the carotid arteries at the side of the sella turcica, is noticed by Dr. Baillie in his useful work on Morbid Anatomy, and he says the same sort of diseased structure is also found in the basilar artery and its branches. (See *Ware's Chir. Obs. on the Eye.*)

On the authority of Ecker, one case is upon record, where the cause of amaurosis depended upon an aneurism of the central artery of the retina. (*Pinel, Nosographie Philos.* t. ii. p. 122.)

Many of the causes of amaurosis are of such a nature as to render the disease totally incurable. Of this description is fungus hæmatodes, in which the structure of the retina and optic nerve is changed in a remarkable manner, the whole cavity of the eyeball becoming filled with a substance resembling medullary matter, and the optic nerve changed in its form, colour, and structure. (See *Wardrop's Essays on the Morbid Anatomy of the Human Eye,* vol. ii. p. 156, 8vo. Lond. 1818.)

Injuries of the supra orbital branches of the fifth nerve have been frequently followed by loss of sight, and the experiments of Vicq d'Azyr, tend to prove the reality of amaurosis from the cause in question. Vicq d'Azyr exposed and lacerated the frontal and superciliary branches of the fifth pair in various animals, and found that the injury was followed by amaurosis. (*Journ. Compl. des Sciences Méd.* t. xliv. p. 201. Paris, 1832.)

According to Mr. Wardrop, it is only when this nerve is wounded or injured, and not divided, that amaurosis takes place; for the blindness may sometimes be cured by making a complete division of the trunk nearest its origin. (*Morbid Anatomy of the Human Eye,* vol. ii. p. 180.)

Dr. Hennen met with one or two cases of amaurosis from wounds of the supra-orbitary nerve: the perfect division of the nerve produced at first no alleviation of the complaint, but after some time the eye partially recovered. (*Principles of Military Surgery,* p. 366.)

Irritation of other portions of the fifth nerve, from carious teeth or from tumors connected with, or pressing upon some of its branches, has been known to produce amaurosis, and in such cases removal of the irritating cause has generally been followed by restoration of the sight. Richter acquaints us with the case of a lady, who had been blind for years, but experienced a short recovery of her sight on having a tooth extracted. (*Anfangsgr.* &c. b. iii. kap. 14.)

A similar fact is recorded by Mr. Travers, who says, that he has seen an incipient functional amaurosis distinctly arrested by the extraction of a diseased tooth, when the delay of a similar operation had occasioned gutta serena on the opposite side two years before. (*Synopsis,* p. 299.)

Richter records the following example. A small shot pierced the upper eyelid, and lodged at the upper part of the right orbit, between the eyelid and eyeball, so that it could be felt externally. The patient shortly afterwards became blind in the left eye; but recovered his sight after the excision of the shot. (*Anfangsgr. der Wundarzn.* band iii. p. 439.)

In 1826, M. Magendie related to the French Academy of Sciences various facts exemplifying the remarkable influence of the fifth nerves over all the senses: and, with respect to the sense of sight, he finds that the action of the eyeball and optic nerve cease immediately they are completely deprived of the influence of those nerves. Thus, a state of the eye is produced that has the greatest analogy to amaurosis. Indeed, when the fifth nerves are divided in an animal, it is instantly bereft of sight on the side on which the nerve has been cut, notwithstanding the eye retains at the moment all the physical conditions necessary for vision. It is not to be supposed, however, that the fifth nerves perform the function usually referred to the optic ones. To *perceive the light,* and *to see,* as Magendie remarks, are, experimentally speaking, two different things. An animal, whose fifth nerves have been divided, does not see, neither is it conscious of the daylight, or of the strongest artificial light; yet it decidedly perceives the impression of the rays of the sun, when they fall directly on the eye. Hence, a healthy, sound condition of the optic nerve on the one part, and of the fifth nerve on the other, is essential to perfect vision; and M. Magendie therefore deems it highly probable, that there are two kinds of amaurosis; one depending on a particular affection of the optic nerve, and retina; the other on disease of the fifth nerve, and the defect of its influence on the organ of vision. These reflections led him to make trial of a combination of acupuncture and galvanism for the cure of certain cases of amaurosis. Thus, in one case, having introduced one needle into the frontal nerve, and another into the upper maxillary one, he brought the needles into repeated contact with the two poles of a voltaic pile. In a fortnight, the patient had received considerable benefit from the plan. Other facts are also recorded in favour of this treatment. (See *Journ. Expér. de Physiol.* t. vi. p. 156 *et seq.*)

The abuse of narcotic poisonous substances may induce amaurosis; as opium, hyoscyamus, belladonna, &c. Lead will do the same thing. Dilatation and a fixed state of the pupil follow the mere application of some narcotics to the skin; a circumstance of which we take advantage in the treatment of several diseases of the eye; but it does not usually happen that belladonna and hyoscyamus, the substances employed in this way, produce any other effect than a degree of obscurity and dazzling, such as a great influx of light through a much dilated pupil might occasion. Taken internally, however, these and some other poisons of the same class, as stramonium, dulcamara, white hellebore, tobacco, opium, &c. cause more or less complete insensibility of the retina, along with mydriasis, or myosis. The blindness is often a very obstinate symptom, continuing a long while after disturbance of the intellectual functions has ceased. (See *Mackenzie on Dis. of the Eye,* p. 1064, ed. 4.)

An *amaurosis* is described as produced by certain vegetable *bitters,* and by particular articles of food. But the reality of such cases is doubted by Mr. Lawrence. (Op. cit. p. 491.)

Cat-eye amaurosis is a case particularly described by Beer; it rarely advances to complete blindness, and occurs chiefly in very old persons. Sometimes, however, it takes place in young subjects, and even in children. Beer alleges that it is always confined either to thin, dwindled, old gray-headed subjects, in whom the exchange of organic matter is carried on but tardily, or else to young subjects, who are unhealthy, and disposed to consumption, hectical adults, emaciated children, and as a consequence of severe injuries of the eye. While this amaurosis is not perfectly formed, the iris retains its mobility, and the pupil is neither preternaturally dilated nor contracted; but when once the patient is quite bereft of vision, the motions of the iris are slow, and the pupil larger than in a healthy eye in an equal degree of light. At the bottom of the eye, far behind the pupil, a concave pale gray, bright yellowish, or variegated reddish opacity, is developed. By this the eyesight is not merely weakened, but rendered quite confused, since all objects, and especially smallish ones, appear to be confounded together, particularly when the patient tries to inspect closely any determinate body. The further the disease advances, the brighter and more visible is the bottom of the eye, the paler is the colour of the iris (a thing very conspicuous in darked-eyed persons); and when once the amaurosis is complete, so that no susceptibility of the impression of light is left, then, upon an attentive examination of the eye, one can mostly perceive, at the troubled deeper part of the eye, a slender vascular plexus, which merely consists of the ordinary ramifications of the central artery and vein. In a half-darkened place, such an eye presents a shining yellowish or reddish appearance, but only in certain positions of the eyeball; and in this respect, it is somewhat similar to the eye of a cat, whence Beer chooses to term the complaint cat-eye amaurosis. The disorder is also not accompanied with any other essential morbid appearances, except the decline of vision, or complete blindness. (*Lehre von den Augenkr.* b. ii. p. 496.) Beer, in fig. 1. tab. 4. of his second vol. has given, from nature, an admirable representation of this remarkable species of amaurosis. The differences in the appearances at the bottom of the eye, in this case, from those presented in the early stage of fungus hæmatodes of that organ, will be best understood by referring to the article FUNGUS HÆMATODES. On this point, however, I may here briefly state, that, in cat-eye amaurosis, there is *no projection*, but, on the contrary, *a concave depression* in the axis of vision. Cat-eye amaurosis may be known from incipient cataract, by the opacity being more deeply situated, and having a shining pearly lustre. (See *Journ. of Foreign Med.* vol. iv. p. 168.)

Beer observes, that the causes of this species of amaurosis are so obscure, that whatever is offered upon the subject can be received only as conjecture. A suspicion is sometimes entertained, that a deficiency of the pigmentum nigrum, and of the tapetum of the uvea, is concerned in the production of this form of blindness.

The prognosis cannot but be very unfavourable; for, as the surgeon is ignorant of causes, he cannot know what means ought to be adopted for their removal. It is fortunate, however, that this amaurosis rarely attains its highest degree, but almost constantly remains in the form of a more or less considerable amblyopia.

Just as little is yet known respecting any well-regulated mode of treatment; but the disease may sometimes be kept from getting worse, by the careful employment of such general remedies, regimen, and diet, as are calculated to improve the health. However, in the most fortunately managed cases, Beer never knew a step made towards the removal of the disease. (*Lehre von den Augenkr.* b. ii. p. 497, 498.)

PROGNOSIS OF AMAUROSIS.

In general, every amaurotic weakness of sight, and every completely formed amaurosis, are attended with the greatest probability of cure, where they began suddenly and were quickly developed. (*Beer, Lehre von den Augenkr.* b. ii. p. 454—456.) This observation perfectly coincides with the account given by Schmucker, who says that many of these suddenly formed cases fell under his notice, and were more easy of cure than when the disorder had come on in a more gradual way. (See *Vermischte Chir. Schriften*, b. ii.) It also agrees with what Mr. Travers has stated, namely, that slow and steadily progressive cases of amaurosis are more to be apprehended in the result, that is, are less tractable, than either the sudden, or the rapidly advancing disease, supposing all to be alike free from unequivocal signs of organic change. (*Synopsis*, p. 298.)

Respecting suddenly produced cases, Mr. Lawrence holds out less encouragement than the preceding authorities. The prognosis, he says, is doubtful, and rather unfavourable than otherwise, as to the complete recovery of vision, if the affection, even in its most recent state, should have produced complete insensibility of the retina. He thinks we should speak doubtfully of the result in the case of complete insensibility to strong light, even if it had only lasted twenty-four hours. He considers it difficult to say in what number of days, or weeks, we should give up all hopes of recovery. In the supposed case of total insensibility, or even of a near approximation to it, there would be more ground for apprehension than hope, at the end of a week, though sight is sometimes restored under these circumstances; but the lapse of a few weeks, without improvement, makes the case hopeless.

If amaurosis be partial, and the case seen early, Mr. Lawrence says a complete cure may be expected. He thinks favourably of the event when amaurosis takes place in conjunction with chronic internal inflammation, or when it is evidently caused by active congestion in the head or eye; for that can be removed by suitable treatment. A similar judgment is delivered by Mr. Middlemore: when the case is recent, takes place in young persons, and is evidently produced by vascular plethora, he says the prognosis is favourable, because the remaining degree of vision proves that no important structural change has yet occurred, and the plethoric state of the system can be removed. (See *R. Middlemore on Dis. of the Eye*, vol. ii. p. 273.)

Dr. Mackenzie says, that "there is scarcely any disease in which the prognosis is, on the whole, so unfavourable as in amaurosis. It is only when the disease is not yet complicated with any material disorganisation, that amaurosis yields to treatment. But in the cases which do yield, the degree of the disease is not always slight, but often serious, and the attack is not always recent, but often of considerable standing. It is chiefly in cases of an inflammatory or congestive nature that the disease is overcome. (*On Dis. of the Eye*, ed. 4, p. 1030.)

When one eye has been completely bereft of sight by amaurosis, and the surgeon can find out little or no cause for the infirmity, there is strong reason for apprehending that the other eye will, sooner or later, become blind. To this fact the exceptions are rare.

According to Beer, the idea entertained by some writers is not built upon experience, that amaurotic patients, in whom the iris is still moveable, and the pupil not much dilated, are more easily and frequently cured than others in whom the iris is perfectly motionless and the pupil exceedingly dilated. For sometimes, during the treatment, or even spontaneously, the iris, after being quite immoveable, recovers its powers of motion, yet the patient may not, at the same time, regain the slightest degree of vision; and, on the other hand, many cases of perfect amaurosis are cured without the iris recovering any of its mobility, and the pupil remains dilated during the remainder of the patient's life. (*Lehre von den Augenkr.* b. ii. p. 458.) Richter also states that an amaurosis may be cured which is attended with a pupil extraordinarily dilated and entirely motionless; and sometimes the disorder proves incurable, notwithstanding the pupil is of its proper size and capable of motion. The pupil sometimes recovers its moveableness, in the course of the treatment, although nothing succeeds in restoring the eyesight. (*Anfangsr. der Wundarzn.* b. iii. p. 424, 8vo. Gött. 1795.) However, the continuance of the perfect mobility of the pupil is set down by Mr. Middlemore as a favourable symptom; but he would not pronounce a case hopeless in which its mobility is entirely lost. (See *Middlemore on Dis. of the Eye*, vol. ii. p. 262.)

In some rare instances, amaurotic blindness has been cured by some apparently accidental, or indeed morbid effect, without any assistance from art; by hemorrhage from the nose, an intermittent fever, a blow on the head, &c. Beer operated successfully upon both eyes of a patient with cataracts, which had been previously depressed too far against the retina, so that their pressure gave rise to amaurosis, which, after continuing eight years, was suddenly removed by the patient's accidentally falling out of bed, and pitching upon the top of his head. (*Lehre von den Augenkr.* b. ii. p. 458.)

The following observations, made by Beer respecting the prognosis, cannot fail to prove interesting. There is a species of amaurosis which gradually diminishes of itself; for instance, that which arises from hard drinking, or the effect of narcotic poisons, belladonna, opium, hyoscyamus, &c.

Sometimes imperfect amaurosis goes away without any assistance from art, in consequence of the accession of some other disease, as an eruption, a discharge of matter from the ear, bleeding from piles, return of the menses, &c.

In most cases, when the surgeon is so fortunate as to cure amaurosis, there still continues, for life, a considerable degree of amblyopia, more especially if the amaurosis has been complete.

Sometimes by successful treatment, vision is in a great measure, or even entirely, restored in one eye, yet the other remains completely blind; or one eye sees again much sooner than its fellow, although they were both affected together with an equal degree of blindness.

It often happens that, though a material degree of vision returns in the course of the treatment, the faculty is restricted to a circumscribed point of the retina, so that the patient is enabled to see objects plainly only when they are held in a particular direction before him; while, in other directions, they are either quite invisible, or very indistinct. (*Beer, Lehre von den Augenkr.* b. ii. p. 459, 460.)

Amaurosis, following an injury of the supra-orbitary nerve, ordinarily resists every endeavour made to relieve it, and this whether it come on directly after the blow, or some weeks subsequently to the healing of the wound of the eyebrow; but it is not always incurable. One cure is recorded by Valsalva. (*Dissert.* 2, § 11.) Additional instances are reported by Hey (*Med. Obs. and Inq.* vol. v.); by Larrey (*Mém. de Chir. Militaire*, t. iv. p. 181.)

Mr. Hennen and Mr. Wardrop both mention instances in which complete division of the trunk of the nerve on the side nearest to its origin has been followed, in some cases, by complete cure, and in others by a partial restoration of the sight.

Perfect, inveterate amaurosis, attended with organic injury of the substance constituting the immediate organ of sight, says Scarpa, is a disease absolutely incurable. *Imperfect, recent amaurosis*, particularly that which is *periodical*, is usually curable; for it is mostly dependent upon causes which, though they affect the immediate organ of sight, are capable of being dispersed, without leaving any vestige of impaired organisation in the optic nerve or retina.

When amaurosis has prevailed several years in persons of advanced age, whose eyesight has been weak from their youth; when it has come on slowly, at first with a morbid irritability of the retina, and then with a gradual diminution of sense in this part, till total blindness was the consequence; when the pupil is motionless, not circular, and not much dilated; when it is widened in such a degree that the iris seems as if it were wanting, and the margin of this opening is irregular and jagged; and when the bottom of the eye, independently of any opacity of the crystalline lens, presents an unusual paleness, like that of horn, sometimes partaking of green, and reflected from the thickened retina, the disease may be generally set down as incurable. Kieser joins Scarpa in representing this alteration as an unfavourable omen, adding, that it only takes place in examples of long standing, and that, when it is considerable, the disease is incurable. Langenbeck differs, however, from both these authors, and particularly from Kieser, assuring us, not only that he has often seen this discoloration of the bottom of the eye in the early stage of amaurosis, but seen patients in this state soon cured. The cases which he has published, in proof of this statement, I have read with care, and find them completely satisfactory. Langenbeck agrees with other writers in imputing the appearance to a morbid change of the retina, and the treatment which he prescribes consists in the internal exhibition of the oxymuriate of mercury in small doses, and friction with mercurial ointment on the eyebrow and temple. (See *Langenbeck's Neue Bibl. für die Chirurgie*, b. i. p. 64—69, &c. Göttingen, 1815.)

Cases, attended with pain all over the head, and a continual sensation of tightness in the eyeball; or preceded by a violent, protracted excitement of the nervous system, and then by general debility, and languor of the constitution, as after masturbation, premature venery, and hard drinking; or connected with epileptic fits, or frequent spasmodic hemicrania; or which are the consequence of violent, long-continued, internal ophthalmia, may be set down as incurable. Nor can any cure be expected, when amaurosis proceeds from a direct blow on, or violent concussion of the eye; foreign bodies in the eyeball, or exostoses about the orbit; or when it is conjoined with a manifest change in the figure and dimensions of the eyeball. The same judgment is applicable to complete amaurosis from long exposure of the eye to vivid light, or to causes which have been protracted in their injurious effects upon the retina. (See *R. Middlemore*, vol. ii. p. 274.)

Recent, sudden cases, in which the pupil is not excessively dilated, and its circle remains regular, while the bottom of the eye is of a deep black colour; cases unaccompanied with any acute continual pain in the head and eyebrow, or any sense of constriction in the globe of the eye itself; cases which originate from violent anger, deep sorrow, fright, gastric disorder, general plethora, or the same partial affection of the head, suppression of the menses, habitual bleedings from the nose, piles, &c., great loss of blood, nervous debility, not too inveterate, and in young subjects, are generally curable. Amaurosis is also mostly remediable, when produced by convulsions or the efforts of difficult parturition; when it arises during the course, or towards the termination of acute or intermittent fevers; and when it is periodical. (*Scarpa, Osservazioni sulle Malattie degli Occhi*, cap. 20. Venez. 1802.) If amaurosis take place from the free administration of mercury, from protracted suckling, from profuse diarrhœa, or from a state of general debility, induced by other causes, the prognosis must depend upon our capacity to remove the debilitated state of the constitution, or its causes. In some cases, this is easy; in others, impossible. (See *R. Middlemore*, op. cit. vol. ii. p. 273.)

According to Mr. Travers, it is rather the degree than the nature and origin of the symptomatic functional amaurosis that should in most cases influence our prognosis; yet the latter circumstances, it is equally clear, afford more or less encouragement, in proportion as the pre-existing states of disease ordinarily admit of relief, or not. Thus, says he, the amaurosis from gastric diseases, from plethora, from irritation, are all of them relievable, and, if treated at an early period, remediable. Whereas paralysis, the sequel of fever, or of epilepsy, or severe constitutional diseases, whether acute or chronic, or depending upon habitual cerebral congestions combined with organic visceral disease, or induced by the operation of noxious agents on the system, is a hopeless form of the malady. (*Synopsis*, p. 296.) I may remark, however, that various examples of recovery from amaurosis induced by fevers have fallen under my own notice.

In general, when the treatment proves successful, the return of vision is accompanied with a regression of the same characteristic effects which were disclosed in the gradual advance of the disorder, viz. appearances as if there were before the eyes flashes of light, a cobweb, network, mist, or flaky substances. (*Beer, Lehre von den Augenkr.* b. ii. p. 460. Wien. 1817.)

Upon the commencement of the cure, there is also a return of the obliquity of sight; one of the most constant symptoms of imperfect amaurosis. This is a circumstance which Hey took particular notice of: he says, that it was most remarkable in these persons who had totally lost the sight in either eye; for in them the most oblique rays of light seemed to make the first perceptible impression upon the retina; and, in proportion as that nervous coat regained its sensibility, the sight became more direct and natural. (See *Med. Obs. and Inq.* vol. v.)

Treatment of Amaurosis.

When amaurosis is to be fundamentally cured, not upon empirical, but scientific principles, all the causes of the disorder must be ascertained, and, if possible, removed, as in the treatment of every other complaint. How often, however, it is impossible to accomplish either the one or the other of these objects, must be clear enough from the preceding observations. Amaurosis is sometimes merely a symptom of another disease, and then attention must be directed to the primary malady, as illustrated in apoplexy, hydrocephalus, depressed fractures of the skull, and disorder of the intestinal or uterine functions.

If no particular circumstance can be assigned as the cause of amaurosis, the surgeon should act with great caution, and constantly bear in his mind, first, the constitution, sex, and age of the patient; secondly, his ordinary employments, and general mode of living; and thirdly, the principal morbid appearances under which the disease originated and was developed. (*Beer, Lehre von den Augenkr.* b. ii. p. 462.)

In that species of amaurosis which arises from causes inducing the disease, by means of a preternatural fulness and dilatation of the blood-vessels of the brain, or eye, the indication is to lessen the quantity of blood and general plethora, and determination of blood to the head and organ affected. For this purpose the patient may be bled in the arm or temporal artery. The evacuation is to be repeated as often as seems necessary, and it will be better to begin with taking away from sixteen to twenty ounces. The efficacy of bleeding, in the cure of particular cases, is strikingly exemplified by numerous well-authenticated observations. Richter informs us of a woman who, on leaving off having children, lost her sight; but recovered it again by being only once bled in the foot. A spontaneous hemorrhage from the nose also cured a young woman who had been blind for several weeks. (*Anfangsgr. der Wundarzn.* b. iii. p. 442.)

That bleeding is sometimes hurtfully and wrongfully practised in amaurotic cases, is a fact which admits of no doubt. Mr. Travers particularly refers to one description of cases where the lancet does harm: these are cases of undue determination of blood to the organ, which are especially common after deep-seated chronic inflammation or distress from over-excitement, by which its vessels have lost their tone; an effect decidedly increased by depletion. In one interesting case of this kind a gradual, but perfect, recovery followed a regulated diet, and a course of the blue pill, with saline aperients. (*Synopsis*, p. 159.) All cases of direct debility and proper paralysis of the retina (says Mr. Travers) are aggravated by loss of blood, and the great prevailing mistake in the treatment of amaurosis is the indiscriminate detraction of blood. (*Synopsis*, p. 303.)

When, in addition to general bleeding, topical is also necessary, leeches may be applied to the temples, or cupping glasses to the back of the neck, or temples. Besides bleeding, purgatives, blisters, bathing the feet in warm water, low diet, repose of the organs, &c. are proper.

In some cases the foregoing means fail in producing the desired benefit, even when followed up, as far as the pulse and strength will allow. Here the continuance of the disease may depend, either upon the stoppage of some wonted evacuation of blood, or else upon some other cause of the first class. In the first of these cases (says Richter) experience proves that the disease will sometimes not give way before the accustomed discharge is re-established. A woman, who (as this author acquaints us) had lost her sight, in consequence of a sudden suppression of the menses, did not recover it again till three months after the return of the menstrual discharge, notwithstanding the trial of every sort of evacuation. He also tells us of another woman, who had been blind half a year, and did not menstruate, and to whose external parts of generation leeches were several times applied. As often as the leeches were put on (says Richter) the menses in part recommenced; and, as long as they made their appearance, which was seldom above two hours, the woman always enjoyed a degree of vision. (*Anfangsgr. der Wundarzn.* b. iii. p. 443.)

For the amaurosis arising from suppression of the menses, Scarpa recommends leeches to the pudenda, bathing the feet in warm water, and afterwards exhibiting an emetic, and laxative pills, made of rhubarb and tartrate of antimony, combined with gummy and saponaceous substances. If these means fail in establishing the menstrual discharge, he says great confidence may be placed in a stream of electricity, conducted from the loins across the pelvis, in every direction, and thence repeatedly to the thighs and feet.

For the amaurosis proceeding from the stoppage of habitual bleeding from piles, Scarpa recommends leeches and fomentations to the hemorrhoidal veins, then an emetic, and afterwards the same opening pills. (*Osservazioni sulle principali Malattie degli Occhi*, cap. 19.)

The principle on which Mr. Lawrence directs the treatment, is that of putting a stop to vascular excitement, with the view of preventing the permanent injury of altered structure and impaired function of the retina. Hence he is a zealous advocate for the antiphlogistic treatment in the early stage of amaurosis. "But," says he, "if this treatment be not found to remove the change which has been produced in the retina, we must have recourse to mercury, which appears to be as decidedly beneficial in these cases as in iritis or general internal inflammation. The remark which I made respecting the use of mercury in those affections, applies also to the present case, namely, that its good effect mainly depends upon the promptitude with which it is employed. The alterative form is insufficient; we give it with the view of arresting inflammation in the structure, which is the very seat of vision; that structure is easily changed by the inflammatory process; our only remedy is to push the mercury in a decided manner, and if we do so, we shall put a stop to the affection." When the amaurotic affection depends on vascular plenitude of the retina, and that peculiar action of its capillary system of vessels which is disposed to bring on organic changes, Mr. Middlemore is also an advocate for mercury, which, for the purpose of stopping such action and producing an absorption of effused or deposited matter, he directs to be employed freely, so as to affect the mouth. But, he observes, if the amaurotic symptoms are not at all relieved when the gums have become sore, its use is not to be continued: on the contrary, if any improvement occur, the constitution should be kept under the influence of mercury by the administration of two grains of the submuriate with a small quantity of opium, once or twice a day. (*R. Middlemore on Dis. of the Eye*, vol. ii. p. 277.) Instead of discontinuing mercury, if no amendment take place directly the gums are sore, he advises the patient to be kept at least two or three weeks well under the influence of the medicine; for, unless this be done, it has not had a fair trial. When the antiphlogistic treatment, and a fair trial of mercury have failed, Mr. Lawrence contents himself with recommending such management as is most conducive to general health; as a residence and frequent exercise in a pure air; plain nutritious diet; mild aperients, with the occasional use of an active purgative; and repose of the affected organ. He mentions also a trial of a seton, or repeated blisters behind the ears, or at the side or back of the neck. As already stated, however, he does not wish it to be supposed that all amaurotic patients require to be bled and salivated. Amaurosis, he says, often comes on in a slow and very insidious manner in persons of enfeebled constitution; the organ suffers from habitual excessive exertion at the same time that the general powers are depressed by residence in confined dwellings, bad air, sedentary occupations, unwholesome diet, costiveness, and the other injurious influences of such causes. If we should see a thin, pallid, and feeble woman, who had destroyed her health by close confinement to needle-work, and whose eyes were beginning to fail, the same active measures would by no means be admissible. We should empty the alimentary canal, perhaps take a little blood by cupping, or by leeches to the temples, and then use mercury in the alterative form, together with mild aperients. A few grains of Plummer's pill may be given every night, or every second night, and the bowels may be kept open with electuary, castor oil, or rhubarb and magnesia, taken occasionally. The blue pill may be taken in combination with aloes or colocynth. It may be necessary, says Mr. Lawrence, to persevere with the mercury, slowly increasing the dose until a slight influence is visible in the mouth. A nutritious but temperate diet, good air and exercise, and repose of the affected organ, are important auxiliaries, and a succession of moderate sized blisters may be advantageously combined with these means. Thus, observes Mr. Lawrence, the same principles regulate our treatment; but it is modified in degree, according to the violence of the symptoms, and the patient's strength. In the latter description of cases, after mild antiphlogistic means and clearing the alimentary canal, he admits that it may be expedient to combine tonics with aperients, or rhubarb with bark, calumba, or cascarilla; and to allow a little porter and wine.

One case of temporary palsy of the retina from over-excitement, mentioned by Mr. Travers, yielded to blistering the forehead, and a gentle salivation excited by calomel joined with opium. (*Synopsis*, p. 164.) Another case, brought on by the use of telescopes and sextants, gave way to a copious bleeding, brisk purging with jalap and calomel, blisters to the temples, and a course of mercury. (Op. cit. p. 166.)

When the disease does not originate from the stoppage of any natural or habitual discharge of blood, and does not yield to the evacuating plan, Richter thinks the surgeon justified in concluding that the paternaturally dilated vessels have not regained their proper tone and diameter, and that topical corroborant remedies, particularly cold water, ought to be employed. In this kind of case, he is an advocate for washing and bathing the whole head with cold water, especially the part about the eyes; a method, he says, which may often be practised, after evacuations, with singular and remarkable efficacy.

When amaurosis follows the healing of old sores, Beer recommends the formation of them again, by applying to the cicatrix strong mustard cataplasms, and the muriate of soda; and, if the new ulcers cannot be made to discharge properly, he recommends issues on the legs or thighs. These plans are to be aided by such medicines as act specifically upon the skin, like antimonials, especially the sulphur auratum antimonii. Beer also speaks favourably of sulphur baths; and, in cases complicated with debility, administers tonics. (See *Lehre von den Augenkr.* b. ii. p. 556—563.) When *amaurosis has followed the sudden healing of ulcers*, or the *disappearance of an eruption*, or the suppression of some customary evacuation, Mr. Middlemore is an advocate for counter irritation by means of a seton or issue. (*On Dis. of the Eye*, vol. ii. p. 279.)

In the *incomplete amaurosis from general nervous debility, copious hemorrhage, convulsions, and long-continued intense study, especially by candlelight*, Scarpa advocates the following plan of treatment. When the complaint is recent, in a young subject, the alimentary canal is to be emptied with small repeated doses of rhubarb, after which tonic cordial remedies are to be given. At the same time, the patient is to abstain from everything that has a tendency to weaken the nervous system, and, consequently, the eyesight. After emptying the stomach and bowels, it is proper to prescribe the decoction of bark with valerian, or the infusion of quassia with the addition of a few drops of sulphuric æther to each dose, with nourishing, easily digestible food. The aromatic spirituous vapours (mentioned in the article OPHTHALMIA) may then be topically applied; or, if these prove ineffectual, the vapour of liquor ammoniæ. The patient must take exercise on foot, horseback, or in a carriage, in a wholesome dry air, in warm weather, and avail himself of sea-bathing. He must avoid all thoughts of care, and refrain from fixing his eyes on minute shining objects. The impression of vivid light on the retina is to be moderated by means of flat green glasses. (*Saggio di Osservaz.* cap. 19.)

Mr. Travers remarks, that the amaurosis from depletion is sometimes mistaken for the opposite case, viz. that from plethoric congestion: this is owing to the coincidence of a dilated and immoveable pupil, muscæ, and a deep-seated pain in the head, with occasional vertigo, and its frequent occurrence in a corpulent habit. By a cautious use of tonics (says Mr. Travers) it is relieved; by whatever lowers, or stimulates, whether diet or medicine, it is decidedly aggravated. In this form of amaurosis, vision is further enfeebled by the loss of as much blood as flows from two or three leech bites. (*Synopsis, &c.* p. 160.)

When the weakness is confined to the eye, Richter thinks corroborant applications alone necessary. Bathing the eye with cold water, says he, is one of the most powerful means of strengthening the eye. The patient should dip in cold water a compress, doubled into eight folds, and sufficiently large to cover the whole face and forehead, and this he should keep applied as long as it continues cold. Or else he should frequently apply cold water to his eyes and face with his hand, on a piece of rag.

The eye may also be strengthened by repeatedly applying blisters of a semi-lunar shape above the eyebrows, just long enough to excite redness. Richter likewise speaks favourably of rubbing the upper eyelid, several times a day, with a mixture of the tinctura lyttæ and spiritus serpilli. (*Anfansgr. der Wundarz.* b. iii. p. 452.)

Here the endermic application of strychnia deserves to be remembered.

In the *amaurosis suddenly formed by exposure to vivid light or lightning*, we may clear out the alimentary canal with an active dose of calomel and jalap. Blisters may then be applied above the eyebrows; and if these fail, electricity, or the external use of strychnia, may be tried. (See *Middlemore on Dis. of the Eye*, vol. ii.)

The employment of electricity in amaurosis was advocated by Mr. Hey, and also by Mr. Ware, and there seems to be sufficient ground for believing that in some cases it has proved highly serviceable. Mr. Ware thought it likely to be especially useful in the amaurosis from the effect of lightning.

Magendie says that he has seen great benefit resulting from its use, and in some cases of incomplete amaurosis that it produced a perfect cure.

The method employed by him was that of galvano puncture. He inserted needles into the frontal and superior maxillary nerves, and then passed a galvanic current along them.

Mr. Lawrence on the other hand considers the indiscriminate use of electricity both ineligible and unsafe, and especially dangerous whenever congestion exists in the head, or active determination in the eye. He thinks it should only be used as an empirical remedy, after other measures have failed. (Ed. 3, p. 559.)

Dr. Mackenzie, too, says that "electricity, galvanism, and electro-magnetism are likely to be useful only in cases of a torpid character, and free from excitement, and that they would be hazardous if inflammation were present, or if they excited pain." (*On Dis. of the Eye*, ed. 4, p. 1034.)

In *amaurosis from the gradual effect of any exposure of the eye to vivid light, or of hard study by light of lamps or candles*, the foregoing treatment would I think be less likely to answer. Here the symptoms depend upon congestion or inflammation affecting the retina and optic nerve, and perhaps even the cerebral portion of the optic apparatus. The treatment, therefore, should consist of moderate depletion, followed by mercury and counter irritation, and the most perfect rest of the organ. (*Mackenzie on Dis. of the Eye*, ed. 4, p. 1059.)

We come now to the consideration of that species of amaurosis which is regarded as the effect of some unnatural irritation. Here, according to the precepts delivered by Richter, we should endeavour to discover what the particular irritation is, and then endeavour to effect its removal. Sometimes the irritation is both discoverable and removable, and still the blindness continues. In this circumstance, Richter thinks that the surgeon should endeavour to obviate the impression which the irritation has left upon the nerves, by the use of anodynes; or else try to remove the torpor of the nerves by stimulants. Now, according to Schmucker, Richter, and Scarpa, curable imperfect amaurosis commonly depends on some disease, or irritation in the gastric system, complicated with general nervous debility, in which the eyes participate. Hence it appears to them that the chief indications are, to free the alimentary canal from all irritating matter, improve the state of the chylopoietic viscera, and invigorate the nervous system in general, and the nerves of the eye in particular.

For an adult, Scarpa directs three grains of antimonium tartarizatum to be dissolved in four ounces of water, and a spoonful of this solution to be given every half hour, until nausea and copious vomiting are produced. The next day some opening powders are exhibited, consisting of an ounce of the supertartate of potash, and one grain of antimonium tartarizatum, divided into six equal parts. The patient takes one of these three times a day, for eight or ten days in succession. If the patient, during their use, should make vain efforts to vomit, the emetic, as at first directed, is to be prescribed again, and repeated a third and fourth time, should it be deemed necessary.

The stomach having been thus emptied, he orders an aperient pill, composed of rhubarb and tartarised antimony to be taken night and morning, for a month or six weeks.

When the state of the stomach has been improved, and the restoration of sight partly effected, such remedies must be employed as strengthen the digestive organs, and excite the vigour of the nervous system in general, and of the nerves of the eye in particular. With this intention, Scarpa prescribes bark and valerian in powder, with nourishing diet, with a moderate quantity of wine, and proper exercise in a salubrious air. For exciting the action of the nerves of the eye, the vapour of liquor ammoniæ, properly directed against the eye, he says, is of the greatest service. This remedy is applied by holding a small vessel, containing it, sufficiently near the eye to make this organ feel a smarting, and to cause a copious secretion of tears, and a redness, when it is proper to stop, and repeat the application three or four hours afterwards.

The operation of these vapours may be promoted by other external stimulants, such as blisters to the nape of the neck; friction on the eyebrow with the anodyne liquor; the irritation of the nerves of the nostrils by sternutative powders, like that composed of two grains of turbeth mineral, and a scruple of powdered betony leaves; and, lastly, electricity. The external use of strychnia would here deserve trial in the manner presently specified. The imperfect amaurosis, suddenly brought on in consequence of the body being excessively heated, or of exposure to the sun, or by violent anger, in plethoric subjects, requires general and topical evacuations of blood, and the application of cold washes to the eyes and whole head. Scarpa then prescribes an emetic, and afterwards antimonial purgatives. By means of bleeding and an emetic, Schmucker often restored the eyesight of soldiers, who had lost it in making forced marches. In amaurosis suddenly occasioned by violent anger, an emetic is the more strongly insisted upon after bleeding, as the blindness thus arising is always attended with a bitter taste in the mouth, tension of the hypochondria, and continual nausea. Richter mentions a clergyman, who became completely blind, after being in a violent passion, and whose eyesight was restored the very next day, by means of an emetic, given with the view of relieving some obvious marks of bilious disorder.

In this country, this free use of tartarized antimony, which has proved so efficacious on the Continent, has not been found to answer. Mr. Travers states, that he does not recollect an instance of decided benefit from it, though he has often tried it fairly. He agrees, however, in the indication, as he remarks, that the removal of an irritating, or oppressing cause, will often effect a sudden and marked relief, as by clearing the intestinal canal of vitiated secretions, restoring the digestive functions, or taking away blood where the necessity is indicated. In gastric cases, for which emetics have been particularly recommended, he prefers a long-continued course of the blue pill, with gentle saline purgatives, and tonic bitters. (*Synopsis*, p. 299—304.)

Beer is another high authority against the use of emetics, even in the amaurosis from disorder of the gastric organs. Emetics, which never operate without some violence, he says, are to be most carefully avoided in plethoric individuals, or those who have a manifest determination of blood to their heads and eyes, or any acceleration of the circulation. The caution here given must be observed, even though emetics may on other accounts seem advisable; and, according to Beer, the determination of blood and the state of the system here mentioned are commonly attendant upon this species of amaurosis. Indeed (notwithstanding the testimony of Schmucker, Richter, and Scarpa, in favour of emetics), Beer positively affirms that the violent operation of an emetic frequently converts this sympathetic amaurotic weakness of sight into complete blindness. Although I apprehend that Beer may here be somewhat prejudiced against emetics, candour obliges me to add, that, in this country, their efficacy in the present disease is by no means equal to the representations of Richter and Scarpa. When there is less tendency to vomiting, but the case is attended with an oppressive sense of weight about the stomach, frequent eructations, an inflated belly, tense hypochondria, and confined bowels, Beer found that clysters and tolerably brisk purgatives were always of the greatest service, both in regard to the general complaints, and the amaurotic weakness of sight; the removal of the offensive matter from the alimentary canal being immediately followed by a cessation of the determination of blood already mentioned. Lastly, when this amaurosis originates altogether from the presence of worms in the bowels, common anthelmintics are to be prescribed. In all these cases, says Beer, mere local treatment is quite inapplicable, and may do mischief. (*Beer, Lehre von den Augenkr.* b. ii. p. 517—521.)

In *periodical amaurosis*, attended with serious impairment or loss of vision, returning daily, weekly, or monthly, or at irregular intervals, the eye being little or not at all affected in the intermediate periods, the best means of cure are bleeding, purgatives, and counter irritation. This treatment is especially applicable to hemeralopia.

In *amaurosis excited by dentition*, the gums may be divided, mild laxatives and small doses of syrup of poppies given, and the child put into a warm bath. If amaurosis depend upon the irritation of a carious tooth, this should be extracted.

For *amaurosis from a partial wound, or laceration of the supra-orbital nerve*, the best plan is to make a free division of it.

Of late, strychnia has been employed as a remedy for amaurosis. It seems to Mr. Middlemore that its use should be confined to cases in which the retina is in a state of atony from some cause acting *directly* upon its texture, or upon its texture through the medium of the general debility of the system. At all events, he is of opinion, that it should not be resorted to when there is much vascular fulness either of the system, or the retina, or a tendency to inflammation. Its effects are likewise to be most carefully watched. An atonic state of the retina, or of some part of the nervous apparatus of the eye, productive of amaurosis, when unconnected with a full plethoric habit of body, determination of blood to the head, or any tendency to apoplexy, or any structural change either in the retina, or its immediate nervous relations, may be treated by means of strychnia, particularly if tonics and general stimulants have been already unsuccessfully tried. The bowels are to be first freely opened, and aperient medicine occasionally given during the use of strychnia. Mr. Middlemore puts a narrow blister above the eyebrow of the affected eye, or above each eyebrow, if both eyes are involved; and after the cuticle and serum have been removed, sprinkles a small quantity of strychnia upon the raw surface, commencing with the fourth of a grain upon each side. If vision be not improved, this quantity may be gradually increased to two grains; the part is also dressed with savine cerate. The strychnia is applied only once in twenty-four hours, and the eyebrow is preferred as the place for its action, on account of the probable special effect of the strychnia upon the supra-orbitary nerve, in addition to its other more general influence. If strychnia excite great local uneasiness, it may be blended with a little flour, or powdered opium. Mr. Middlemore observes, that if the patient should become sensible of occasional flashes of light before the eye, soon after the commencement of this treatment, there would be great encouragement to persevere; but that if vision should be not at all influenced, or improved, after the strychnia had been tried a fortnight in sufficiently powerful but not imprudent quantities, it ought to be discontinued. Strychnia appears to him to be well adapted to the case of miners, whose eyes are affected with incomplete amaurosis, and who have been accustomed to follow their employment by means of a very feeble light; and also to cases of impaired sensibility of the retina, occasioned by too great a delay in curing congenital cataract. (See *Middlemore on Dis. of the Eye*, vol. ii. p. 282.)

Strychnia has also been prescribed as an internal remedy for amaurosis.

A more extended experience has not shown that strychnine deserves to occupy any very prominent place as a remedy for amaurosis; Mr. Tyrrell says that he has frequently tried it in the cases that appeared to him most appropriate, but that he had not seen one single instance of benefit from its employment, although he had persevered till alarming muscular contractions were produced. He considers further that serious mischief has resulted from its indiscriminate use. And Mr. Lawrence states that his opinion coincides with that of Mr. Tyrrell, with reference not only to strychnia, but also to veratria, which he has found equally inefficacious. (*On Dis. of the Eye*, ed. 3, p. 565.)

Dr. Mackenzie, after mentioning that it has been given, as well as a host of other drugs of similar properties, in the hope that they might produce some stimulating effect on the nerves of sense, states his opinion that it is extremely doubtful if they have ever been productive of the least good effect (*On Dis. of the Eye*, ed. 4, p. 1033), and Mr. Dixon says that "its action appears to be so precisely limited to the motory fibres of the nervous system, that to expect it to influence a nerve of special sense, is to confound all our notions of nervous physiology." In no case of impaired or lost vision has he seen it effect the slightest improvement. (*Practical Study of Dis. of the Eye*, 1855, p. 189.)

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AMBE (from ἄμϐη, the projecting edge of a rock). An old chirurgical machine for reducing dislocations of the shoulder, and so called because its extremity projected like the prominence of a rock. Its invention is referred to Hippocrates. The ambe is the most ancient mechanical contrivance for the above purpose; but it is not at present employed. Indeed, it is scarcely to be met with in the richest cabinets of surgical apparatus. It is composed of a piece of wood, rising vertically from a pedestal. With the vertical piece is articulated, after the manner of a hinge, a horizontal piece, with a gutter formed in it, in which the luxated limb is laid and secured with straps. The patient places himself on one side of the machine; his arm is extended in the gutter, and secured; the angle, formed by the union of the ascending piece, and by the horizontal branch, is lodged in the armpit, and then the horizontal branch is depressed. In this way extension is made, whilst the vertical part makes counter-extension, and its superior part tends to force the head of the humerus into the articular cavity. But there is nothing to fix the scapula, and the compression made by the superior portion of the vertical piece of the machine tends to force the head of the humerus into the glenoid cavity, before it is well disengaged by the extension.

AMBLYOPIA (from ἀμβλὺς, dull, and ὤψ, the eye). Hippocrates means by this word, in his Aph. 31, sect. 3, the dimness of sight to which old people are subject. Modern writers generally understand by amblyopia incomplete amaurosis, or the weakness of sight attending certain stages and forms of this disorder.

AMMONIÆ MURIAS, AMMONIÆ HYDROCHLORAS. *Sal Ammoniac.* Its chief use in surgery is as an external discutient application. (See *Lotio Ammon. Muriatæ cum Aceto.*)

Mr. Justamond recommends the following application to milk-abscesses: ℞ Ammoniæ Muriatis ℥j. Spiritus Roris marini lb. j. Misce. Linen rags, wetted with the lotion, are continually applied to the part affected. There can be little doubt of the utility of this lotion in dispersing the induration left after mammary abscesses; but while these cases are accompanied with much pain, tension, and inflammation, emollient fomentations and poultices are to be preferred. For rubefacient purposes, pure ammonia is extracted from the decomposition of muriate of ammonia by means of the soda contained in soap. A plaster is made by combining ℥j. of soap with ʒij. of common litharge plaster; and when nearly cold, adding ʒj. of muriate of ammonia in fine powder. From this nearly ℈j. of ammonia in a pure state is slowly evolved, and exerts its action on the skin. (See *A. T. Thomson's Elem. of Materia Med.* p. 957, ed. 2.)

If muriate of ammonia be mixed with its weight of powdered nitre, and dissolved in six or eight parts of water, it produces a very cold lotion, which may be used, as a substitute for ice, in cases of strangulated hernia.

AMPUTATION. The operation of cutting off a limb, or other part of the body, as the breast, penis, &c.

Such an operation frequently becomes indispensably proper, on the principle of sacrificing a branch, as it were, for the sake of taking the only rational chance of saving the trunk itself. Indeed, the suggestion of this measure, in cases of mortification, where there is no chance of the parts recovering, may be said to be derived from nature herself, who, by a process to which I shall advert in speaking of *mortification*, detaches the dead from the living parts; this separation is followed by cicatrisation, and the patient recovers.

The necessity for amputation has always existed, and ever will continue, so long as the destructive effects of injuries and diseases of the limbs cannot be obviated in any other manner. As Graefe observes, there was once a period when the operation was more frequently practised than at present, and this fact is to be imputed less to the caprice of surgeons than to the imperfection of the means which used to be employed for the relief of local diseases. For then, aneurisms of the limbs, and some other cases, at present treated with success, were always deemed incurable without amputation.

As the author of another valuable modern work has said, it is an excellent observation founded on the purest humanity, and justified by the soundest professional principles, that to *save one limb is infinitely more honourable to the surgeon, than to* have performed numerous amputations, however successful; but it is a remark fully as true, that it is much better for a man "to live with three limbs than to die with four." (*Hennen on Military Surgery*, p. 251, ed. 2.) To this should be added the reflection, that some unfortunate beings have been known to submit to the loss of all their legs and arms, and yet recover. In the Hôtel des Invalides at Paris, mutilated objects are in recollection, who had lost all their thighs and arms, so that, unless assisted, they could not stir, and it was necessary to feed and wait upon them, like new-born infants. (*Morand. Opusc. de Chir.* p. 183; and *Graefe*, op. cit. p. 23.)

The amputation of limbs was anciently practised under many disadvantages. The best way of making the incisions was unknown; the ignorance of the old surgeons about the right method of stopping hemorrhage was the death of a large proportion of the patients who had courage to submit to the operation; the mode of healing the wound by the first intention was not understood, or not duly appreciated; and the instruments employed were as awkward and clumsy as the dressings were irritating and improper.

Modern practitioners have materially simplified all the chief operations in surgery: an object which has been accomplished, not merely by letting anatomical science be the main guide of their proceedings; not simply by devising more judicious and less painful methods; not only by diminishing the number, and improving the construction of instruments; but also, in an essential degree, by abandoning the use of a multitude of external applications, most of which were useless or hurtful.

But much improved as amputation has been, it cannot be dissembled that it is an operation at once terrible to bear, disagreeable to behold, and sometimes severe and fatal in its consequences, while the patient, if saved, is left for ever afterwards in a crippled mutilated state. Hence it is the surgeon's duty never to have recourse to so serious a proceeding, without a perfect and well grounded conviction of its necessity. Amputation should be generally regarded as the last expedient to which a surgeon ought to resort; an expedient justifiable, as a late writer says, only when the part is either already gangrenous, or the seat of so much injury, or disease, that the attempt to preserve it any longer would expose the patient's life to the greatest danger. (*Dict. des Sciences Méd.* t. i. p. 472.)

Although this amounts to a confession that the cure of some local disorders is not within the limits of our art, yet, on the other hand, it furnishes a proof that surgery may be the means of saving life, under circumstances which, without its assistance, would infallibly have a fatal termination. The operation is adopted as the safest measure: the cause is removed for the prevention of consequences. (*Graefe*, op. cit. p. 14.)

Nothing can be more absurd, or more misapplied, than the censures sometimes passed upon amputation, because the body is mutilated by it, &c. Although the objection proves the limitation of human knowledge and ability, it must be very unfair on this account to throw blame on surgery, or the practitioner who thus saves the patient's life. For, without dwelling upon the fact that a humane surgeon would never amputate through a mere love of operating, and without urgent cause, one may simply ask, Are all diseases in their nature curable? Does not the surgeon cure such as are curable, without mutilation? And are not cases, which were in the beginning remediable, often first brought to the surgeon, when, from neglect, they have become totally incurable? Is it not his duty then to employ the only means left for saving the patient? And is not the preservation of a long and healthy life a compensation for the sacrifice? Indeed, is it not rather a greater honour to surgery, that, even when death has already taken possession, as it were, of a part, and is threatening inevitable destruction to the whole, a means is yet furnished, not only of saving the patient's life, but of bringing him into a state in which he may recover his former good health? (*Brünninghausen, Erfahrungen und Bemerkungen über die Amputation*, p. 11, 12mo. Bamberg, 1818.)

The first duty of the surgeon is, therefore, to ascertain with precision the cases which demand the operation, those in which it may be dispensed with, and the exact periods at which it should be practised. These are considerations requiring profound attention and the brightest talents. The most expert operator (as Mr. O'Halloran observes) may not always be the best surgeon. To do justice to the sick and ourselves, we must, in many cases, rather avoid than perform capital operations; and with respect to amputation, if we consider the many cases in which it has been unnecessarily undertaken, or done at unseasonable periods, it may be suspected that this operation, upon the whole, may have done more mischief than good. At all events, it is not enough for a surgeon to know *how* to operate; he must also know *when* to do it. (See *O'Halloran on Gangrene and Sphacelus: Preface.*)

For such reasons, I shall first take a view of some of the circumstances under which the best surgeons deem amputation necessary; though in each of the articles relative to the particular diseases and injuries which ever call for the operation, additional information will be offered. Some of these affect the bones or joints; others, more especially the soft parts. As a general maxim, it is the rule to amputate, whenever the injury, or disease, of the parts, is such, that either primarily, or consecutively, the limb must be lost, or symptoms induced putting the patient's life into imminent peril. (See *Dupuytren, Clin. Chir.* t. iv. p. 234.)

1. Compound Fractures.

In a compound fracture, the necessity for amputation is not altogether proportioned to the seriousness of the accident, but frequently depends in part upon other circumstances. For example, in the field, and on board of a crowded ship, it is not constantly in the surgeon's power to pay such attention as the cases demand, nor to procure for the patient the proper degree of rest and good accommodation. In the field, there is often a necessity for transporting the wounded from one place to another. Under these circumstances, it is proper to have immediate recourse to amputation, in numerous cases of bad compound fractures, some of which, perhaps, might not absolutely demand the operation, were the patients so situated as to be capable of receiving all the advantages of the best and most scientific treatment in a well-ventilated, quiet house, or hospital, furnished with every desirable convenience. At the same time, daily experience proves, that there are many other cases, in which it would be improper to have recourse to the knife, even under the most unfavourable circumstances of the above description. So, when a compound fracture occurs, in which the soft parts have not been considerably injured; in which the bones have been broken in such a direction that they can be easily set and kept in their proper position; or in which there is only one bone broken; amputation would be unnecessary and cruel. But, when the soft parts have been more extensively hurt, and the bones have been so badly broken, that perfect quietude and incessant care are required to afford any chance of recovery, it is a good general rule to amputate whenever these advantages cannot be obtained.

The bad air in crowded hospitals and large cities,—a circumstance so detrimental to wounds in general,—is another consideration which may seriously lessen the chances of saving a badly-broken limb, and should be remembered in weighing the reasons for and against amputation.

On this part of the subject, I find the sentiments of Graefe interesting. "Besides an absolute," says he, "there is a relative, necessity for amputation: it is the most mournful, and proceeds altogether from unfavourable external circumstances, though, alas! in many cases nearly unavoidable, when life is to be preserved. In war, every bloody action furnishes proof of what has been stated. The number of the wounded is immense; the number of surgeons for the duty too limited. The supplies most needed are at a distance. In those emergencies, though the military surgeon may, from routine and genius, be able to suggest the quickest method of obtaining what is wanted, know how to avail himself of every advantage which circumstances permit, and contrive tolerable substitutes for such things as are deficient, yet this will not always do.

"Who doubts (says Graefe) that a soldier with a gunshot wound, complicated with a smashed state of the bones, may sometimes be saved, without loss of his limb, by employing all the means which the resources of surgery offer? But these very resources are often wanting in a campaign: and the business of dressing the patient would occupy the surgeon several hours daily, during which his useful assistance could not be extended to other sufferers. Notwithstanding the utmost care, the removal of patients from one place to another frequently makes their wounds extremely dangerous, or fatal; and we now lose many a man, who, had he undergone amputation, would have been able to bear the journey." (See *Normen für die Ablösung grösserer Gliedmassen*, p. 15, 16.)

When a compound fracture is caused by the passage of a heavy body over a limb, such, for instance, as the broad wheel of a waggon or loaded cart, or by the fall of a very ponderous body on it, or by a cannon-shot, or by any other means so violent as to break the bones into many fragments, and so to tear, bruise, and wound the soft parts, that there shall be good reason to fear that there will not be vessels sufficient to carry on the circulation with the parts below the fracture, it becomes, as Mr. Pott observes, a matter of the most serious consideration, whether an attempt to save such a limb will not occasion loss of life. This consideration must be given before any degree of inflammation has seized the part, and, therefore, immediately after the accident. When inflammation, tension, and a disposition to gangrene in the limb have arisen, the period is highly disadvantageous for operating, and the patient's chances of being saved by amputation, under these circumstances, are much smaller than before the changes here spoken of have taken place.

In compound fractures, as Mr. Pott has correctly pointed out, there are three points of time when amputation may be proper. The first of these is immediately, or as soon as possible, after the receipt of the injury. The second is, when the bones continue for a great length of time without any disposition to unite, and the discharge from the wound has been so long, and is so large, that the patient's strength fails, and general symptoms foreboding dissolution come on. The third is, when mortification has taken such complete possession of the soft parts of the inferior portion of the limb, quite down to the bone, that, upon the separation of such parts, the bone or bones are left bare in the interspace.

The first and second of these are matters of very serious consideration. The third hardly requires any.

The necessity of immediate or very early decision, in this case, makes it a delicate part of practice; for, however pressing the case may seem to the surgeon, it will not, in general, appear in the same light to the patient or his relations; yet suffering this point of time to pass often decides the patient's fate.

This necessity of early decision arises from the quick tendency to mortification, which ensues in the injured limb, and too often ends in the patient's death. That this is no exaggeration, says Pott, melancholy and frequent experience evinces, even in those whose constitutions, previous to the accident, were in good order; but much more in those, who have been heated by violent exercise, or labour, or liquor, or who have led debauched and intemperate lives, or who have habits naturally inflammable and irritable. This is often the case when the fracture happens to the middle part of the bones, but is much more likely to happen when any of the large joints are concerned. In many of these cases, a determination for or against amputation, is really a determination for or against the patient's existence.

That it would have been impossible to have saved some limbs, which have been cut off, no man will pretend to say; but this does not render the practice injudicious. Do not the majority of those who get into the above hazardous condition, and on whom amputation is not performed, perish in consequence of their wounds? Have not many lives been preserved by amputation, which, from the same circumstances, would otherwise most probably have been lost?

Pressing and urgent as the state of a compound fracture may be, at this first point of time, still it will be a matter of choice, whether the limb shall be removed or not; but, at the second period, the operation must be submitted to, or the patient must die.

The most unpromising appearances at first do not necessarily, or constantly, end unfortunately. Sometimes, after the most threatening first symptoms, after considerable length of time, great discharges of matter, and large exfoliations of bone, success is ultimately obtained, and the patient recovers his health and the use of his limb.

Dupuytren relates two cases, in one of which the hand was terribly shattered by the kick of a horse; while, in the other, all the anterior part of the foot had been crushed by an iron machine. In the first case, all the parts of the hand, not broken to atoms, were preserved, the patient recovering without any severe symptoms. In the second, where the great toe was broken, and the first and second metatarsal bones comminuted, the other toes wounded, and all the integuments of the sole torn away, gangrene ensued; but, in the end, the patient recovered with the loss of only the great toe. In both these instances, Dupuytren removed all loose fragments of bone. In the last case, he was singularly favoured by the youth and good constitution of the patient. "Things," says he, "do not always end in this way: a very slight difference in these favourable conditions, or in the degree of the injuries, might perhaps have made us seriously repent of not having amputated." (*Clin. Chir.* t. iv. p. 237.)

But sometimes after the most judicious treatment through every stage of the disease; after the united efforts of physic and surgery; the sore, instead of granulating kindly, and contracting daily to a smaller size, shall remain as large as at first, with a tawny, spongy surface, discharging a large quantity of thin sanies, instead of a small one of good matter; the fractured ends of the bones, instead of tending to exfoliate, or to unite, will remain as perfectly loose and disunited as at first, while the patient shall lose his sleep, his appetite, and his strength; a hectic fever, with a quick, small, hard pulse, profuse sweats, and colliquative purging, contributing at the same time to bring him to the brink of the grave, notwithstanding every kind of assistance: in these circumstances, if amputation be not performed, Mr. Pott asks, what else can rescue the patient from destruction?

The third and last period is a matter which does not require much consideration. Too often, the inflammation, consequent upon the injury, instead of producing abscess and suppuration, tends to gangrene and mortification, the progress of which is often so rapid as to destroy the patient in a short space of time, constituting that very sort of case in which amputation should have been immediately performed. But sometimes even this dreadful malady is, by the help of art, put a stop to, but not until it has totally destroyed all the surrounding muscles, tendons, and membranes quite down to the bone, which, upon the separation of the mortified parts, is left quite bare, and all circulation between the parts above and those below is by this totally cut off. In this instance, whether the surgeon saw through the bare bone, or leave the separation to be effected by nature, the patient must lose his limb. (See *Pott's Remarks on the Necessity of Amputation in certain Cases, &c. Chir. Works,* vol. iii.)

At the same time, there are certain examples of mortification from external causes, where, as far as one can judge from the results of later experience than that of Mr. Pott, the surgeon should not defer amputation, even though the disorder is yet in a spreading state, attended with considerable swelling and tension reaching far up the limb. This is a subject, however, which will require more explanation hereafter. (See what is presently said on *Mortification.*) Nor are the cases, to which reference is made, meant to affect the general truth of the observation, delivered by the most experienced surgeons of every age, that, when a limb is extensively swelled and inflamed, with a part of it either in a state of spreading mortification, or ready to become gangrenous, the period is so unfavourable for amputation, that very few patients, so circumstanced, ever recover after the operation. Nor is it meant to be insinuated, that, in the very cases, which form exceptions to the general rule of not amputating before the tendency to gangrene has ceased, the patient might not have had an infinitely better chance of his life, had the operation been done immediately after the first receipt of the injury, before any disposition to gangrene had had time to be produced.

[The period at which amputation may most advantageously be performed has been a subject of discussion among surgeons for a period of nearly a century, the majority being in favour of immediate or primary amputation, (agreeing, therefore, in the doctrines of Mr. Pott, which have been just quoted,) while others, among whom may be mentioned Hunter and Abernethy, have advocated delay. M. Boucher, in a memoir addressed to the French Academy, defined *three* periods for operation, 1. The period between the receipt of the injury and the appearance of the inflammatory symptoms. 2. When the inflammatory action has commenced, and is more or less capable of disturbing the animal economy. 3. When the violence of the inflammatory symptoms and symptomatic fever have abated; that is, when the suppurative stage is fully established. This division of periods has been sanctioned and adopted by Mr. Guthrie, and also by Mr. Rutherford Alcock. The first and *third*, it will be seen, correspond to the first and *second* of Mr. Pott, the second is a further subdivision and is intermediate between the other two.

Mr. Alcock considers this further distinction an important one, and he proposes the terms *primary, intermediary, and secondary*, to designate the operations performed at the three several periods. He considers that the intermediary "differ greatly from the others in the principal circumstances which are held to influence the propriety of the amputation and its result, and ought neither to be classed with the primary of the first class, or the secondary of the third." (*Medical Hist. of the Spanish Legion*, 1838, p. 66.) This intermediate period is unquestionably the most unfavourable of the three, and Sir G. Ballingall observes, that "as it is a period which no one advocates or adopts from choice, a period, in short, in which amputations are looked upon as compulsory and undertaken with reluctance, their number is not likely to be great, and the main question comes again to lie between primary and secondary operations." (*Military Surg.* ed. 5, 1855, p. 424.)

It is desirable, however, that these intermediate cases should be distinguished from the other two classes, in estimating results, or they will lead to erroneous deductions. Looking upon them as compulsory operations, they should be excluded altogether from the calculation, in estimating the comparative merits of the primary and secondary periods, properly so called.

It is from the experience of military surgeons that the principal deductions in favour of primary amputations, as compared with secondary, have been drawn. There is, however, a considerable difference between military and civil surgery in this respect, the contrast between the results of primary and secondary amputations being by no means so well marked in the latter as in the former. According to Mr. Alcock, "The same proportion no longer exists, nay, is not seldom reversed:" and Sir G. Ballingall says, "Upon this point I have had as good opportunity of forming an opinion as most of my contemporaries, having now served thirteen years in the former, and nearly thirty in the latter. In civil hospitals the comparative success of primary amputation has been by no means so great as that which I was accustomed to see and to hear of in the army. Sanson, who has noticed this fact, has assigned several reasons obviously leading to a different result; and amongst these, the moral influence of the different circumstances under which a patient is received into a civil and into a military hospital, has always appeared to me one of the most important. A tradesman, with perhaps an indifferent constitution, and a wife and family dependent on his exertions, is admitted with an injury requiring amputation, which may be the result of an accident originating in intoxication, ignorance, or folly, and by which he finds himself suddenly reduced to misery and dependence: while the soldier, again, with a constitution originally sound, and accustomed to contemplate such an accident, loses his limb in a good cause, under circumstances creditable to himself and duly appreciated by his country, from which he is certain of a pension for life." "In addition to the powerful effect which this moral contrast must necessarily produce, there is a physical cause operating, which I believe to be one of the most influential, although one of the least observed. A soldier going from a filthy billet or a crowded barrack room, into a clean well aired, and well regulated, military hospital, goes often from a worse atmosphere into a better, while a mason or house carpenter accustomed to work all day in the open air, is taken into a large civil hospital constantly occupied with its full complement of patients, and having its atmosphere thereby necessarily vitiated." (*Mil. Surg.* p. 423, ed. 5, 1855.)

Mr. Alcock is likewise in favour of primary amputation, although he does not recommend it quite so exclusively as other military surgeons. In fact, he found, in his own experience while attached to the Spanish Legion, that his primary were not so successful as his secondary operations; and he thinks, therefore, that the latter have been too indiscriminately condemned. For a full discussion of the whole subject, the reader is referred to Mr. Alcock's valuable and elaborate lectures on Amputation (see *Lancet*, 1840–41); but the following are his principal deductions on the present question. He thinks errors have been introduced into both sides of the argument, and that "*the mortality of the secondary has been greatly exaggerated, and the dangers of the primary underrated*," but that, on the other hand, the advocates for secondary operations have equally lost sight of all the lives lost with and without operation, in the intervening period between the first and twentieth day." (*Lancet*, vol. ii. 1840–41, p. 292.) Mr. Alcock holds that "primary amputation is, beyond question, the best practice in the majority of instances, *not because the human system is at that period in the best state for meeting the consequences of the double shock, moral or physical* — not because these present such decidedly more favourable results than secondary amputations, under every condition of circumstances (when the latter are not compulsorily performed), but because *many will be the forced amputations in an intermediate and still less favourable period ; many more the deaths before the favourable period arrives;* and a large number even then remain who arrive at that period, *but offer no reasonable chance of surviving the shock of an operation if superadded on the diseased and exhausting actions to which the original injury had given rise.* Add all these deaths to those from secondary amputation (properly so called) and he must be a bigot indeed to the adverse opinion, who can have one moment's hesitation as to which side of the question the amount of human suffering and the loss of human life preponderates " (loc. cit. p. 292). M. Velpeau says, " The fundamental argument of the partizans of temporization, to wit, that a multitude of mutilated persons would have been enabled to save their limbs, if the surgeon had delayed, is more specious than solid ; for we can reply to them, that a goodly number of the other cases would be *living with three limbs*, if, in delaying the operation they had not *suffered them to die with four*." (*Elem. of Op. Surg.* vol. ii. p. 469. Mott's Translation.) The opinions of Mr. Alcock, as quoted above, embody, we believe, as nearly as possible, the doctrine of the great majority of surgeons of the present day, and that doctrine may be briefly stated as follows: when the injury is such that it is obvious that there is no chance for the ultimate preservation of the limb, primary amputation should always be preferred ; but when the surgeon has doubts on this point, which will very frequently be the case, for the question is often one of the greatest possible difficulty and delicacy, he should give the limb the benefit of the doubt, holding the alternative of secondary amputation in reserve in case of need ; the results of this latter, if not equal to those of the former, being yet sufficiently favourable, in civil practice especially, to warrant the delay.

Primary amputation, however, is not always to be "*immediate*" in the literal sense of the word, but the state of collapse, or shock, which is often the immediate effect of a serious injury, must be allowed to pass off before the operation is attempted. The surgeon may often wait with advantage, as Mr. Guthrie recommends (see article Gunshot Wounds), for six or eight hours or even longer, cordials being administered at intervals until reaction has duly taken place. A still longer delay is in many cases admissible, although Mr. Skey perhaps goes too far in thinking that " the condition of the patient is as favourable for amputation at the expiration of thirty-six, or even forty-eight hours, as at the expiration of three or four."

On the question of reaction after serious accidents, the last named author thinks sufficient distinction is not made " between the consequences of violence done to the circulating and that to the nervous system. A man receives a severe blow on the abdomen or elsewhere ; his nervous system sustains the first effect of the shock ; his pulse sinks till it becomes almost imperceptible, but he has lost no blood. To amputate a limb which may have been fractured, or crushed, or otherwise severely or hopelessly mutilated, in this condition of his system, is to hurry him on to his death. The cause is a shock which time can, and under favourable circumstances will, remedy. We give him stimulants, and his circulation rallies ; his physical powers revive, and in the course of one or more hours, we amputate, with success. Contrast this case with that of a man reduced to an equal degree of prostration by *loss of blood*, consequent on severe compound fracture or mutilation of any kind. In such a case how can we expect reaction to take place with the circulation reduced by a large diminution from its standard quantity." Mr. Skey thinks that in the former case we should postpone the operation until reaction has taken place, but in the latter (that is, if there exist good grounds for believing the hemorrhage to have been considerable) we must attribute the prostration primarily to that cause, and resort to immediate amputation. (*Skey, Op. Surg.* p. 315.)]

For the consideration of a variety of complicated circumstances affecting the question of amputation in compound fracture, I must refer to Gunshot Wounds.

2. Extensive Contused and Lacerated Wounds.

These form the second class of general cases requiring amputation. Wounds without fracture are not often so bad as to require this operation. When a limb, however, is extensively contused and lacerated, and its principal blood-vessels are injured, so that there is no hope of a continuance of the circulation, the immediate removal of the member should be recommended, whether the bones be injured or not. Also, since no effort on the part of the surgeon can preserve a limb so injured, and such wounds are more likely to mortify than any others, the sooner the operation is undertaken the better.

In these cases, as in those of compound fractures, though amputation may not always be necessary at first, it often becomes so afterwards. The foregoing observations, relative to the second period of compound fractures, are equally applicable to badly lacerated wounds, unattended with injury of the bones. Sometimes a rapid mortification comes on ; or a profuse suppuration, which the system can no longer endure.

For information on the proper period of amputating in traumatic gangrene, see Mortification, and the section on this disorder in the present article.

3. Cases in which part of a Limb has been carried away by a cannon-ball.

When part of a limb has been torn off by a cannon-ball, or any other cause capable of producing a similar effect, the formation of a good and serviceable stump; the greater facility of healing the clean, regular wound of amputation ; and the benefit of a far more expeditious, as well as of a sounder cure, are the principal reasons which here make the operation advisable.

This was an instance, in which some former surgeons disputed the necessity of amputation. They urged as a reason for their opinion, that the limb being already removed, it is better to endeavour to cure the wound as speedily as possible than increase the patient's sufferings and danger, by making him to submit to amputation. It must be remembered, however, that the bones are generally shattered, and reduced into numerous fragments; the muscles and tendons are unequally divided, and their ends torn and contused. Now, none of the old surgeons questioned the absolute necessity of extracting the splinters of bone, and cutting away the irregular extremities of the tendons and muscles, which operations would require a longer time than amputation itself. Besides, we should recollect that, by making the incision above the injured part, so as to be enabled to cover the bone with flesh and integuments perfectly free from injury, the extent of the wound is so diminished, that the healing can be accomplished in one third of the time which would otherwise be requisite, and a much firmer cicatrix is also obtained. Such reflections must convince us that amputation here holds forth great advantages. It cannot increase the patient's danger; and as for the momentary augmentation of pain which he suffers, he is amply compensated. (See Gunshot Wounds.)

4. Mortification.

Mortification is another cause, which, when advanced to a certain degree, renders amputation indispensably proper. We have noticed, that bad compound fractures, and wounds, often terminate in the death of the injured limb. In such cases, there can be no doubt that the operation is generally the safest and most advantageous measure. Nay, there are, as we shall presently see, certain forms of mortification, in which the early performance of amputation is the only chance of saving the patient.

Practitioners have entertained very opposite opinions concerning the period when one should operate in cases of mortification. Some pretend that whenever the disorder presents itself, and especially when it is the effect of external violence, we should amputate immediately the mortification has decidedly begun to form, and while the mischief is in a spreading state. Others believe that the operation should never be undertaken before the progress of the disorder has stopped, even not till the dead parts have begun to separate from the living ones.

The advocates for the speedy performance of amputation declare, that the further progress of the mortification may be stopped, and the life of the patient preserved, by cutting above the parts affected. However, according to the reports of the greater number of eminent surgical writers, this practice is highly dangerous, and undeserving of confidence. Whatever pains may be taken, in the operation, only to divide sound parts, there is no certainty of succeeding in this object, and the most skilful practitioner may be deceived. The skin may appear to be perfectly sound and free from inflammation, while the muscles which it covers, and the parts immediately surrounding the bone, may actually be in a gangrenous state. But even when the soft parts are found free from apparent distemper on making the incision, still, if the operator should not have waited till the mortification has ceased to spread, the stump will almost always be attacked by gangrene. Surgeons who have had opportunities of frequently seeing wounds which have a tendency to mortify, entertain the latter opinion. Such was the sentiment of Pott, who says that he has often seen the experiment made, of amputating a limb in which gangrene had begun to show itself, but never saw it succeed, and it invariably hastened the patient's death.

The operation may be postponed, however, too long. Mr. S. Sharp, in particular, recommended too much delay, advising the operation never to be undertaken till the natural separation of the mortified parts had considerably advanced. Mr. Sharp was a surgeon of immense experience, and his authority carries with it the greatest weight. But, perhaps, he was too zealous in his opposition to a practice, the peril of which he had so often beheld. When the mortification has ceased to spread, there is no occasion for further delay. We now obtain, just as certainly, all the benefits of the operation, and get rid of a mass of putridity, the exhalations from which poison the atmosphere which the patient breathes, and are highly detrimental to his health. Nay, patients in these circumstances may actually fall victims to the absorption of putrid matter. However, this danger would not be so considerable as that which would arise from too precipitate an operation; and it is better to defer amputation a little more than is absolutely requisite, than run any risk of performing the operation before it is certain that the parts have lost their tendency to gangrene.

In the article Mortification, we have noticed particular cases of gangrene, where, the surgeon is not to wait for the line of separation being formed, but have recourse to the immediate performance of amputation. The experience of Mr. Lawrence, and several cases which I saw in the British military hospitals during the last war, tend to confirm the propriety of such practice. (See *Medico-Chir. Trans.* vol. vi. p. 156, &c.)

In an example, where a large part of the arm was deeply affected with gangrene from external violence, and the disorder was yet making rapid progress, I once recommended the performance of amputation at the shoulder-joint. On the whole, this instance was favourable to the practice; for, though the patient died at the end of a fortnight, probably he would not have lived twenty-four hours, had the operation not been done; nor was the stump attacked with mortification, — a circumstance worthy of attention, because it is a danger particularly insisted upon by the opponents of amputation under the preceding circumstances; and, had it not been for a large abscess, which formed in the back, as was supposed, from a violent blow received in the fall which produced the original injury, there were well-grounded hopes of recovery.

There is likewise a species of gangrene, which is pointed out by Mr. Guthrie, as requiring early amputation. "A soldier (says he) shall receive a flesh-wound from a musket-ball in the middle of the thigh, which passes through the limb apparently, on a superficial inspection, without injuring the main artery; or it shall pass close behind the femur, where the artery turns to the back part of the bone; or it may go through the middle of the bone, from behind forwards, between the condyles of the femur, into the knee-joint, and the patient shall walk to the surgeon with little assistance, be superficially dressed, and, in many cases, considered slightly wounded; yet the femoral artery and vein, in the whole of these cases, and, indeed, in many others, shall be wounded, or cut across, and the local inflammation be so slight as to obtain little attention. On the third or fourth day, the patient shows his toes discoloured, and complains of pain and coldness in the limb below the wound, the constitution begins to sympathise with the injury, and the surgeon probably thinks the case extraordinary. Perhaps he suspects the real state of the injury; but is surprised that a wound of the femoral or popliteal artery, with so little attendant injury, could cause mortification, &c. He is anxious to do something; but mortification, or at least gangrene, having commenced, he must, according to general rule, await the formation of the line of separation. The temperature of the leg, a little above the gangrene, is good, perhaps higher than natural; he hopes it will not extend farther, and it probably does remain stationary for a little time. At last, the parts originally affected—the toes—become sphacelated, and gangrene quickly spreads up the leg as far as the wounded artery, by which time the patient dies."

For the purpose of preventing such a disaster, where the artery, or artery and vein, have been divided, Mr. Guthrie recommends the performance of amputation as soon as the gangrene is perceived to extend beyond the toes: and the swelling and slight attendant inflammation, which is marked more by the tumefaction than the redness of the part, has passed higher up than the ankle. (See *Guthrie on Gunshot Wounds*, p. 60, 61.)

Mortification of a limb, after operation for aneurism, is another exception to the general rule of not amputating till the mortification has stopped. Where also grangrene arises from the obstruction of the circulation, by an aneurism bursting, and its blood passing copiously into the cellular tissue of the limb, amputation should be performed without delay, though the mortification may not have stopped. An example of the success of this practice, I have laid before the profession. (See *Med. Chir. Trans.* vol. xvi.)

5. Diseased Joints.

Excluding from present consideration the proposal to undertake the excision of some joints which are in particular states of injury, or disease, I may observe, that scrofulous joints, with diseased bones, and distempered ligaments and cartilages, is another case in which amputation may become absolutely necessary. As Mr. Pott remarks, there is one circumstance attending this complaint, often rendering it particularly unpleasant, which is, that the subjects are most frequently young children, so as to be incapable of determining for themselves: which inflicts a distressing task on their nearest relations. All the efforts of physic and surgery often prove absolutely ineffectual, not only to cure, but even to retard the disease in question. Notwithstanding many cases admit of cure, numerous others do not. The disease often begins in the very inmost recesses of the cellular texture of the heads of the bones forming the large articulations, such as the hip, knee, ankle, and elbow; the bones become diseased in a manner which will be explained in the article Joints, sometimes with great pain and symptomatic fever; sometimes with little of either, at least in the beginning. The cartilages covering the ends of these bones, and designed for the mobility of these joints, are totally destroyed; the epiphyses in young subjects are either partially, or totally separated from the said bones; the ligaments of the joints are so thickened and spoiled by the distemper, as to lose all natural appearance, and become quite unfit for all the purposes for which they were intended: the parts appointed for the secretion of the synovia, become distempered in like manner. All these together furnish a large quantity of stinking sanious matter, which is discharged either through artificial openings, made for the purpose, or through small ulcerated ones. These openings commonly lead to bones which are diseased through their whole texture. When the disease has got into this state, the constant pain, irritation, and discharge bring on hectic symptoms of the most destructive kind, such as total loss of appetite, rest, and strength, profuse night sweats, and as profuse purgings, which foil all the efforts of medicine, and bring the patient to the brink of destruction. (See *Pott on Amputation.*)

In these cases, amputation is attended with more success when performed late, than when undertaken at an early period, before the disease has made great advances. This is fortunate, as it affords time for a fair trial of such remedies as are best calculated to check the progress of the disorder. (See Joints.)

Whenever the disease of a joint is likely to terminate in anchylosis, amputation should not be resorted to, as a cure will be effected without it (See Anchylosis.) In deciding to amputate, or not, a great deal will depend upon the state of the patient's health, and his kind of constitution, as well as upon the condition of the joint itself.

[The treatment of diseased joints by excision of the articular extremities of the bones, has of late years been adopted with signal success in many cases in which formerly the entire limb would have been sacrificed, and the number of amputations performed for this class of diseases has in consequence materially diminished. Nevertheless, there will always remain cases to which excision is inapplicable, and in which amputation may become absolutely necessary. When the disease commences in the bones, and when these are affected for some distance from the articulation, so as to render it impossible to *excise* the whole disease without removing *more* than the articular extremities of the bones; when, also, the soft parts are extensively disorganised, and there are abscesses and sinuses extending upwards and downwards along the limb; when it is not probable that the patient will have sufficient strength to support him through the protracted effort of repair that excision will demand from him; or when the constitutional symptoms are such as to render it necessary to remove speedily and completely the source of irritation by which his life is endangered, in all such cases, amputation is the alternative which must still be resorted to, and the injudicious employment of excision would only serve to bring undeserved discredit on one of the most valuable improvements which have been introduced into modern surgery.]

6. Necrosis.

Another distemper, sometimes producing a necessity for amputation, is necrosis, or the death of the whole, or of a considerable part, of the bones of the extremities, accompanied with such extensive abscesses, such disease of the soft parts, such disorder of the constitution, and prostration of strength, that every hope of a cure being effected by a natural process must be renounced. By necrosis, is here meant, not merely some disease which destroys the surface of a bone, but one which extends its depredations to the whole of the internal substance, and that from end to end. Portions of the bones die from a variety of causes, such as struma, lues venerea, deep-seated abscesses, pressure, &c.; and bones in this state, when properly treated, often exfoliate and cast off their dead parts. But, when the whole substance of a bone becomes diseased, from end to end, frequently no means will avail. Nevertheless, I would not positively affirm, as Mr. Pott has done, that every extensive necrosis, affecting a bone nearly its whole length, must inevitably require amputation. The power of nature in restoring the bones is sometimes wonderful. (See Necrosis.)

When, however, in a case of necrosis, the limb breaks in the midst of the diseased part of it, followed by vast deformity, profuse suppuration, and urgent constitutional derangement, amputation is indicated. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 260.)

7. Cancerous and other inveterate Diseases.

Cancerous diseases, and malignant incurable ulcers on the limbs, sometimes render amputation a matter of necessity. In treating of cancer, we shall remark, that little or no confidence can be placed either in internal or any kind of topical remedies, and that there is nothing except the total separation of the part affected, upon which any rational hopes of cure can be built. Cancer, of the scirrhus variety, is not frequently seen on the extremities. Every man of experience, however, must occasionally have seen, in this situation, if not *scirrhoma*, as it is termed by Dr. Carswell (see his *Illustrations of the Elementary Forms of Disease*, Fasc. 1 et 2), medullary tumors, and other diseases quite as intractable, and which cannot be cured, except by removing the affected part. This may often be accomplished without cutting off the whole limb: but when the disease has spread beyond certain bounds, amputation, above the part affected, is the only thing to which recourse can be had with any hope of success. In a few cases of medullary tumor, the operation has succeeded; and even after the disease had reappeared, a cure has now and then been achieved by another excision of the diseased parts. Yet, from what I have seen of fungus hæmatodes, I should much doubt, whether the benefit obtained by amputation would frequently be lasting, as when this disease shows itself only externally, internal organs are mostly at the same time similarly affected. (See Fungus Hæmatodes.)

Besides cancerous, there are other ulcers, which may render amputation indispensable. Thus, when an extensive ulcer, of any sort whatsoever, is evidently impairing the health; when, instead of yielding to remedies, it becomes larger and more inveterate; when, in short, it puts life in imminent danger; amputation should be advised.

8. Various Tumors.

Tumors commencing in the soft parts, if we except those of malignant nature, may generally be removed without sacrificing the limb; but it is otherwise with those which originate in the osseous tissue, as the enchondromatous and other tumors of bone. Occasionally, perhaps, when the tumor grows from the surface of a bone and has not a very extended basis of attachment, excision of the *tumor only* may be successfully practised, but in the majority of cases, the whole thickness of the bone is implicated to a greater or less extent, and in these, since their dispersion is out of the question, amputation of the limb is the only resource.

Exostosis may render amputation necessary, when the tumor becomes hurtful to the health, or insupportable, on account of its weight, or other circumstances, and cannot be removed by any of the plans specified in the article Exostosis.

Before the late facts and improvements relative to the treatment of aneurisms on the extremities, these cases were generally set down as requiring amputation. Even Pott, and J. L. Petit, wrote in recommendation of such practice, and their observations on this subject are among the few parts of their writings which the enlargement of surgical knowledge, since their time, has rendered objectionable. The surgeon, to whom the honour of first correcting this erroneous doctrine belongs, is A. N. Guenault, who opposed the advice delivered by Petit. (*Haller, Disp. Chir.* vol. v. p. 155.)

I shall conclude these remarks on the cases requiring amputation, with advising surgeons never to undertake this serious operation without consulting the opinions of other professional men, whenever their advice can be obtained. The best operators are often deficient in that invaluable kind of judgment, by which the cases, absolutely demanding amputation, are discriminated from others, in which the operation may be wisely postponed, and a chance taken of preserving the limb.

Surgeons should generally refuse to amputate limbs merely affected with stiffness or deformity. Operations under such circumstances, termed by the French *opérations de complaisance*, are more frequently followed by fatal consequences than amputations in more urgent cases. (See *Dupuytren, Clin. Chir.* t. iv. p. 271.)

The History of Amputation

Evinces, that the steps of surgery to perfection are slow, and that they even sometimes deviate from the straight path, though, upon all essential points, no retrogradation has ever taken place. Here nature has acted as the guide, and the surgeon's chief merit has consisted in obeying the hints which she herself has thrown out. As already mentioned, the following natural occurrence, no doubt, was one of the circumstances which first led to the bold practice of amputation; in consequence of disease, and grievous local injuries, whole limbs were sometimes seized with mortification. In the majority of cases this was attended with so much constitutional disturbance, that the patients died; but, in other instances, the mortification was confined to the part; suppuration was established between the dead and living parts; the whole of the mortified limbs fell off; the suppurating surfaces healed up; and thus, by the powers of nature, the patients were restored to health. Here was clearly proved the possibility of recovery, notwithstanding the loss of a limb. The surgeon, as Brünninghausen remarks, viewed with surprise this course of nature, and hardly ventured to promote it by the feeble means formerly employed. But, as the mortified parts, previously to their detachment, caused great annoyance by their fetor, a surgical attempt was at length made to get rid of them; in doing which, the knife was always kept from touching the living flesh, on account of a well-grounded fear of bleeding, for the suppression of which no effectual methods were known. Such was the practice that prevailed from Hippocrates down to Celsus. (*Erfahr. &c. über die Amp.* p. 14.)

A. C. Celsus, who lived in the reign of Tiberius, and whose book, *De Re Medicâ*, should be read by every surgeon, has left us a short description of the mode of amputating gangrenous limbs. (Lib. vii. c. 33.) It has been often remarked, that Celsus has left no instructions for securing the divided blood-vessels; but it has not been commonly noticed, that, in his chapter on wounds, he directs us to stop hemorrhage by taking hold of the vessels, then tying them in two places, and dividing the intermediate portion. If this measure cannot be adopted, he advises the use of a cauterizing iron. Several hints are to be met with in the writings of Celsus, from which it may be inferred, that the ligature of bleeding vessels was sometimes practised at the early age in which he lived; and this supposition is strengthened, by a fragment of Archigenes, preserved by Cocchius, on the subject of amputation, where he speaks of tying, or sewing, the blood-vessels. We are not, however, in possession of all the writings of medical authors, prior to the time of Galen, and must therefore remain in doubt upon this point. (*Rees's Cyclopœdia*, art. *Amputation.*)

It has been argued, therefore, with some appearance of reason, that if amputation often proved fatal in the days of Celsus,—"sæpe in ipso opere," as the expression is, — it was owing to the want of some efficacious method of compressing the blood-vessels during the operation itself.

But, admitting that the ancients were not altogether uninformed of the plan of tying arteries, it cannot be credited that they adopted the practice to any extent; for, if they had, they would not have continued so partial to the cautery, boiling oils, and a farrago of astringent applications. They would also never have had recourse to the barbarous method of cutting the flesh with a red-hot knife, with the view of stopping the hemorrhage by converting the whole surface of the stump into an eschar. Painful in its execution, and horrid in its consequence, as this burning operation was, it seldom proved a lasting antidote to the bleeding, which generally came on in a fatal manner, as soon as the sloughs were loose. On this part of the subject my own ideas fully agree with those of a distinguished foreign surgeon, who says, that although the document left us may prove that the ligature was known to the ancients, and employed in cases of aneurisms and wounded blood-vessels, nay, that the arteries were secured with a needle and ligature; yet the practice could not have been extended to the operation of amputation, since, with the custom of making the incisions in the dead parts, the method scarcely admitted of being put in execution. (*Brünninghausen, Erfahr. über die Amput.* p. 29.)

At the period of making the incision, the ancients contented themselves with having the skin forcibly drawn upward by an assistant; they next divided, with one sweep of the knife, the integuments and flesh down to the bone, and, afterwards, sawed the bone on a level with the soft parts which were drawn upward. Celsus considered it better to let the incision encroach upon the living flesh, than leave any of the diseased parts behind. "*Ei potius ex sanâ parte aliquid excidatur, quam ex ægrâ relinquatur.*" (*De Medicinâ*, lib. vii. c. 33.)

It appears, however, that his views extended further than those of most of his contemporaries, and even his followers, almost down to modern times. After cutting the muscle down to the bone, he says, that *the flesh should be reflected, and detached underneath with a scalpel, in order to denude a portion of the bone which is then to be sawn as near as possible to the healthy flesh, which remains adherent.* He states that, when this plan is pursued, *the skin around the wound will be so loose, that it can almost be made to cover the extremity of the bone.* It is to be lamented, that this advice inculcated by Celsus, should not have been comprehended or that it should have been so neglected as to stand in need, as it were, of a new discoverer. But, the fact is, that hemorrhage formerly rendered amputation so dangerous that the ancient surgeons could not devote much attention to anything else in the operation, and practitioners amputated so seldom, that we read in Albucasis, that he positively refused to cut off a person's hand, lest a fatal hemorrhage should ensue, and the patient did it himself and recovered. Over that part of the stump which the small quantity of preserved skin would not cover, Celsus recommended compresses, and a sponge dipped in vinegar to be laid. (*De Re Medicâ*, lib. vii. c. 33.)

Archigenes, born at Apamia in Syria, was the disciple of Agathinus, and physician to Philip, king of that country. He repaired to Rome, where he practised physic and surgery in the reign of the emperor Trajan, about 108 years after the birth of Christ. (*Portal. Hist. de l'Anatomie et de la Chirurgie*, t. i. p. 61.) In the history of amputation, the name of Archigenes is conspicuous; for he is supposed to have been the first to apply a circular ligature to the limb: he also wetted the whole member with cold water, for the prevention of loss of blood; and it is sometimes believed that he entertained some notion of previously taking up the vessels. Dupuytren observes, however, that this is very doubtful, because it would imply such anatomical knowledge of the circulation as did not exist at the early period alluded to. Archigenes imitated Celsus in the important point of making the incisions in the sound flesh. (*Nicet. Coll. Chir.* p. 155; *Sprengel, Geschichte de Chir.* b. i. p. 404. Halle, 1805.) Such was likewise the practice of Heliodorus, who at this early period made objections to the plan of cutting off a limb by a single stroke — a proposal that was renewed in far later days. The same author has also spoken of amputating at the joints; a method of which he disapproves. (*Nicet. Coll. Chir.* p. 155.) However, Galen entertained a favourable opinion of it. (*Com.* 4, in lib. *de Artic.* p. 650.) Galen's precepts concerning amputation are, upon the whole, very like those of Hippocrates; for he directs only the dead parts to be cut, and the stump to be cauterized. (*De Arte Curativâ ad Glauconem.* lib. ii.) By all the old writers, amputation was entirely restricted to cases of mortification; further they were afraid to go; and this precept, and all the other doctrines of Galen, may be said to have been the guide of the whole surgical profession for at least fourteen centuries.

The timid Arabians were not partial to amputation; and even in cases of mortification, generally preferred a farrago of useless applications, like Armenian bole, &c. Paulus Ægineta, like Galen, deviated from Celsus's good rule of making the incisions in the healthy parts, and only approved of making the requisite division near them. (Lib. iv. c. 19, p. 140.) Avicenna repeated the directions left by the Greek writers (*Can.* lib. iv. Fen. 3, tr. 1, p. 454), and Albucasis recommended the performance of the operation with a red-hot knife. (*Chirurg.* lib. i. sect. 52, p. 99.) In the middle ages, little was done for the improvement of amputation. But in the fourteenth century, gunpowder was invented, and soon applied to the purposes of war; so that an abundance of cases must have presented themselves, in which the wise maxim of not deferring amputation until mortification had come on, but of preventing the mischief by the operation, ought to have struck an intelligent surgeon. One might also have expected that practitioners would now have been led to make the incisions in the sound flesh. Unfortunately, the invention of gunpowder, and its immediate consequences in surgery happened at a period when practitioners were ill qualified to profit by the new lessons of experience set before them. The writings of their predecessors furnished them with no directions how they ought to act, and they were themselves too much confounded at the sight of the mischief for which they were consulted, to be able to form any correct opinion about causes and effects. Their first idea was, that the terrible symptoms proceeded from the parts being actually burned, and they afterwards inclined to believe that gunshot wounds were poisoned. Hence the most absurd modes of treatment were instituted, and, as Brünninghausen expresses himself, human nature groaned under a new evil, for which there were for some time no judicious plans of relief. (*Erfahr &c. über die Amp.* c. 19.) This deplorable state was the natural result of the depression of science in general, and of the healing art in particular, in the days to which I now refer. In these middle ages, as they are called, the population of all Europe was plunged in the deepest ignorance; and whatever little knowledge remained either of the arts, or languages, was monopolized by the priesthood, the physicians of those times, who instead of studying the volume of nature, wasted most of their time in discussing the doctrines of Galen. Surgery itself sunk to the lowest ebb, as may be well conceived from the decrees issued by Pope Boniface the Eighth, forbidding any of the clergy to do any thing themselves which drew blood; and of course, all the operative part of surgery was transferred to a set of illiterate, low-bred mechanics, far inferior to the worst country farriers of modern times. Yet, the clergy, who were thus scrupulously averse to soiling their own hands with blood, or hurting their own tender feelings by viewing the agony of their fellow-creatures, when submitted to operations, had no hesitation in taking the chief emoluments and honours of the profession, or in turning over these poor sufferers to men more qualified to torture and murder than give relief; and, what nearly staggers all credulity, the same professors of Christianity, who shuddered to spill a drop of blood themselves on a proper occasion, as Haller observes, eagerly had a hand, and acted an important part in every sanguinary war where it was possible for them to interfere. In these dismal days of surgery, the advice delivered by Celsus was renewed by Theodoricus, who used to administer opium and hemlock previously to the operation, for the purpose of rendering the patient less sensible of pain, and afterwards vinegar and fennel were given, with the view of dispersing the intoxicating effects of the preceding medicines. (*Chirurg.* lib. iii. c. 10.)

The renowned Guido di Caulico was the inventor of the plan of taking off limbs without bloodshed. It is better, says he, for the limb to drop off, than be cut off. This practice consisted in covering the whole member with pitch plaster, and applying round one of the joints so tight a band that the parts below the constriction ultimately dropped off. (*Chirurg.* tr. 6, Doctr. 1, cap. 8.) The method of amputating, suggested by Celsus, was again revived by Gersdorf, who, after the operation, not only drew down over the stump the skin which had been retracted, but applied a hog's or bullock's bladder over the stump, so as to render all burning and stitching of the part needless. (*Feldbuch der Wundarzn.* fol. 63.) Bartholomew Maggi also endeavoured to preserve a considerable flap of integuments for covering the stump. (*De Vulner. Bombard. et Sclopet.* 4to. Bonon. 1552; see *Sprengel's Geschichte der Chirurgie*, p. 404, 406, 8vo. Halle, 1805.)

At length, in the 15th century, when the revival of learning had commenced in Italy, medical practitioners began to think for themselves again, and they turned from compilations and scholastic nonsense to the consideration of nature. Anatomy was cultivated with great ardour, and made brilliant progress under eminent characters of the time; De la Torre, Berengarius Carpi, Vesalius, Fallopius, Eustachius, and others, who were also for the most part very distinguished surgeons. "*In Italiâ scientiarum matre medici se nunquam chirurgia abdicarunt. Seculo* 15 *et* 16, *professores medici academiæ Bononiensis, Patavinæ, et aliarum in Italia illustrium scholarum et manu curaverunt, et consilio, et inter istos viros summi chirurgi extiterunt.*" (*Haller, Bibl. Chir.* b. i. p. 161.) Practitioners now ventured to amputate limbs in the sound part for other incurable diseases besides mortification; but the art of stopping hemorrhage after the operation continued imperfect. Though the method of applying the ligature in cases of wounded arteries and aneurisms was understood, yet, from some unaccountable causes, the practice was never thought of in amputation. Even Fallopius knew of no other means for stopping the bleeding but the cautery. (*De Tum. præter n.* p. 665.) On the whole, the stoppage of bleeding was not attended with a degree of success, proportionate to the advances of the healing art in general. Straps, bands, and compresses were, indeed, put round the member; but, as the circulation of the blood was not yet correctly known, they were not applied in the proper places; being arranged either close to the wound, or several of them put at random round the limb. The effect of such immoderately tight, long-continued constriction, could be nothing less than gangrene, and hence the actual cautery was chiefly employed. The other means for suppressing hemorrhage scarcely merit the name. Terrified at the insecurity and ill-consequences, J. de Vigo (*Practica in Chirurgia copiosa*, 491, Romæ, 1514) and Fabricius ab Aquapendente (*Op. Chir.* Venet. 1619) disapproved of amputating in the sound flesh, and returned to the principle, inculcated by the ancients, of making the incision in the mortified parts. Others endeavoured to lessen the peril of the bleeding by the rapidity with which the limb was removed, and the instantaneous application of the cautery. For this purpose, L. Botalli invented a sort of guillotine, by means of which a member was severed from the body in an instant (*De Curandis Vulneribus Sclopetorum.* Lugd. 1560); while others laid a sharp axe upon the limb, and effected the dismemberment by the blow of a wooden mallet. This barbarous practice was once followed by Fabricius Hildanus, who is called by his countrymen the patriarch and ornament of German surgery, and who, previously to his acquaintance with the use of the ligature, was accustomed to amputate with a red-hot knife, the representation of which is given in his work. (*De Gangrænâ et Sphacelo, Op.*) Hildanus became a better surgeon, however, as he grew older, and, in the end, partly contributed to the improvement of amputation, inasmuch as he made the incisions completely in the sound parts, and adopted the method of tying the arteries, as then recently proposed by Paré; though in weak persons he still preferred the actual cautery to the ligature. (*Op.* p. 814.) One of his inventions was a linen bag, or cap, for the stump; and a sort of retractor for holding back the muscles.

By many surgeons, however, the tying of arteries continued to be deemed too troublesome, and hence they persisted in the barbarous use of the actual cautery: of this number were Pigrai (*Epitome des Préceptes de Med. et de Chir.* 8vo. Rouen, 1642), F. Plazzoni (*De Vuln. Sclopet.* 4to. Venet. 1618), and P. M. Rossi (*Consult. et Observ.* 8vo. Francof. 1616). Nay, so difficult was it to eradicate the blind attachment shown to the ancients, that Theodorus Baronius, a professor at Cremona, publicly declared, in 1609, that he would rather err with Galen, than follow the advice of any other person; and Van Hoorne seems even to have countenanced the detestable machine of Botalli. (Μικροτέχνη, p. 75.)

Ambrose Paré, who flourished in the 16th century (*Opera*, Parisiis, 1582), and to whom I have already alluded, made some beneficial innovations in the operation of amputation. It is to his industry, good sense, and skill, that we are chiefly indebted for the abolition of cauterizing instruments, and the general use of a needle and ligature for the suppression of the bleeding. (Lib. vi. c. 28, p. 224.)

An anonymous writer has given the following account of the practice and opinions of this distinguished surgeon in relation to amputation. "Paré recommended to cut off the whole of the gangrenous part, if the limb be mortified; but to encroach as little as possible upon the living flesh. At the same time he laid it down as a rule, not to leave a very long stump to an amputated leg; because the patient could more conveniently make use of a wooden leg, with the stump only five finger-breadths long below the knee, than if much more of the flesh were to be preserved. In the arm, however, he left the whole of the living and healthy portion of the member, only separating the diseased part from the sound.

"In preparing for amputation, he directs the skin and muscles to be drawn upwards, and bound tight with a broad bandage, a little above the part where the incision is to be made. This fillet was intended to answer a threefold purpose: 1st, To afford a quantity of flesh for covering the bone, and facilitating the cure. 2ndly, To close the extremities of the divided blood-vessels. 3rdly, To dull the patient's feelings, by pressure on the subjacent nerves. When this firm ligature has been applied, Paré directs an incision to be made down to the bone, either with a common scalpel, or a curved knife. Then, with a smaller curved knife, we are carefully to divide the muscles, or ligament, remaining between the bones of the forearm, or leg; after which, we may proceed to saw off the bone as high as possible, and to remove the asperities occasioned by the saw.

"With the assistance of a curved pair of forceps, he drew out the extremities of the bleeding arteries, either by themselves alone, or with some portion of the surrounding flesh, to be firmly tied with a strong double thread. He now loosened his bandage, brought together the lips of the wound over the face of the stump, and kept them as close as he could, without actual stretching, by means of four stitches or sutures. If the larger tied vessels should accidentally become loose, he desires the ligature, or bandage, to be again passed round; or else, what is better, to let an assistant grasp the limb firm with both hands, and press with his fingers over the course of the bleeding vessel, so as to stop the hemorrhage; then, with a square-edged needle, about four inches long, and a thread four times doubled, the surgeon must secure the artery in the following manner: — Thrust the armed needle into the outside of the flesh, half a finger's breadth from the vessel which bleeds, and bring it out at the same distance from the bleeding orifice: then surround the vessel with the ligature, pass it back again to within one finger's breadth of the place where it first entered, and tie a fast knot upon a folded slip of linen rag, to prevent its hurting the flesh. By this means, says Paré, the orifice of the artery will be agglutinated to the adjoining flesh so firmly, as not to yield one drop of blood: but if the hemorrhage were not considerable, he contented himself with the application of astringent powders, &c.

"Thus did this famous surgeon endeavour, by his single example and precepts, to exclude the barbarous use of hot irons in amputation. He says, he knew not of any such practice among the old surgeons; except that Galen recommended us to tie bleeding vessels, towards their origin, in accidental wounds: and he thought proper to do the same in cases of amputation. But, in an apology, at the end of his book, Paré has quoted in his own defence a dozen authors, who employed or recommended the ligature before him; and he might have cited many more.

"From the statement we have here given, it may be seen how far the best writers of almost every country have erred in ascribing the original invention of tying arteries to Ambrose Paré. Great merit, indeed, was due to him, for the part he took in extending, and even reviving, this incomparable practice: nay, *it is not certain whether any one before him had ever applied the needle and ligature in* *similar cases*, i. e. *after amputation* : but how very wide of the truth Mr. John Bell's recent account of this matter is, will appear to every person who will inquire into the facts themselves ; for not only were ligatures and needles in use among the ancients, but likewise the tenaculum, or hook, to lay hold of the bleeding vessels, when they had buried themselves in the muscles. We refer our inquisitive readers to Avicenna, Ætius, Albucasis, Brunus, Theodoric, Guido di Caulico, John de Vigo, L. Bertapælia, Tagaultius, Petrus Argillata, Andreas à Cruce, &c. &c., where they will find enough to satisfy them on this head." (*Rees's Cyclopædia*, art. *Amputation.*)

I shall not here expatiate upon the ill-treatment which Paré experienced from the base and ignorant Gourmelin ; nor upon the slowness and reluctance with which the generality of surgeons renounced the cautery for the ligature. These circumstances may be conceived from what has been already stated. Almost 100 years after Paré, a button of vitriol was ordinarily employed in the Hôtel Dieu at Paris for the stoppage of hemorrhage after amputations ; and Dionis was the first French surgeon who taught and recommended Paré's method. This happened towards the close of the 17th century, while Paré lived towards the end of the 16th. (*Dionis, Cours d'Opérat.* Paris, 1707.)

As Paré, like the rest of the old surgeons, used to cut directly down to the bone, many of the stumps, which he made, must have been badly covered with flesh, and ill fitted for bearing pressure. But all that I have read on the subject of amputation, impresses me with a strong conviction, that, in former times, the projection of the end of the bone, the sugar-loaf form of the stump, the frequent exfoliations, and the difficulty in healing the part, and keeping it healed, were as much owing to the mischief done with the cautery, the rude way of dressing the stump, and ignorance of the method of promoting union by the first intention, as to the mode of operating, or any other circumstance.

What, asks Brünninghausen, was the reason why the ligature of the arteries, which is now regarded by the surgeons of all civilised nations as the best, easiest, and safest method of stopping hemorrhage after amputation should so long have remained unadopted ? Besides the prejudice for the opinions of the ancients already mentioned, another cause was, undoubtedly, the imperfect knowledge of the circulation of the blood,—a correct description of which was first delivered by the immortal Harvey early in the 17th century. (*Exercitatio Anat. de Motu Cordis et Sanguinis in Animalibus.* Francof. 1628.) For some time, this grand discovery met with violent opposition ; but, after it had been acknowledged as an eternal truth, a happy application of it was made to surgery by a French surgeon, named Morell, who, at the siege of Besançon, in 1674, invented the field tourniquet, by means of which more certain pressure was made on the trunk of the artery. By this simple invention, founded, however, on a knowledge of the circulation, the surgeon could at option let the blood of the stump spirt out, or stop its jet entirely ; and now, both during and after the operation, he was first enabled to command the hemorrhage, and coolly and judiciously employ whatever measures were indicated ; for the most powerful bandages and pressure, previously in use, either stopped the circulation in the whole limb, or could not be made to have the right effect with sufficient quickness. (*Brünninghausen, Erfahr. &c. über die Amp.* p. 36.) Morell's tourniquet, however, was very imperfect ; and it was not till the year 1718, that J. L. Petit, whose name shines so brightly in the history of surgery, invented the kind of tourniquet now employed.

Richard Wiseman, who is justly considered as the father of good English surgery, saw the necessity of making the incision in the sound parts, because gangrene does not always spread evenly, but frequently extends much higher up one side of the limb than the other. He deemed the actual cautery objectionable, as the sloughs were so long in being thrown off. He applied a ligature round the limb, two inches above the limits of the mortification, and, drawing up the muscles, made the incision with a large curved knife, with the back of which he scraped off the periosteum. The bag, or sort of retractor, employed by Fabricius Hildanus, Wiseman thought unnecessary, as the muscles spontaneously drew themselves up as soon as divided. He tied the blood-vessels after the manner of Paré, and deprecated all burning of the stump. After the operation, he drew the flaps over the bone, and either fastened them in this position with stitches, or a tight bandage ; though he generally preferred the former, as the surest means of keeping the end of the bone from protruding. Across the stump he laid a pledget of wax-cerate, and over this a thick layer of Armenian bole and other styptics, and the whole was covered with a bullock's bladder, and a roller applied spirally from the upper part of the remaining portion of the limb, down to the extremity of the stump. On the third day, the dressings were taken off, and a digestive ointment applied. (*Chirurg. Treatises*, vol. ii. p. 220, 8vo. Lond. 1690.)

From this time, amputation may be considered as being an infinitely safer proceeding than it used to be ; for, as we have explained, the ligature of the arteries was now practised and commended in Germany by F. Hildanus, in England by Wiseman, and in France by Dionis. Much, however, remained to be done. The wound was large, and suppurated long and profusely ; the healing was slow ; the ends of the bones perished, and, projecting far beyond the soft parts, retarded the cure so long that the patient was not unfrequently worn out. Hence the best surgeons began seriously to consider what further could be done, with a view of lessening the exposed surface of the wound, and making a better covering of flesh for the ends of the bones.

According to Sprengel, most of the old surgeons preserved a flap of flesh, and he is therefore by no means disposed to regard our countryman Lowdham, as the inventor of this method, though it is acknowledged that the latter surgeon's practice was novel, inasmuch as the flap was formed by making an oblique incision through the integuments from below upwards. (See *James Yonge's Currus Triumphalis e Terebintho*, 8vo. Lond. 1679 ; and *Sprengel's Geschichte der Chirurgie*, b. i. p. 408.) Here, if Sprengel means that many of the old surgeons endeavoured to preserve a partial covering of flesh for the bone, there can be no doubt of its correctness, because we find that they drew back the flesh before they divided it; and Celsus and some others even did more; for, after cutting down to the bone, they detached the flesh further from it upwards, previously to taking the saw: but, on the contrary, if Sprengel wishes us to believe that there were practitioners, who, previously to Lowdham, in the operation of amputation, formed what in England is usually understood by a flap,—that is, a portion of flesh, generally of a semilunar shape, and saved from one side, or both, of the member, for covering the bone,—I cannot see any reason for coinciding with Sprengel's observation. Upon the merit of Lowdham's suggestions, and the practice and principles inculcated by J. Yonge, some reflections, communicated to me by Mr. Carwardine, I insert with great pleasure, as perhaps he is right in thinking that some former editions of this work did not do justice to the memory of the latter writer.

"At the time Yonge wrote (1679)," says Mr. Carwardine, "it was supposed impossible to heal a stump before the bone had exfoliated, and therefore no surgeon would venture upon an attempt at uniting the surface by the first intention. Now, this union by the first intention *was the chief object* of Mr. Yonge in proposing the flap-operation; and it is to him, and not to Mr. Alanson, who wrote precisely 100 years after him, that we must attribute the honour of this improvement. It is related in a letter addressed to his friend Thomas Hobs, chirurgeon, in London, dated Plymouth, August 3, 1678, and published 1679, at the end of his 'Currus Triumphalis e Terebintho.' It begins thus:—

"'Sir, I find by yours that you are surprised with the intimation I gave you, of a way of amputating large members, so as to be able to cure them *per symphysin* in *three weeks;* and without fouling or scaling the bone. It is a paradox which I will now evince to you to be a truth, after I have first taken notice of what you affirm, that there is a necessity of scaling the ends of those bones left bare after the usual manner of dismembering, before the stump can be soundly cured; that you never yet found it otherwise, but that, where it hath been attempted, the stumps have apostumated, and the caries come off thereby.'

"Yonge then acknowledges, that it was from an ingenious brother, Mr. C. Lowdham, of Exeter, that he had the first hint thereof. He then describes the operation—the laying down the flap over the face of the stump, and sewing it by four or five stitches, &c. After this Yonge proceeds with a methodical enumeration of the advantages of this mode of operating over all others then in use, viz. that it is more *speedy*—the cure not occupying *a fourth of the usual time*—*no suppuration*—*no exfoliation*—less danger of hemorrhage—not liable to break open again from slight injury—and, lastly, much better adapted to the pressure from an artificial leg, &c.

"The foregoing abstract will show (says Mr. Carwardine) how far Mr. O'Halloran's method, in which he dresses the flap and the stump as distinct surfaces, can be regarded as a revival of Lowdham's operation, or whether it has been superseded or improved upon by the *mechanical* ingenuity of the Dutch and French surgeons:—The apparatus of M. De La Faye and Verduin appear to have been merely clumsy and unscientific contrivances for the suppression of hemorrhage. Garengeot's operation had also for its object, to supersede the use of the ligature, which, however, after twelve years' practice, he was obliged to give up, and tie the vessels before he laid down the flap. In the removal of the arm at the shoulder-joint, doubtless the advantages of making a flap from the deltoid, &c., are sufficiently established; but, in the mode of dressing, I presume that no English surgeon will admit, that the practice of M. Larrey (perhaps the most eminent surgeon that has been formed by the wars of Bonaparte, and whose practice will be hereafter noticed) can supersede the method of Yonge (or Lowdham), who wrote 140 years before him! Larrey introduces charpie beneath the flap to *prevent* union by the first intention! Lowdham's object is simply to lay the flap over the wound to prevent exfoliation, and to heal the surface '*per symphysin*' in three weeks." After the receipt of this communication from Mr. Carwardine, I looked over the copy of the "Currus Triumphalis e Terebintho," preserved in the valuable library of the Royal Medical and Chirurgical Society, and found his statement fully confirmed by the contents of that ancient work. At the same time, I retain the belief, that the example set by Mr. Alanson, with respect to the proper method of dressing stumps, and obtaining a speedy union of the wound, is entitled to the praise of posterity because his advice was so well enforced that it soon produced a revolution in practice; while the correct suggestions of Lowdham and Yonge, like the hint in Celsus, of the double incision, had sunk into oblivion, or were only known to a few admirers of surgical antiquities.

Mauquest de la Mothe was one of the first who commonly used the tourniquet in amputations, afterwards drawing out the vessels with the forceps and tying them. (*Traité compl. de Chir.* vol. iii. p. 171.) Lowdham's original suggestion of amputating with a flap has been briefly noticed. About eighteen years after Yonge's publication, Peter Verduin, an eminent surgeon at Amsterdam, submitted to the judgment of the profession a new kind of flap amputation. (See *Dis. Epistolica de Novâ Artuum decurandorum Ratione*, 8vo. Amst. 1696.) Two compresses were applied, one under the ham, and the other on the course of the large vessels. The thigh was wrapped in a fine linen cloth, which was sustained by some turns of a roller. This apparatus was covered with a piece of leather, six inches broad, furnished with three straps with buckles, to secure it round the part. The tourniquet was placed in the usual manner. The part, above the place intended to be amputated, was surrounded with a leather strap. The point of a crooked knife, which was made to pass as near to the back part of the bones as possible, was thrust in on one side of the leg, and made to come out on the other. The knife was then carried down, and a flap made of almost the whole calf of the leg. The operation was finished in the ordinary manner. The wound was then washed with a wet sponge, in order to clear it from the fragments of sawn bone. The leather strap, which served to secure the flesh was next loosened, and the flap laid over the stump. The wound was dressed with lycoperdon, lint, and tow, over which was put a bladder, sustained by strips of sticking-plaster. Upon this bladder was placed an instrument, called a *retinaculum*, consisting of a compress, and a concave plate, which were made to press upon the stump by means of two straps, which crossed each other, and were attached to the broad leather strap surrounding the thigh.

Some excellent precepts on amputation were delivered by J. L. Petit. He improved the tourniquet; and instead of the large crooked amputating knife, formerly employed, first brought into use the straight, more moderate sized knives with sharp backs, now seen in the hands of the best surgeons, because much better calculated than crooked knives for dividing the flesh by a sawing movement, which is the only right and surgical way of attempting to cut any part of the human body. He proved that making the division in the mortified parts was frequently followed by hemorrhage; and for the suppression of bleeding, he thought it the best principle to promote the formation of a coagulum. (*Mém. de l'Acad. des Sciences*, an. 1732, p. 285. See HEMORRHAGE.) For compressing the vessels he employed an instrument which covered the stump, like Verduin's retinaculum, and made pressure by means of a screw. His only objection to Verduin's method was, that the extension of gangrene up the limb frequently hindered the formation of so large a flap. He laid down the valuable general maxim of always removing as much bone, and as little flesh, as possible; for which purpose, he invented what is termed the *double incision*, or dividing the business of cutting through the soft parts into two stages. At some distance below the place where he meant to saw through the bones, he first made the circular cut through the integuments down to the muscles; the skin was then pulled up so as to leave the flesh uncovered to the extent of an inch, and the muscles were now divided at the highest point of their exposure. Lastly, the flesh was held out of the way with a retractor, and the bone was sawn through high enough up to allow of its extremity being well covered with flesh and integuments. The greatest defect in the doctrines of Petit, relative to amputation, was the confidence he put in pressure, instead of the ligature. (*Traité des Malad. Chir.* vol. iii. p. 126.)

The first performance of amputation at the shoulder joint, by Le Dran, and the improvements and alterations of that operation suggested by Garengeot, De La Faye, Desault, Larrey, &c., I shall notice in a future section. (See *Amputation at the Shoulder-joint.*)

Verduin, in his method, formed only one flap. Ravaton and Vermale afterwards thought that it would be better to save a flap from each side of the limb. They were also advocates for tying the vessels, and bringing the two flaps into contact, so as to procure their speedy union, and hinder exfoliations and profuse suppuration. (*Traité des Playes d'Armes à feu, par Ravaton*, 8vo. Paris, 1750; *De La Faye, in Mém. de l'Acad. de Chir.* t. v. ed. 12mo.; *Vermale, Obs. de Chir.* 8vo. Manheim, 1767.)

The multiplicity of machines, described by Verduin, La Faye, &c., had no other end but that of keeping the flap near the orifices of the vessels, so as to compress and close them. In consequence of the difficulty of making this compression precisely as required, the most considerable vessels between the two bones, when cut, generally becoming retracted, Garengeot determined to employ ligatures.

His first operation of this kind was an amputation of the arm with two flaps. The brachial artery was tied, and the patient cured without any exfoliations.

Garengeot operated also on a soldier dangerously wounded in the right foot by the bursting of a bomb, which fractured the interior part of the two bones of the leg, and several of the foot: the patient recovered in twenty-seven days. A single flap was made. He rightly preferred dressing and bandaging the stump to the use of the compressing machines invented by Verduin and La Faye; and his choice of a straight knife, instead of a crooked one, was equally judicious.

The preceding case dictated a truth, which will last as long as surgery itself, viz. *that it is advantageous to apply the ligatures in such a manner as to embrace no more than the vessel, so that they may fall off the sooner, and the parts more quickly unite.* (*Garengeot, in Mém. de l'Acad. de Chir.* t. v. 12mo.)

At one time, an objection frequently urged against the foregoing methods, was, that, when the fresh cut flap was immediately laid over the stump, inflammation and abscesses were apt to ensue. Hence, in 1765, Sylvester O'Halloran, a surgeon at Limerick, was led to make the experiment of deferring laying down the flap till the end of the first eight or twelve days after the operation, when it was conjectured that the risk of inflammation and abscesses would be diminished. The tenor of O'Halloran's book is apparently corroborated by the facts brought forward. Here we see one of the grand points insisted upon by our worthy countryman James Yonge, viz. the chance of an immediate union of the wound from laying down the flap without delay, suddenly given up, and because the wound could not always be healed without suppuration, it was determined that it never should do so.

Alexander Monro, senior, disapproved of the tourniquet: he secured the vessels with needles and ligatures; and was the inventor of a bandage, which has been extensively approved of, under the name of Monro's roller. (*Medical Essays of Edinb.* vol. iv. p. 257.)

Bromfield, like Le Dran, restricted amputation to a few cases; and he did not acknowledge its necessity, as a matter of course, in every case of gangrene, much less in every instance of white swelling, or caries. From a passage which I have cited from Dr. Rees's Cyclopædia, it would seem that the tenaculum was known to the ancients; but Bromfield is allowed to be the first modern surgeon who employed this useful instrument. (*Chir. Cases and Obs.* vol. i. p. 41, 8vo. Lond. 1773.)

About the year 1742, the removal of thighs without bloodshed was a subject a good deal broached. A single case, recorded by Schaarschmid, where a mortified thigh separated without hemorrhage, was the foundation of the scheme. The arteries were completely blocked up, and the parts insensible. (*Haller, Dis. Chir.* vol. v. p. 155.) A similar occurrence was related by Acrel (*Chir. Händels.* p. 557); and Lalouette professed himself a believer in the security from hemorrhage, on account of the vessels being filled with coagula, and therefore he also approved of letting dead parts be removed, or rather fall off, without bloodshed. (*Haller, Dis. Chir.* vol. v. p. 273.)

In cases where the projecting bone of the stump was affected with necrosis, Bagieu ventured to amputate a second time, and urged a variety of arguments in defence of the practice. (*Mém. de l'Acad. de Chir.* t. ii. p. 274.) He coincided with Le Dran and Bromfield, however, about the propriety of restricting amputation to few cases; and has related numerous examples of limbs being saved, which, according to the doctrines then in vogue, ought to have been cut off. (*Deux Lettres d'un Chir. de l'Armée*, 12mo. Paris, 1750.)

M. Louis, a French surgeon of extraordinary talents, introduced the plan of dividing the loose muscles first; and lastly, those which are closely connected with the bone. He noticed, that the muscles of the thigh, after being divided, were retracted in an unequal degree. He observed, that the superficial ones extending along the limb, more or less obliquely, without being attached to the bone, were drawn up with greater force, and in a greater degree, than others, which are deeply situated, in some measure parallel to the axis of the femur, and fixed to this bone throughout their whole length. The retraction begins the very instant when the muscles are cut, and is not completed till a short time has elapsed. Hence the effect should be promoted, and be as perfect as possible, before the bone is sawn. In amputation of the thigh, M. Louis was always desirous of letting the muscles contract as far as they could: and, for this reason, he was rather averse to using the tourniquet, as the circular pressure of this instrument in some measure counteracted what he wished to take place, and hence, at one time, he preferred letting an assistant make pressure on the artery; though he subsequently expressed his approbation of the tourniquet proposed by M. Pipelet for compressing the femoral artery. (*Mém. de l'Acad. de Chir.* vol. iv. p. 60, 4to.) Actuated by such principles, Louis practised a kind of double incision different from that of Cheselden and Petit, and different also from Alanson's method, which I shall hereafter notice. By the first stroke, he cut, at the same time, both the integuments and the loose superficial muscles; by the second he divided those muscles which are deep, and closely adherent to the femur. On the first, deep, circular cut being completed, Louis used to remove a band, which was placed round the limb, above the track of the knife. This was taken off, in order to allow the divided muscles to become retracted without any impediment. He next cut the deep adherent muscles, on a level with the surfaces of those loose ones, which had been divided in the first incision, and which had now attained their utmost state of retraction. In this way, he could evidently saw the bone high up, and the painful dissection of the skin from the muscles was avoided. Louis was conscious that there was more necessity for saving muscle than skin; and he knew that, when an incision was made at once down to the bone, the retraction of the divided muscles always left the edge of the skin projecting a considerable way beyond them. Hence he deemed the plan of first saving a portion of skin, by dissecting it from the muscles, and turning it up, quite unnecessary. As the bone should always be sawn rather higher than the division of the soft parts, Louis, like J. L. Petit, and most other judicious surgeons, highly approved of the employment of a retractor. He was likewise the author of some valuable instructions for preventing the protrusion of the bone after the operation. (See *Mém. de l'Acad. de Chir.* t. ii. p. 268—410, &c. 4to.) The impartial reader, who takes the trouble to read the remarks on amputation published by this greatest of all the French surgeons of the last century, with the exception perhaps of J. L. Petit and Desault, will be impressed at once with the force and perspicuity of his matter, and with the evident propriety of a good deal of the practice inculcated. Dupuytren often followed the maxim of dividing the skin and loose superficial muscles together.

In England, Cheselden, and not J. L. Petit, is regarded as the surgeon who revived Celsus's method, by having recourse to *a double incision*—that is, by cutting the skin and cellular substance first, and then, by dividing the muscles down to the bone, on a level with the edge of the skin, so that the bone might be sawn higher up, and its end be more completely covered with skin. Whether Cheselden had the priority in this improvement, I cannot presume to say; but he gave an account of it in Gataker's translation of Le Dran's treatise on the operations as early as 1749, which was long prior to the appearance of Petit's posthumous writings; and Cheselden further mentions, that, during his apprenticeship to Mr. Fern, he had communicated to that gentleman his sentiments about the double incision.

In order to hinder the stump from assuming a pyramidal, or sugar-loaf shape, which sometimes happened, notwithstanding every improvement hitherto mentioned, a circular bandage was employed, which acted by supporting the skin and muscles, and preventing their retraction. This bandage, when properly applied, from the upper part of the limb downward, fulfilled in a certain measure the end proposed, though many stumps yet turned out very bad ones. Mr. Sharp was induced, therefore, to revive the ancient plan of bringing the edges of the skin together with sutures; but the pain and other inconveniences of this method were such, that it was never extensively adopted and Mr. Sharp himself ultimately abandoned it. The cross bandage, however, which he used to put over the end of the stump, remains partially in fashion even at the present day. (*Treatise on the Oper.* p. 216; *Critical Inquiry*, p. 268.)

Since the introduction of anæsthesia, and its almost universal employment in surgical operations, the principal objection to the use of sutures, namely, the pain which they occasion, has been removed, and they are now again extensively employed, not only in the union of wounds after amputation, but also after most other surgical operations where accurate apposition and union by the first intention are desired.

The inefficiency of the method of Louis for hindering the protrusion of the bone was asserted by Valentin, who thought the object might be better attained by dividing the parts while they were in a state of tension; for which purpose he recommended changing the posture of the limb, according to the parts which he was about to cut. (*Recherches Critiques sur la Chirurgie Moderne*, 8vo. Amst. 1772.) Valentin's proposal seems never to have excited much attention; whether on account of its inconvenience, or inefficacy, I know not; certain it is, many cases present themselves, in which the posture of a limb absolutely cannot be changed during the operation, owing to the nature of the disease, or cannot be altered without extreme agony.

About the middle of the 18th century, arose the celebrated controversy about the propriety of amputation in general. Several surgeons now began to be convinced, with Le Dran and Bagieu, that the operation was undertaken on too light grounds; and, in particular, that many bad complicated fractures might be cured without amputation. Such was the doctrine of Boucher (*Mém. de l'Acad. de Chir.* t. ii. p. 304), Gervaise (*Anfangsgr. der Wundarzn.* 8vo. Strasb. 1755), and Faure (*Mém. qui ont concouru pour le Prix de l'Acad. de Chir.* vol. i. p. 100). The latter, especially, urged the prudence of delay in gunshot wounds and comminuted injuries of the bones. But the writer who at this time made the greatest noise in the world, by his general condemnation of amputation, was Bilguer (*Diss. de Membrorum Amputatione*, 8vo. Hal. 1761), whose sentiments received, however, a complete refutation from his own contemporaries, Pott (*Chir. Works*, vol. ii.), Morand (*Opusc. de Chir.* t. i. p. 232), and De la Martinère (*Mém. de l'Acad. de Chir.* vol. iv. p. 1.), and also from later writers, to whom reference will be made in speaking of *Gunshot Wounds.* Even Bilguer himself was compelled to admit the necessity of amputation in cases of gangrene. (*Anweis. für die Feldwundärzen*, s. 170.)

Bilguer's colleague, the celebrated Schmucker, inclined to the same doctrines, and has detailed several cases, where limbs were not only shattered, but actually carried away by balls, yet where a cure followed without amputation. One of his maxims was, that it was better for the member to be taken off by gunshot than by the surgeon's knife, as the ball operated on a healthy subject, the knife on a person debilitated by an hospital. (*Chir. Wahrn.* th. ii. s. 493.) In a later valuable essay on this subject, he restricts amputation to shattered limbs affected with gangrene. His mode of operating was that of M. Louis. He sanctioned joint-operations at the hip and shoulder; but condemned those of the knee and elbow, as never answering. (*Verm. Schrift.* th. i. s. 3.)

Soon after the middle of the last century, the practice of amputating at the joints began to excite increased attention; but, as this is a topic to which I must presently return, it is unnecessary now to dwell upon it. The writings of Puthod, Wohler, Brasdor, Barbet, Sabatier, Park, Moreau, and Vermandois, in relation to this subject, deserve particular notice.

I now come to Mr. Alanson, whose name is as conspicuous in the history of amputation as that of any surgeon yet mentioned. His chief objects were to hinder a protrusion of the bone, and promote union by the first intention. He rejected the band, which was formerly put round the limb for the guidance of the knife, as altogether useless, and an impediment to the quick performance of the circular incision through the skin. When the tourniquet had been applied, an assistant grasped the integuments with both hands, and drew them and the muscles firmly upwards. The operator then fixed his eye upon the proper part where he was to begin the incision, which was made with considerable facility and dispatch, the knife passing with greater quickness in consequence of the tense state of the integuments.

After the incision through the skin had been made, the assistant still continued a steady support of the parts, while Mr. Alanson separated the cellular and ligamentous attachments with the point of his knife, till as much skin had been drawn up as would, with the muscles, divided in the particular way hereafter recommended, fully cover the whole surface of the wound. Then, instead of applying the knife close to the edge of the integuments, and dividing the muscles in a circular perpendicular manner down to the bone, Mr. Alanson proceeded as follows:—When operating upon the thigh, and standing on the outside of the limb, he applied the edge of his knife under the edge of the supported integuments, upon the inner margin of the vastus internus muscle, and cut obliquely through that and the adjacent muscles, upwards as to the limb and down to the bone, so as to lay it bare about three or four finger-breadths higher than is usually done by the common perpendicular circular incision. He now drew the knife towards himself; then keeping its point upon the bone, and the edge in the same oblique line already pointed out for the former incision, he divided the rest of the muscles in that direction all round the limb: the point of the knife being in contact with, and revolving round the bone through the whole of the division.

According to Mr. Alanson, the speedy execution of the above-directed incision will be much expedited by one assistant continuing a firm and steady elevation of the parts, and another taking care to keep the skin from being wounded, as the knife goes through the muscles, at the under part of the limb. Mr. Alanson censures the old method of depriving the bone of its periosteum to a considerable extent, above and below the part where the saw is to pass, not only as creating unnecessary delay, but since the periosteum serves to support the vessels in their passage to the bone, as apt to produce exfoliations above the part where the bone is to be divided with the saw. Instead of this practice, he recommends first the application of the retractor, as advised by Gooch and Bromfield; and then denuding the bone at the part where the saw is to pass, whereby the bone may be sawn off higher than is usually practised; a material object in hindering a projection of the bone, and forming a small cicatrix.

If the flesh of a stump, formed in the thigh, agreeably to the foregoing plan, be gently brought forward after the operation, and the surface of the wound be then viewed, it may be said to resemble in some degree a conical cavity, the apex of which is the extremity of the bone; and the parts, thus divided, Mr. Alanson thought the best calculated to prevent a sugar-loaf stump.

The part where the bone is to be laid bare, whether two, three, or four finger-breadths higher than the edge of the retracted integuments; or, in other words, the quantity of muscular substance to be taken out, in making the double incision; must be regulated by considering the length of the limb, and the quantity of skin that has been previously saved by dividing the membranous attachments. The quantity of skin saved, and muscular substance taken out, must be in such exact proportion to each other, that the whole surface of the wound will afterwards be easily covered, and the limb not more shortened than is necessary to obtain this end.

After the removal of the limb, Mr. Alanson drew each bleeding artery gently out with the tenaculum, and tied it as nakedly as possible, with a common slender ligature. When the large vessels had been tied, the tourniquet was immediately slackened, and the wound well cleaned, in order to detect any vessel that might otherwise have remained concealed with its orifice blocked up with coagulated blood ; and before the wound was dressed, its whole surface was examined with the greatest accuracy ; by which means Mr. Alanson frequently observed a pulsation, where no hemorrhage previously appeared, and turned out a small clot of blood from within the orifice of a considerable artery. He is very particular in recommending every vessel to be secured that is likely to bleed on the attack of the symptomatic fever ; for, besides the fatigue and pain, to which such an accident immediately exposes the patient, it seriously interrupts the desired union of the wound. He used always to cleanse the whole surface of the wound well with a sponge and warm water, as he rightly thought that the lodgment of any coagulated blood would be a considerable obstruction to the quick union of the parts.

The skin and muscles were now gently brought forwards : a flannel roller was put around the body, and carried two or three times rather tightly round the upper part of the thigh, as at this point it was intended to form what Mr. Alanson called a sufficient basis, which materially added to the support of the skin and muscles. The roller was then carried down in a circular direction to the extremity of the stump, not so tight as to press rudely or forcibly, but so as to give an easy support to the parts.

The skin and muscles were now placed over the bone in such a direction that the wound appeared only as a line across the face of the stump, with the angles at each side ; from which points the ligatures were left out, as their vicinity to either angle might direct. The skin was easily secured in this posture by long slips of linen or lint of the breadth of about two fingers, spread with cerate, or any cooling ointment. If the skin did not easily meet, strips of sticking-plaster were preferred. These were applied from below upwards, across the face of the stump, and over them a soft tow-pledget and compress of linen ; the whole being retained with the many-tailed bandage, and two tails placed perpendicularly, in order to retain the dressings upon the face of the stump.

Mr. Alanson censured the plan of raising the end of the stump far from the surface of the bed with pillows, as the posterior muscles were retracted by it ; and he considered it best to raise the stump only about a half hand's breadth from the surface of the bed, by which means the muscles were put in an easy relaxed position. The many-tailed bandage Mr. Alanson found much more convenient than the woollen cap, frequently used in former times to support the dressings ; and he observes, that, though this seems well calculated to answer that purpose, yet if it be not put on with particular care, the skin is liable to be drawn backwards from the face of the stump ; nor can the wound be dressed without first lifting up the stump to remove the cap. (See *Alanson's Practical Obs. on Amputation,* 8vo. Lond. 1779.)

The chief peculiarity in Alanson's method of operating, namely, the mode in which he recommends the oblique division of the muscles to be performed, did not, however, meet with universal approbation ; and his extensive dissection of the skin from the muscles was complained of, as excessively painful. The formation of a conical wound, by following Alanson's directions, was regarded by several as impracticable. (See *Murten's Paradoxieen*, b. i. s. 88 ; *Loeffler, Beytrage*, i. No. 7 ; *Wardenburg. Briefe eines Arztes*, 2 b. p. 20 ; *Richter, Anfangsgr.* vol. vii. ; *Graefe, Normen, &c.* p. 8; *Hey, Pract. Obs.*) In my opinion, there can be no doubt of the truth of some of the criticisms made by these, and some other writers, on the impossibility of making a wound, with a regular conical cavity, by observing the directions given by Alanson ; for if the knife be carried round the member with its edge turned obliquely upwards towards the bone, it will pass spirally, and, of course, the end of the incision will be considerably higher than the beginning. But, though Alanson probably never did himself exactly what he has stated, I am sure that his proposition of making an oblique division of the muscles all round the member has been the source of great improvement in amputations in general. It is true that surgeons do not actually perform the oblique incision all round the limb by one stroke, or revolution of the knife round the bone, as Alanson says that he did ; but they accomplish their purpose by repeated, distinct, and suitable applications of the edge of the instrument turned obliquely upwards towards the bone or bones.

Amongst others, Mynors found fault with some of Alanson's instructions, and thought every desideratum might be more certainly attained by saving skin enough, and then cutting through the muscles. The first incision, however, he directed obliquely upwards through the integuments, while they were drawn up by an assistant, and he then cut down to the bone. (*Pract. Thoughts on Amputation*, 8vo. Birming. 1783.)

The removal of limbs without bloodshed, proposed by Guido di Cauliaco in the 14th century, met with modern defenders in J. Wrabetz and W. G. Plouquet. J. Wrabetz, with a ligature which was daily made tighter, took off an arm above the elbow. Into the fissure he sprinkled a styptic powder. On the fourth day the flesh was severed down to the bone, which was sawn through. (*Geschichte eines ohne Messer abgesetzen Oberarms*, 8vo. Freyb. 1782.) Plouquet thought the plan suited to emaciated timid subjects ; but not well adapted to the leg or fore-arm. (*Von der Unblütigen Abnehmung der Glieder*, 8vo. Tub. 1786.) The only exemplification of the practice of taking off limbs without bloodshed in modern practice, is sometimes afforded in chronic mortification, where, after the separation of the dead from the living parts down to the bone by Nature herself, the surgeon saws through the exposed bone. In the North London Hospital, an upper extremity, attacked with chronic mortification, was thus removed by Mr. Liston, a little below the axilla, and the patient, a very old woman, recovered.

Some modes of performing flap-amputations, and, in particular, the suggestions and improvements made by Hey, Chopart, Dupuytren, Larrey, Lisfranc, Liston, and other modern practitioners, will be noticed in the description of the amputation of particular members. In the mean time, I shall conclude this section with mentioning the laudable attempts, made at different periods, to render the patient less sensible of the agony produced by the removal of a limb. Theodoricus administered for this purpose opium and hemlock, and, though he was imitated by many of the ancient surgeons, few moderns have deemed the practice worthy of being continued. The inhalation of stupefying gas has been tried, and so has magnetism. M. J. Cloquet, by some preparatory means not specified by Velpeau, brought a patient into a condition in which the removal of the breast was accomplished without her having been aware of it. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 297.) Guido made the experiment of benumbing the parts with a tight ligature; but a machine, devised a few years ago in England, expressly for the object of stupefying the nerves of a limb previously to amputation, seems freer from danger than some of the means adopted to bring the patient into a stupefied state. (See *J. Moore's Method of preventing or diminishing Pain in several Operations of Surgery*, 8vo. Lond. 1784.) The great reason of the latter plan being given up is, that some patients have made more complaint of the sufferings occasioned by the process of dulling the sensibility of the nerves than of the agony of amputation itself without any such expedient. Yet daily experience proves that the pressure caused on the sciatic nerve by sitting with the pelvis in a certain position will completely benumb the foot and leg, and this with such an absence of pain, that the person so affected is actually unaware of his foot *being asleep*, as it is termed, until he tries to walk.

The above paragraph is interesting as showing the efforts formerly made to alleviate pain during operations. The reader, however, is referred to the article Anæsthesia, for information respecting the more perfect agents, now so universally employed for this purpose.

GENERAL REMARKS ON AMPUTATION.

Amputations may be divided into two classes; amputations in the "*continuity*" of the bones, *i. e.* where the bones are sawn through; and amputations in their "*contiguity;*" or where the limb is separated at one of the articulations. The terms disarticulation and exarticulation are also employed to designate the latter class of operations. The remarks which follow, although they are for the most part applicable to both cases, refer more especially to the former class, and some additional observations on the mode of performing amputation through the articulations will be afterwards offered.

The different steps of the operation, meriting particular attention, are, the choice of the part of the limb where the incisions are to begin; the measures for guarding against bleeding during the operation; the division of the integuments, muscles, and bones, which is to be accomplished in such a manner that the whole surface of the stump will afterwards be covered with skin; tying the arteries, which should be done without including the nerves, or any other adjacent part; placing the integuments in a proper position after the operation; and, finally, the subsequent treatment of the wound.

It is a general rule to amputate as low as the disease will allow; so that as little of the limb may be cut off as possible, the surface of the wound have less extent than would otherwise happen, and the preserved portion of the limb have greater power in proportion to its length. The longer it is, the better also will it be suited for the adaptation to it afterwards of some artificial substitute.

This rule admits of no exception in the upper extremity. In some parts of the lower limb, however, as will be subsequently explained, it has been customary to select certain situations for the performance of amputation with reference to the future convenience of the patient, even though the disease or injury might admit of the removal of a smaller portion of the limb. But it should always be borne in mind, that the shock which the system sustains at the time, and the subsequent danger to the patient from the various untoward symptoms which may set in while the healing of the wound is in progress, will depend very much on the size of the part removed, and the proportion which it bears to the whole bulk of the body. Amputation, for instance, is unquestionably more dangerous at the shoulder-joint than in the forearm; in the thigh than in the leg; in the upper than in the lower third of the thigh. And when the patient has suffered from long continued disease, and his powers have been already so severely tested, that when amputation is performed the chances in his favour and against him are perhaps nearly evenly balanced, the demand made upon his constitution to heal a larger wound instead of a smaller one may be sufficient to turn the scale, and make all the difference between his death and his recovery.

Here, however, through an imprudent solicitude to obtain the above advantages, let not the surgeon ever be unmindful of the great axiom in surgical operations, that all the diseased parts should be removed; and let him be assured of the truth of what Graefe inculcates, that it is more pardonable to cut away too much than too little. (*Normen für die Ablösung grösserer Gliedm.* p. 60.) At the same time, I do not agree with some modern writers, who deem it necessary to amputate beyond the limits of every abscess and sinus which may extend very far above a diseased joint or compound fracture. Many of these suppurations are only like ordinary abscesses, and finally get well after the main disease or injury is removed, as I have often seen. Were it an invariable rule to amputate above every collection of matter, sometimes five or six inches more of the limb would be sacrificed than circumstances absolutely demanded, and the greater danger of a high, than a low operation, would be encountered. However, in all cases where the bone is suspected to be unsound, or the muscles are affected with the morbid changes peculiar to fungus hæmatodes or other incurable diseases, the operation should be practised sufficiently high to take away all the distempered parts. In secondary amputations, where there has been much suppuration in the limb, and a sinus runs up, Mr. Guthrie says, that if the sinus extend only a short way between the muscles, the membrane lining it may be dissected out; but, if the matter has lain upon the bone, this will have become diseased, and amputation should be practised high enough to remove the affected part of it. (*On Gunshot Wounds*, p. 87.)

Arrest of hemorrhage during the operation is the next point which demands the attention of the surgeon, and to accomplish this the tourniquet is the instrument which is most commonly employed. (See Tourniquet.)

We know that it was an opinion of the late Mr.

J. Bell, that the flow of blood through a large artery could not be completely stopped by pressure; and the late Mr. Hey adopted a similar notion, in consequence of seeing a case in which the application of two tourniquets to the thigh did not restrain the hemorrhage from a fungus hæmatodes of the limb. He says, the pressure of the tourniquet does not completely obstruct the passage of blood in the arteries; it only diminishes so much of the force of the current as to enable the vessels, *in a sound state*, to exert their natural contractive power so effectually as to prevent hemorrhage. (See *Hey's Pract. Ob.* p. 257, 258, ed. 2.) Of the inaccuracy of this doctrine no man can doubt who sees the femoral artery with its open mouth on the face of a stump, not bleeding while the tourniquet is tight, or skilful pressure is kept up, but throwing out its blood to a great distance the instant the pressure is discontinued. Nor, I apprehend, can any surgeon, who has amputated at the shoulder, and seen how completely pressure commands the flow of blood through the open-mouthed axillary artery, join in the sentiment of John Bell and Hey upon this particular point.

Mr. Liston confirms the preceding statement, observing that pressure complete enough not only to stop the pulsation of an artery in a limb, but also to arrest completely the flow of blood, can be easily applied by means of the fingers only: and, in order to prove the correctness of this remark, he has repeatedly, when no proper assistant was at hand, compressed both the femoral and humeral arteries with the fingers of one hand, whilst, with the other hand, he removed the limb; and this, as he affirms, with the loss of much less blood than if he had followed the ordinary mode. His common practice is to let the pressure be made by an assistant; and in one place, he declares, that he would rather trust to no very efficient assistant than put on a tourniquet. The ease with which the flow of blood through the largest arteries is commanded by manual pressure, is a fact likewise attested by Dupuytren, who only employed the instrument, which he terms the compressor, in a few special cases. (See *Leçons Orales, &c.* t. iv. p. 377; *Elements*, part iii. p. 361; and *Ed. Med. and Surg. Jour.* vol. xx. p. 44.) The following passage explains Mr. Liston's views of this subject: "In all cases, and in all situations and circumstances, hemorrhage can be restrained during the completion of the incisions, and during the employment of means to close the cut ends of the vessels, by means of very slight, but exact pressure on the trunk of the principal vessel. (See also *Dupuytren, Leçons Orales de Clinique Chir.* t. iv. p. 382.) *The point at which this should be applied should be at as short a distance as possible above the place of the incision, and at the same time above the origin of any branches which must be cut.* Not the slightest pressure should be made until the instant when the incisions are about to be commenced, so that no venous congestion may take place in the limb. All the blood in the limb below the incisions must necessarily be lost. The veins are more easily compressed than the arteries; and pressure made a short time before the operation may arrest the return of blood, whilst it may not stop its influx. Thus engorgement of the lower part of the limb is produced, and the quantity of blood that must be lost is increased. For a similar réason, pressure sufficiently firm to stop arterial hemorrhage, is to be continued till the principal branches are tied, and then entirely removed; for the continuance of even slight pressure will increase the flow of blood from the surface of the stump — blood flowing in, and being arrested in its venous return, trickles out through the open ends of the veins. If a circular band be used for the compression, such as the screw-tourniquet, it should be put on quickly, screwed up at once, and then the incisions should not be delayed one instant." Baron Dupuytren did not employ the common tourniquet, nor any kind of compress furnished with a handle (see *Leçons Orales*, t. iv. p. 298); he sometimes availed himself of an instrument which he termed a compressor, and which makes pressure on two opposite points of the limb. (See *Leçons Orales, &c.* t. iv. p. 386.)

If, then, the flow of blood through an artery can easily be commanded by pressure, how are we to explain the occasional continuance of bleeding, notwithstanding the pressure of one, or even two, tourniquets? Without doubt, by the fact that the pads of these instruments, when not duly arranged, do more harm than good, by raising the band off the vessel, and perhaps, also, in Mr. Hey's example, by the additional consideration, that tumors of the fungus hæmatodes kind include a large quantity of blood, and will bleed profusely, and for a considerable time after the main supply of blood to them is cut off. The same thing happens in the disease called aneurism by anastomosis, as I have had several opportunities of witnessing, but in no instance more strikingly than in one, where, some time after Mr. Hodgson had tied the radial and ulnar arteries, Mr. Lawrence divided every part of the finger, excepting the tendons and bone, and yet a considerable bleeding went on from the further side of the wound. (See *Med. Chir. Trans.* vol. ix. p. 216.)

The application of the tourniquet is generally left too much to assistants; but so far as my judgment extends, no operator is justified in commencing his incisions before he has examined and fully satisfied himself that the instrument is correctly applied. Mr. Guthrie candidly tells us, that he once lost an officer, in consequence of hemorrhage during amputation of the thigh, although the tourniquet was in the charge of a surgeon of ability; and the advice with which he follows this statement is worth recollecting: "In a case of this kind, where it (the tourniquet) is found of little benefit, the surgeon should not continue twisting and turning it, whilst his patient is bleeding, but quit it altogether, and compress the artery against the pubes." This maxim cannot be too highly commended.

Mr. Guthrie says, "The pad should be firm and rather narrow, and carefully held directly over the artery, whilst the ends of the bandage, in which it is contained, are pinned on the thigh. The strap of the tourniquet is then to be put round the limb, the instrument itself being directly over the pad, with the screw entirely free. The strap is then to be drawn tight, and buckled on the outside, so as to prevent its slipping, and not interfere with the screw, which is to be turned until the pressure is sufficiently forcible to stop the circulation. If the screw require to be turned for more than half its number of turns to effect this, the strap is not sufficiently tight, or the pad has not been well applied, and they must be replaced." (*On Gunshot Wounds*, p. 204.)

In two amputations at St. Bartholomew's Hospital, I saw the tourniquet break after the soft parts had been divided; and as in one of these cases a good deal of blood was lost, because another tourniquet happened not to be in the room, and pressure on the artery in the groin was not immediately adopted, I coincide with such writers as recommend the rule of always having two tourniquets ready. Graefe even goes so far as to advise putting both of them round the limb before the operation commences (*Normen für die Ablösung grösserer Gliedmassen*, p. 48); but, the frequency of a tourniquet breaking is not so great, as to demand such precaution; and the plan would be objectionable in thigh amputations, where it is a material advantage to have plenty of room between the place of the incision and the band which goes round the limb.

Provision having been made for the arrest of hemorrhage during the operation, either by the application of a tourniquet, or by compression of the vessel by the hands of a trustworthy assistant: the point next to be considered is the division of the soft parts of the limb.

There are two principal methods by which this may be accomplished, by *circular incisions*, and by the *formation of flaps*; but to these may be added modifications by means of *oval* and *elliptical* incisions, which, it will be hereafter seen, combine in some measure the characters of *both* the first-mentioned proceedings.

AMPUTATION BY CIRCULAR INCISION.

In order to make the first cut, the arm is to be carried under the limb, till the knife reaches almost round to the side on which the operator stands. With one sweep, penetrating at least to the fascia, the knife is then to be brought round to the point where it first touched the skin. Thus, the wound is more likely to be regularly made than by cutting first on one side, and then on the other, while the patient is saved some degree of pain, in consequence of the uninterrupted quickness with which the incision is made. Whether the fascia and subjacent muscular fibres be reached or not, is deemed by Velpeau a matter of no consequence; the only essential thing being the perfect division of the skin. (See *Nouv. Elém. de Méd. Opér.* t. i. p. 508.)

The next object is the preservation of as much skin as will afterwards, conjointly with the muscles cut in an oblique direction, cover the end of the stump with facility. It is rather difficult to lay down any other than general principles for the guidance of the surgeon in saving integuments. I am disposed to agree with several modern writers, that the painful dissection of the skin from the muscles has been recommended and practised to a very unnecessary extent, — that is to say, unnecessary, if the division of the muscles be performed in the most advantageous manner. Instead of dissecting back the skin, Dupuytren used to cut all the soft parts at once to the bone, which he next divided, after retracting the muscles. (*Dupuytren, Leçons Orales, &c.* t. iv. p. 297.) However, Langenbeck, another of the most skilful operators on the Continent, prefers detaching the integuments from the fascia for about two fingerbreadths (*Bibl. für die Chir.* b. i. p. 567), as is the common practice in the London hospitals. Some late writers, particularly Mr. Syme, in expressing their preference to muscle as a covering for the end of the bone, seem to forget one fact which I have often noticed, viz. that the muscular cushion, though at first thick and good, soon shrinks to a comparatively small mass. Sir Astley Cooper states that the covering for the end of the bone must be integuments and not muscles; for, if muscular fibres are preserved with the integuments, they will contract, and retraction of the skin covering the stump will be the result. (*Lancet*, vol. i. p. 148.) Brünninghausen also thinks skin a better and more durable covering for the end of the bone than muscular fibres, which after a time dwindle away; and thence he computes the quantity of integuments which ought to be saved, by the measure of the circumference and diameter of the member. Thus, when the limb is nine inches in its circumference, the diameter is about three; therefore, one inch and a half of skin on each side is to be saved. (*Erfahr. &c. über die Amp.* p. 75.) But this author cuts the muscles perpendicularly, so that he is obliged to separate much more skin from the flesh than is necessary when the incision through the muscles is carried obliquely upward. Dr. Hennen and Mr. Guthrie both recommend carrying the knife through the fascia in the first circular incision; and so does Mr. C. Hutchison, who makes no mention of dissecting back the skin, but simply states, that the "integuments and fascia being divided by a circular incision, and retracted upwards, as high as is judged necessary, the superficial muscles should next be divided," &c. (*Pract. Obs. in Surgery*, p. 23, 8vo. Lond. 1816.) We are, therefore, to conclude that he joins Graefe and others in thinking the separation of the skin from the fascia unnecessary. My own observations in practice lead me to believe, that the dissection of the integuments from the subjacent parts used formerly to be carried to an extent beyond all moderation and necessity; and that, as it is a most painful proceeding, and hurtful, by forming a large loose pouch for the lodgment of matter, it ought to be abandoned by every surgeon who follows the method of sawing the bone considerably higher than the first cut through the superficial muscles. Mr. Hey, like Desault (*Œuvres Chir.* t. xxi. p. 545), is an advocate for amputating with a triple incision, and for preserving such a quantity of muscular flesh and integuments as are proportionate to the diameter of the limb. By a *triple* incision, he means first an incision through the integuments alone; secondly, an incision through all the muscles, made somewhat higher than that through the integuments; and thirdly, another incision through that part of the muscular flesh which adheres to the bone, made round that point the bone where the saw is to be applied. The proper distance of these incisions from each other, he says, must be determined by the thickness of the limb upon which the operation is to be performed, making allowance for the retraction of the integuments, and of those muscles which are not adherent to the bone. Supposing the circumference of the limb to be twelve inches where the bone is to be divided, the diameter is about four inches; and, if no retraction of the integuments were to take place, a sufficient covering of the stump would be afforded by making the first incision at the distance of two inches from the place where the bone is to be sawn, that is, at the distance of the semi-diameter of the limb on each side. But, as the integuments, when in a sound state, always recede after they are divided, it is useful to make some allowance for this recession; and to make the first incision, in this case, at least two inches and a half, or three inches, below the place where the bone is to be sawn. As the posterior muscles of the thigh retract a great deal in the process of healing, Mr. Hey advises their division to be begun half an inch above the place where the integuments were cut, and the anterior muscles three quarters of an inch. "The integuments," says he, "will retract a little both above and below the place where they were divided: but the distance from that place must be computed from the mark left upon the surface of the muscles in dividing the integuments." Thus, in fact, in a common thigh amputation, Mr. Hey deemed it necessary to detach the skin from the muscles merely to the extent of half an inch at the back part of the limb, and of three quarters in front; a very different practice from the old custom of making quite a bag of integuments, and turning them back, as the upper piece of a glove is turned down, or rather as the sleeves of a coat are turned up.

This triple incision is well adapted for those parts of the limbs where there is but one bone, as in the thigh and arm; but it is not applicable to the forearm and leg. In these latter situations, it is always necessary to turn back the skin, as a sufficiency of covering cannot otherwise be obtained.

In amputating the thigh at its upper part, Velpeau believes the oblique division of the muscles, with the edge of the knife turned upwards, to be advantageous, as, without this precaution, or the saving and turning back the skin to the extent of two inches, the sides of the wound will not admit of being brought together. (*Nouv. Elém. de Méd. Opér.* t. i. p. 508.) Nor are there many living surgeons who entertain a doubt of the excellence of the principle inculcated by M. Louis respecting the utility of dividing the loose superficial muscles first, and then such as are deeper and adherent to the bone. In fact, a combination of this last method, with the oblique division of the muscles, not exactly by one, but several strokes of the knife, constitutes the mode of performing the circular operation at present most extensively adopted, and sometimes termed, as already mentioned, amputation by a triple incision. Thus, after the skin is cut, and as much of it retracted and saved as is deemed necessary, the operator cuts through the loose muscles at the edge of the retracted skin, first those on the fore part of the limb, and then such as are situated behind. For this purpose, he makes two or more sweeps of the knife, as may be found necessary, carefully directing them obliquely upwards towards the point, where he means to saw the bone. The oblique division of the muscles does not merely enable the operator to saw the bone higher up than he could otherwise do, and to leave, at the same time, more muscle for covering its extremity, but it is a preservation of sound, undetached integuments, which assuredly form the most efficient and durable covering for the stump. I say this, without precisely coinciding with Brünninghausen, who, trusting entirely to skin for covering his stumps, makes an extensive detachment of it from the muscles, and then cuts straight down to the bone. The loose muscles actually cut through now retract considerably, leaving those which are deeper and attached to the bone in a condition to be cut higher up than could have been previously done. Lastly, these are also to be divided with the edge of the knife directed obliquely upwards towards the place where the saw is to be applied. Some operators do more than this; for, after cutting down to the bone, they follow the plan of Celsus, and detach the flesh from its whole circumference upwards with a scalpel, to the extent of about another inch, in order to be enabled to saw the bone still higher up. "*Inter sanam vitiatamque partem incidenda scalpello caro usque ad os, reducenda ab eo sana caro, et circa os subsecanda est, ut eâ quoque parte aliquid ossis nudetur.*" This method, I think, deserves commendation, because it may have considerable effect in hindering a protrusion of the bone, if it does not, in conjunction with the foregoing method of operating, and judicious dressings, render this disagreeable event quite impossible. However, I shall never forget a poor soldier, whose thigh had been amputated in Bergen-op-Zoom, and who was brought about ten days after the operation into the military hospital at Oudenbosch under my care. Not the slightest union of any part of the wound had taken place; abscesses had formed under the fascia on every side of the stump; the loose skin was literally a large bag of purulent matter; the muscles were wasted to almost nothing, and their remains retracted, and shrinking still further away from the extremity of the bone, which protruded at least three inches beyond the soft parts. This unfortunate man had been attacked with chronic tetanus soon after the operation, and, probably, it was to the disturbance of the stump by the effects of that disease, and to the strong and continual tendency of the muscles to retract themselves, induced by this state of the system, that the deplorable state of the stump was to be attributed. He lingered nearly a fortnight in the hospital before he died; previously to which event, large abscesses, communicating with the hollow of the stump, surrounded the greater part of the pelvis. As I had every reason to believe that the operation had been skilfully done, perhaps when I say that the above mode of amputating will make a protrusion of the bone impossible, it is not exactly correct, as the occurrence may sometimes originate from causes which are quite independent of the particular way in which the operation has been executed.

[Instead of the usual circular division some surgeons now make two semilunar incisions on the opposite aspects of the limb. These incisions form the outline of two equal semilunar flaps of integument, which are to be dissected from the subjacent textures and reflected back. This having been done, the muscles are to be cut through opposite the base of the flaps by circular incisions, according to the instructions already given. The flaps should be of sufficient size to meet readily, and without stretching, over the cut ends of the bone and muscles. This differs from the usual operation only in the mode of making the incision in the integuments; it is in principle the same both as regards the division of the remaining soft parts and in the nature of the covering left for the stump. Its advantages are, that the flaps admit of being reflected back with greater facility than the circular cuff of skin, a matter of some importance if the integument is infiltrated and rigid from disease; and, also, that after the wound is closed, the projecting corners of skin which result from a circular incision are avoided, and the stump has consequently a more rounded and neater appearance.]

All the muscular fibres, on every side, having been cut down to the bone, a piece of linen, somewhat broader than the diameter of the wound, should be torn at one end, along its middle part, to the extent of about eight or ten inches. This is called a *retractor*. It is applied by placing the exposed part of the bone in the slit, and drawing the ends of the linen upward on each side of the stump. In this manner the retractor will obviously keep every part of the surface of the wound out of the way of the saw. Where there are two bones the retractor must have two slits, an inch or an inch and a half apart. The two slits receive the two bones, and the intermediate strip of linen is passed through the interosseous space. Graefe thinks that in amputations of parts where there is only one bone, the unslit portion of the linen should always be applied over the anterior muscles, as these ought constantly to be most evenly kept back, so that no projection of them may interfere with the action of the saw. (*Normen für die Ablösung grösserer Gliedm.* p. 105.) That meritorious surgeon, J. L. Petit, whose name I always mention with pleasure, strongly commends the use of the retractor, the ends of which he drew over the anterior muscles; he says that he has employed this simple and natural means, but that it did not suit the taste of everybody, especially those who consider all the merit of an operation to consist in the quickness of its performance, or who think it satisfactory reasoning to say this is not their method. (*Traité, des Mal. Chir.* t. iii. p. 152.) I have seen the saw do so much mischief, in consequence of the operator neglecting to use the retractor, that my conscience obliges me to censure such surgeons as neglect to defend the soft parts by this simple contrivance. There are some who have rejected the use of the retractor, because they have seen it get under the teeth of the saw and obstruct the action of the instrument; but this very circumstance adduced against the retractor is, when considered, the strongest one that could possibly be brought forward in its favour, as the surface of the wound itself, and particularly the edges of the skin, would, in all probability, suffer the same fate as the linen, by getting under the teeth of the saw, if no retractor were employed, in attempting to saw the bone high up, as closely as possible to the soft parts. But, besides defending the surface of the stump from the teeth of the saw, the retractor will undoubtedly enable the operator to saw the bone higher up than he could otherwise do.

Mr. Liston pronounced all kinds of retractors superfluous. Here it should be remembered, that this gentleman's practice was that of flap-amputation, to which he gave the universal preference; a method in which, unquestionably, the retractor may be dispensed with, as, while the saw is acting, one, or both of the flaps can be effectually held out of the way by an assistant. (See *Edinb. Med. and Surg. Journ.* vol. xx. pp. 43—45.) Here, however, I am treating of amputation by the circular incision, in which the retractor is too useful to be relinquished. Were any further authority necessary in support of the practice of employing the retractor, I might refer to that of Dupuytren (see *Leçons Orales de Clinique Chir.* t. iv. p. 298), whose directions for its application are the following: — If there is only one bone, it is to be placed in the angle of union of the two tails of the retractor, which are to be brought over the anterior surface of the limb, and made rather to cross one another. Thus, the retractor forms a sort of bag covering the wound, and out of the centre of which the bone passes, and becomes the more denuded in proportion as the assistant draws the retractor towards the trunk.

Division of the Bones.

In no part of amputation, do operators in general display more awkwardness than in sawing the bone, though, if we except directing the saw against the flesh, the faults are here less pernicious in their consequences than the errors already noticed. At the time of sawing the bone, much depends upon the assistant who holds the limb. If he elevate the lower portion of the bone too much, the saw becomes so pinched that it cannot work. On the other hand, if he allow the weight of the limb to operate too much, the bone breaks before it is nearly sawn through, and its extremity is splintered. It is one of the most common remarks of such persons as are in the habit of frequently seeing amputations, that the part of these operations, which a plain carpenter would do well, foils the skill of a consummate surgeon, and few operators acquit themselves well in the management of the saw. Many of them begin the action of this instrument by moving it in a direction contrary to the inclination of its teeth. Many endeavour to shorten this part of the operation, by making short, very rapid, and almost convulsive strokes, with the saw. Almost all operators fall into the error of bearing too heavily on the instrument. That operator will saw best, who makes the first stroke of the saw by applying its heel to the bone, and drawing the instrument across the part, towards himself, so as to make a slight groove in the bone, which serves very materially to steady the future movements of the instrument; and who makes long regular sweeps with the saw, at first rather slowly than quickly, rather lightly than heavily. The saw is directed by Dupuytren to be applied perpendicularly, and worked in the beginning slowly, but afterwards more quickly, in proportion as the groove becomes deeper, and the risk of the instrument getting out of it is lessened. When the bone is nearly divided, the sawing should proceed with the greatest gentleness. Then the assistants who hold the opposite parts of the limb, should redouble their care to maintain them in their natural directions. (See *Leçons Orales de Clinique Chir.* t. iv. p. 300.) Mr. Liston places himself so that he may grasp the part to be removed during the sawing of the bone, without change of position. He makes the incisions with the left hand free; but, as soon as the saw is in the right, he takes firm hold of the limb below the wound. He disapproves of entrusting the limb to an assistant during the sawing, and lays it down as a rule, that the management of the lower part of the limb should always be left to the person using the saw. The saw, he says, may be worked either horizontally or vertically, but the latter direction seems to him best, because, when the section is nearly completed, the uncut part of the bone is deep, and less likely to snap on the weight of the limb, or undue pressure, operating downwards. (See *Liston's Elem.* part iii. p. 364.) But there is often a fault in the construction of the saw itself, which impedes its action, quite independently of any fault on the part of the surgeon. I allude to the edge of the instrument not being a little broader than its blade. When the saw is well made, the teeth always make plenty of space for the movement of the rest of the instrument. The saw, recommended by Mr. Guthrie, cuts with both edges, backwards and forwards, which expedites the operation, and (what is of more consequence) helps to prevent splintering when the bone is nearly divided, because the division can be finished by the backward motions, which are the most gentle. (*On Gunshot Wounds*, p. 89.)

If the bone happen to break before the sawing has been finished, the sharp-pointed, projecting spiculum, thus occasioned, must be removed by means of a strong, cutting sort of forceps, termed *bone-nippers*. The perpendicular division of the bone leaves a sharp edge at the extremity of its circumference: it is not the common practice to take any measures for the removal of such sharpness; yet Graefe recommends filing it away (op. cit. p. 66), and Mr. A. C. Hutchison makes it an invariable rule, whether there be any occasion to use the bone-nippers or not, "to take off the asperities, and scrape, or endeavour somewhat to round, the sharp cut edge of the bone with a strong blunt scalpel, in order to prevent the soft parts from being injured, when brought over the end of the bone in forming the stump." (*Pract. Obs. in Surgery*, p. 24.) Though I have not followed this practice, or rather the part of it which relates to cutting off the edge of the bone, I know of no objection to it, unless it be on the score of its inutility, and the delay which it occasions. All projecting points of bone, it is the ordinary custom to remove.

The bone forceps may also be used, instead of the saw, for the division of smaller bones, such as those in the hand or foot.

One proceeding, which seems fit for reprobation, and which, indeed, Mr. Alanson very properly condemned, is the practice of scraping up the periosteum with the knife, as far as the muscles will allow. Nothing seems more probable, than that this may be the cause of the exfoliations which occasionally happen after amputations. At all events, it is a superfluous, useless measure, as a sharp saw, such as ought to be employed, will never be impeded by so slender a membrane as the periosteum. All that the operator ought to do is to take care to cut completely down to the bone all round its circumference. Thus a circular division of the periosteum will be made, and upon this precise situation the saw should be placed. This is the method which was approved of by J. L. Petit. (*Traité des Mal. Chir.* t. iii. p. 159.) It is what I have always done and recommended; yet it must be confessed, that differences of opinion prevail about the necessity, and modes, of dividing the periosteum. Graefe, in common with several others, entertains considerable apprehensions of the effects of the periosteum being torn and lacerated by the saw, exfoliations of the bone and abscesses up to the joint being possible consequences of the rude separation and inflammation of this membrane. Hence he is an advocate for making a circular cut through it at the place where the saw is to be applied, and then scraping away all below this point in the direction downwards. (*Normen für die Abl. grösserer Gliedm.* p. 105 and 165.) Perhaps no very great objection may lie against this mode, which is not uncommonly followed, though I have some doubts of its real utility, as it scarcely seems practicable in the midst of the oozing of blood to hit with the saw the precise line at which the remains of the periosteum terminate; and, in confirmation of the safety of Petit's practice, Mr. Guthrie's experience may be adduced, who says, "I have often sawn through the bone, without previously touching the periosteum, and the stumps have been as soon healed, and with as little inconvenience as any others. (*On Gunshot Wounds*, p. 88.) A modern author, impressed, like many others, with the fear of tearing the periosteum with the saw, differs from them in thinking it best to scrape the periosteum upwards, by which means, he says, that at least half an inch of this membrane, and a proportionate quantity of muscular fibres, may be preserved for covering the end of the bone, inasmuch as the muscular fibres, adherent to the periosteum, will remain connected with it: an advantage which this author deems very important while the edges of the bone are sharp. In amputation below the knee, he considers the method highly useful, as the sharp edge of the tibia may be not merely covered with skin, but with periosteum and the cellular membrane connected with it. Since his adoption of this practice, he assures us that he has not for a long time seen any exfoliation of the tibia, and never any protrusion of the bone of a stump. (*Brünninghausen, Erfahr. &c. über die Amp.* p. 65, 66, 8vo. Bamb. 1818.) Baron Dupuytren passes the knife circularly through the periosteum close to the retracted soft parts, and then detaches it upwards and downwards with the heel of the knife. (*Leçons Orales de Clinique Chir.* t. iv. p. 299.)

[AMPUTATION BY FLAPS.]

[An account of the invention of this method by Lowdham, and its subsequent adoption and modification by Verduin, Ravaton, and Vermale, has already been given with the history of amputation. Its object is to provide a thick cushion of soft parts to cover the ends of the bones, by preserving flaps composed of both muscles and integuments, instead of integument only, as in the circular operation. This covering may be procured by forming a single large flap on one side, or two equal flaps on opposite sides of the limb. In the ordinary method they are made by transfixing the limb with a sharp-pointed knife, and by cutting the soft parts from within outwards, or from its centre towards its circumference.

The operation with *one flap* was that originally performed by Lowdham and Verduin in the leg; it is best adapted for situations where the greater bulk of the soft parts is placed on one side of the bones, as in the leg and forearm, but it may be followed with advantage in some of the articulations, in the shoulder-joint for example, and in the fingers. It is also useful in any part of a limb if the soft parts on one side have been so damaged by injury or disease that they are not fitted to form part of the covering for the stump, as in such cases it enables a greater length of limb to be preserved.

The method of amputating the leg with a single flap, cut from the muscles of the calf, which is frequently practised in the present day, is, as nearly as possible, the same as that originally adopted by Verduin, excepting that a straight, instead of a curved knife is now used. Verduin published an account of his operation in 1696, and this has been already referred to in the history of amputation.

The knife is passed through the limb from one side to the other, close behind the bones, and is carried downwards in such a manner that in cutting its way out a semicircular flap is made of sufficient size to cover completely the whole surface of the stump. The angles of this flap are then united by an incision carried transversely (or with a slight convexity downwards) across the opposite half of the limb. Any remaining muscular fibres are then divided transversely at the same level, and the knife is carried between the bones and around each of them in succession, to clear them completely for the application of the saw. Operations with a single large flap, are subject to the disadvantage that the cut edges of skin which are intended to unite with each other do not correspond in their dimensions, the circumference of the flap being much longer than the transverse incision to which it is to be opposed, and some unevenness and puckering is the inevitable result when they are brought together.]

Amputation with two equal flaps, as practised by Vermale, is well adapted for situations where there is a nearly equal bulk of soft parts on opposite sides of the bone. Vermale, after applying the tourniquet, surrounded the part with two red threads, at the distance of four finger-breadths from each other; one at the place where the bone was to be sawn; the other at the place where the incision of the flaps was to terminate. He afterwards thrust a long bistoury down to the bone, at the fore part of the limb; turned it round the circumference, so that it might come out at the opposite part; then, directing the edge of the knife along the bone, he cut down to the inferior thread, where he completed the first flap, which, as the author says, was of a round or conical figure at its extremity. The second flap was made in a similar way on the inferior side of the member. The flaps being held back by an assistant, the knife was carried circularly round the bone to divide any muscular fibres still adhering to it. This method is essentially the same as that which is often practised at the present time, in the thigh and arm. The red threads, however, are dispensed with, and the operator determines with his eye the requisite length for the flaps which ought slightly to exceed the semi-diameter of the limb, supposing two *equal* flaps are to be made.

[Ravaton formed two flaps by first making a circular incision through all the soft parts down to the bone; he then made a vertical incision on each side leading upwards from the circular incision, and, like it, extending through all the soft parts down to the bone. The two square flaps thus made were then dissected up.

Many surgeons make their flaps more or less square in shape, by keeping the knife close to the bone as it is carried downwards, and then cutting abruptly outwards when a sufficient length has been given to the flap. Any method, however, is objectionable which preserves so large a quantity of muscle towards the free border of the flaps; since, if this is done, the edges of the skin cannot be brought together over the muscle without considerable difficulty. The most desirable shape for the flaps is that which is obtained by cutting *obliquely* outwards; by this means their thickness gradually diminishes from their attached towards their free border, and the free border has an even and regular semicircular edge. In this way also the surfaces of the flaps as well as their edges will be made exactly to correspond.

Langenbeck preferred to cut the flaps in the opposite direction, or from the skin towards the bone, thinking their shape could be determined with greater certainty in this way. Mr. Luke forms the first flap by transfixion, and the second by cutting from the skin towards the bone. This plan has the merit of obviating one inconvenience which results from making both flaps by transfixion, which is, that the second flap is seldom cut evenly at its edge, for the skin having lost its tension as soon as the first flap is made, is apt to fall in folds under the pressure of the knife, and is more or less notched and mangled in consequence. Mr. Luke transfixes the limb exactly through its centre, whether this be close to the bone or at some distance removed from it, in order that the two incisions in the skin may be exactly equal to each other, but he considers it important that the surfaces should correspond as well as the edges, and should be maintained in contact while the healing is going on. It was for amputation of the thigh that this method was proposed by Mr. Luke, but it seems well adapted for almost any situation, and whether the bones are placed at the centre or near the surface of the limb. Mr. N. Ward, in describing it, says, "Whether it is performed on the thigh, leg, arm, or forearm, the *centre* of the limb should always be taken as the point at which the knife is to be passed in, without reference to the bone or bones. Sometimes the knife will be passed in nearer to the bone than at others, this depending on the relative muscular development of the part operated on." (*Medical Times and Gazette*, Jan. 1852.)]

[AMPUTATION BY THE OVAL INCISION.]

[*The oval or oblique incision*, described by M. Scoutetten, forms an excellent operation for the shoulder and some other joints, but is not often practised in the continuity of the limbs. It differs from the circular incision, in being made to extend higher up on one side of the limb than on the other, and this extension upwards is commonly made in the direction of the prominence of the articulation, in order to admit of its more ready and complete exposure. At this point the portions of the incision coming from the two sides of the limb, are united to each other, so as to form an angle giving the appearance of an inverted V, the apex of which is over the prominence of the joint, and forms the small end of the oval or *egg-shaped* incision.

For a more detailed description of this mode of amputation the reader is referred to the article on *Amputation at the Shoulder-Joint*, where it will be seen, that it is in some degree a combination of the double flap and circular methods, and possesses many of the advantages belonging to both. (See *Scoutetten sur la Méthode Ovalaire*. Paris, 1827, 4to.)]

[AMPUTATION BY ELLIPTICAL INCISION.]

[*The elliptical method*, as described by M. Soupart, is not dissimilar in its results to a single flap amputation. An elliptical incision is made round the limb through the integuments down to the muscles. The two ends of the ellipse are of course on opposite sides of the member, and one is necessarily at a considerably higher level than the other. The upper end should be opposite to, or a little below, the point at which the bone is to be sawn, or where the transverse incision would be made in the single flap operation; its lower end should be at the same level as the lower border of the flap would be, in a similar case. The muscles are then to be divided in the same oblique direction from the surface down towards the bone or bones. The result is a single large flap, the edges of which are uninterruptedly continuous with the opposite portion of the incision, instead of forming an angle with it on each side, as in the ordinary method. M. Malgaigne observes that this plan merits a decided preference over the usual operation with a single flap, in those situations where the bones occupy nearly all the transverse diameter of the limb; and where the ordinary operation with a single flap occasions a loss of substance at the two extremities of this diameter; at which point there is all the greater need to preserve the integuments intact, to avoid denudation of the bones. (*Manuel de Méd. Opér.* ed. 5. p. 248.)

From the mode in which its vessels are divided, a flap thus made would also have the advantage of being better nourished than one cut in the usual way by transfixion; and the risk of sloughing, which always attaches, more or less, to a single large flap with a limited basis of attachment, would be considerably diminished.]

[COMPARISON OF THE FLAP AND CIRCULAR METHODS.]

Although the majority of surgeons in England and France (see *Velpeau, Nouv. Elém.* t. i. p. 510), regard the operation by a circular incision as the most eligible under ordinary circumstances, no doubt can exist about the preference which should be given to amputating with a flap, in particular examples. The choice, Dr. Bushe conceives, ought to depend on the state of the limb and nature of the malady. "One surgeon is so devoted to the double circular incision, that he performs no other (method), though his coadjutor in the same hospital is equally bigoted to the double flap operation, and never amputates but after this manner. But the unprejudiced practitioner will look to the nature of the case, and adjust means accordingly." (*Lancet*, No. 246, p. 204.) Notwithstanding the profession of this doctrine, however, Dr. Bushe is in reality very partial to flap amputations, affirming that there is only one part, viz. the upper third of the leg, where he would recommend the double circular incision to be preferred. (Op. cit. p. 207.) At the same time, he confesses that when the arm is much emaciated, and flaccid, Dupuytren's mode, with a single circular incision, is that to which he has himself given the preference. He admits, also, the frequency of tedious suppuration and sinuses after flap amputations, which evils, however, he ascribes to the fault of making the flaps too long (p. 206). Flap amputation of the thigh occupies less time than the circular method, and, I believe, has the important advantage of being less exposed to the danger of a protrusion of the bone. Hence, whenever any reasons exist in the state of the parts or the constitution for apprehending that disagreeable occurrence, it should be preferred. An experienced military surgeon informs us, that, in the first years of his practice he performed several amputations by the double incision strictly according to the precepts of Sabatier, Desault, Pelletan, and Pott, but had the mortification to have three cases in which the bone protruded, though the greatest circumspection was used in the operation and after-treatment. Hence he was induced to make trial of the flap amputation; and, although he imitates O'Halloran in not attempting to bring the flaps close together for the first six or eight days, he reports that the stump is generally healed in twenty or thirty days, and exfoliations rarely happen, on account of the bone being so well covered. In short, he says, that this method is to be preferred to all others. (*J. B. Paroisse, Opusc. de Chir.* p. 185—203, Paris, 1806.) Mr. Syme also states, that though the flap amputations seen by him have been numerous, he has never met with an instance of the bone protruding, or exfoliating after them. (*Ed. Journ.* vol. xiv. p. 38.)

[During the last twenty or thirty years there has been much controversy upon the comparative merits of circular and flap amputations. Mr. Liston was a strong partizan of the method by flaps, and never performed any other operation. He did not even describe the circular method, but said that "its inferiority is so obvious, and so generally acknowledged, that detail of the different steps of the operation is altogether unnecessary. It is more tedious in performance, more painful to the patient, does not afford so good a covering for the end of the bone, and consequently not so convenient and useful support for an artificial limb, and the cure of the wound is protracted. The stump is almost always conical, the end of the bone is, ultimately at least, covered only by integument, and from even very slight pressure this is apt to ulcerate; exfoliation of bone follows to a greater or less extent," &c. &c. (*Elements of Surg.* p. 770.) Messrs. Lizars, Syme, and Fergusson have also almost invariably adopted the flap method, and it has been practised, though not so exclusively, by numerous other surgeons.

The results of more extended experience of the flap operation have failed to establish that decided superiority which some of its advocates have claimed for it; while in answer to the above remarks by Mr. Liston, and in behalf of the circular method, it may now be stated, that rapidity of performance, and the saving of pain to the patient are, since the introduction of anæsthetics, no longer to be considered as recommendations; that it is not true that immediate union is more frequent after the flap than after the circular method; or, if the circular operation is properly performed, that it is more likely to be followed by protrusion of the bone, or conical stump than the method by flap. Again, it is erroneous to suppose that a thick cushion of soft parts will enable a stump to support much pressure, for under *no* circumstances (excepting after ankle-joint, and, perhaps, also knee-joint amputations, where the osseous surfaces are large, and the integument covering them is dense, and has been accustomed to pressure) will the patient be able to support the weight of his body on the extremity of the stump; after amputation of the thigh or leg, if the artificial limb is properly constructed, he will never be called upon to do so. Besides this, after a lapse of time, the thick cushion of muscle left in flap amputations degenerates or is absorbed, and the ultimate thickness of the covering differs very little, if at all, in the two cases. It has been objected, on the other hand, to flap amputations that the size of the wound is greater; that more arteries are divided, or that the same artery may be divided in two places, that they are divided obliquely instead of transversely, and that the hemorrhage therefore is more serious and more difficult to be arrested. With respect to the first of these objections, namely, the greater size of the wound, its truth is somewhat doubtful, in fact if the whole surface were accurately measured in two equal-sized limbs, operated upon by the two methods, and if, in the circular method, the entire area of the reflected integument were added to that of the cut extremities of the muscles, the advantage in point of size might even, as was stated by Mr. Liston, be found to be on the side of the flap operation. The majority of surgeons, however, will be disposed to admit the second objection, that there is a greater tendency to hemorrhage, and a greater difficulty in restraining it. It is not that more vessels are *divided*, or that the same vessel is often divided in two places, as has been stated; but more vessels *require ligature*, because they are divided obliquely, and are not so favourably circumstanced for retraction within their sheath, and contraction of their open orifices as when they are divided transversely. Hemorrhage a few hours after the operation is also, and for the same reason, much more frequent with the flap than with the circular method, and it was, in fact, as Sir G. Ballingall observes, to remedy this inconvenience, and to afford facilities for dealing with this sort of secondary hemorrhage, that the practice arose of not bringing the flaps together till some hours after the patient had been placed in bed. Those who speak of additional hemorrhage from the same artery when divided in two places, have overlooked the obvious fact, that however often it may be cut through, it can not possibly bleed excepting from the one orifice which is nearest to the centre of the circulation.

The truth in this, as in most other controversies, has been found to lie between the two extremes, and Mr. Fergusson's comparison of the two methods is worthy of notice, on account of the impartial way in which he recognises the merits of the circular method, although he himself advocates and almost invariably performs flap amputation. He says, "If a circular operation is improperly performed, the whole catalogue of evils may result; but the same may ensue from the method by flap. I do not here speak from conjecture, for I have seen as thorough protrusion of bone after a flap operation as after a circular. If in the circular the incisions are made directly down to the bone — no adequate provision being made for covering its cut end, or if the operator has failed in doing so, then there is no calculating what may follow: if, by the other operation, the flaps are not well made, — too short, and selected from improper parts of the limb — the same evils may ensue. In short, in so far as my experience goes, the evils resulting from one operation may be as great as from the other, according to the manner in which each is performed, the nature of the coverings, the condition of the parts, or of the constitution; and all, too, must be the result of a badly performed operation by either mode. The latter circumstance constitutes, I believe, the main part of the difference between the two, as a circular operation is much more likely to be ill-done than one by flap; it is in fact a more difficult proceeding, or at all events there is a greater chance of a mistake occurring in the one than in the other." "I deem it" (the circular method) "inferior to the other as regards its execution, but think that it remains to be proved, whether when equal skill and pains are bestowed, and the same mode of dressing is applied to each, the results are so very different as some modern authorities would lead us to believe." (*Pract. Surg.* 3rd ed. p. 197, 198.)

Mr. South says, "I have performed about an equal number of each, and the result has been so nearly the same, that in most cases I hardly think one method is to be preferred to the other." (Translation of Chelius, vol. ii. p. 903.) Mr. Skey is inclined to prefer the circular method. He says, "I am much disposed to believe that for purposes of utility and for power of resistance against pressure, the stump made by the circular operation will, in the end, be found preferable." (*Op. Surg.* p. 323.) And he further says, "My colleague, Mr. Stanley, who has frequently adopted the flap operation, has almost entirely abandoned it, as have also Mr. Lawrence, and Mr. Bransby Cooper."

We have given these quotations from several recent authorities, with the view of showing the present state of professional opinion on this controverted question, and have only further to add, that no judicious surgeon should commit himself to an exclusive preference for either one or the other method: it is his duty to acquaint himself thoroughly with the most approved methods of performing *both*, and to adopt whichever may appear to be best suited to the circumstances of each particular case. In many situations, and especially in amputating through the joints, the flap operation is decidedly to be preferred, and in the continuity of the limbs, it may sometimes possess superior advantages. Perhaps the most favourable case for the circular method is when the amputation is performed immediately after an accident, and when the skin is freely movable on the muscles beneath, and can be readily retracted or reflected; while the flap operation is often more convenient in cases of chronic disease, where the parts have become adherent to each other, and are rigid and immovable from infiltration with lymph. In the latter case the rigidity, which would render a circular operation more difficult, enables the flaps to be cut with greater regularity and precision.]

[OF AMPUTATION THROUGH THE JOINTS, OR DISARTICULATION.]

[In these it is more necessary than in ordinary amputations to determine beforehand the exact situation for the incisions, and a more correct anatomical appreciation of the parts is required.

To a surgeon well acquainted with anatomy, the neighbouring prominences of bone will afford the necessary landmarks, and will enable him to determine with precision the exact situation of the articular interspace, and, this being ascertained, to decide upon the position and direction of his incisions. To perform these operations creditably, a familiar acquaintance with the direction and form of the articular surfaces is also important, or the knife will be liable to become entangled between the bones, and its point and edges will be injured in fruitless endeavours to separate the parts. Special instructions will be given on these points, in speaking of particular amputations.

In other amputations it is a matter of no great importance on which side the surgeon stands; in operations at the joints, however, he should always place himself so that he may hold with his left hand the part to be removed, as he will require to manipulate it himself during the operation, in order to put the ligaments upon the stretch as he is about to divide them with the knife, and to disarticulate the bones when their division is completed.

All the different modes of amputating which have been described may be employed in these operations. The *circular method*, however, is not so often adopted as the flap, or the oval incision, although it answers well in certain situations, in the wrist joint, for example. As a general rule it is not so convenient as the other methods, because it does not admit of so free an exposure of the articulation.

The *methods with double and single flaps* are excellent operations in many cases. Indeed, whatever may be said in favour of circular as compared with flap operations in the continuity of limbs, there can be no doubt that at many of the joints the latter method is very decidedly preferable to the former. In a double flap operation, the joint should generally be opened after the first flap is formed; the ligaments should next be freely divided, and the bone disarticulated, when the knife may be carried through the joint, to complete the operation by the formation of the second flap. It is as well, when practicable, to have the vessels in the second flap, that they may not be divided till the close of the operation, but this is not absolutely necessary: indeed, in the hip-joint, where the danger from hemorrhage is greatest, the anterior flap, which contains the vessels, is usually made first. They can, in fact, either at the hip or shoulder, be effectually compressed before they are cut through by the hands of an assistant, passed into the wound behind the knife while the flap is being made. In a single flap operation, it may sometimes be desirable to make the flap first, then to disarticulate the joint and carry the knife straight out on the opposite side; while, in some cases, the reverse order of proceeding may be preferred; or both incisions may be made before the joint itself is attacked.

The *oval incision* seems to belong almost exclusively to the articulations, being rarely, if ever, practised in the continuity of the limbs. It is one of the best among the many operations proposed for the shoulder joint; and is often practised in the removal of fingers and toes, and of metacarpal and metatarsal bones.

The division of the ligaments and the disarticulation of the bones is perhaps the most difficult part of these operations; and repeated practice on the dead subject, as well as anatomical knowledge, is necessary to enable the surgeon to effect it with precision and dexterity. In a large, loose joint, like the shoulder, there will be no great difficulty, but the case is otherwise in close and complicated articulations, like those of the carpus and tarsus. The surgeon should throughout the operation hold the part to be removed in his left hand, and, when the joint is exposed, and he has determined in his mind the exact position of the articular interval, he should put the ligaments on the stretch, and then divide them by touching them lightly with the point of the knife. In the application of the knife no force is required; its point only should be used, and its blade should never be allowed to become locked between the articular surfaces. If he knows where to look for the joint, he need never break off the point of his knife or notch its edge, by cutting forcibly and uselessly against the bones.

Amputations at the joints have been advocated by many French surgeons of note, Lisfranc, Blandin, Velpeau, &c., but they have never been much in favour in this country, where they are seldom practised, excepting in the smaller joints of the hand and foot, or when no choice remains, as at the hip or shoulder. Many surgeons hesitate to perform these operations, knowing the serious consequences resulting from wounds into joints, and dreading constitutional symptoms of a similar character. The large open wound made in amputation, however, is not altogether a parallel case to a punctured wound of a closed synovial cavity, and it is, to say the least, extremely doubtful, whether, other things being equal, amputations at the joints are really followed by more serious constitutional irritation than amputation at other parts, while they have the advantage of often permitting a greater length of limb to be preserved. The presence of the articular cartilage is also considered an objection by many, on the ground that adhesion cannot take place between it and the surface of the flap, and that the wound will not heal till it has been absorbed or has exfoliated. In consequence of this idea, it has been recommended that the cartilage should be scraped or sliced away from the bone beneath, and some surgeons, at the present day, in order to remove it completely, even think it better to saw off a thin slice of the bone. The objection, however, has been made on insufficient grounds, for the experience of amputation at the small joints amply demonstrates that the surfaces *can* adhere, and that the wound often heals by the first intention as readily and as rapidly as it could possibly do in any case where the bone had been sawn through. On this subject M. Velpeau remarks, that "it is incorrect to say, with Béclard and many others, that after amputation in the contiguity, the smooth face of the cartilage does not unite with the flaps, but remains free even after the final cure, unless by some means or another inflammation has been excited. This can only take place by exception. Whether the instrument come in contact with it or not, it nevertheless contracts, and that speedily, firm adhesions with the tissues that cover it, and it is as useless to scrape it with a scalpel as to cauterise it in the manner practised in the time of Heliodorus." (*Velpeau*, *Op. Surg.* vol. ii. p. 488 of Mott's Translation.)

When, however, the wound does not unite by adhesion, it is perfectly true that the cartilage does undergo removal while the suppurative process is going on; either by gradual disintegration from its free surface, or by a species of necrosis in masses, and separation from its attached surface to the bone beneath.

Dr. Pancoast, of Philadelphia, gives the following account of the changes which he observed to take place in the cartilage, in a case of amputation at the knee joint, when, from the shortness of the flap, one of the condyles of the femur became exposed. Dr. Pancoast says, "This structure neither reddened nor became painful, so as to exhibit any coating of synovial membrane or other appearance of organisation. It became by the end of a week softened and pulpy on its free surface, in the same manner as occurs when the joint is subjected to the macerating tub of the anatomist. The pulpy lamina which was so soft as to leave a track when rubbed with the end of a probe, *was insensibly removed with the discharges;* by a continuation of the same process of softening and removal, the thin lamina of bone, covering the articular face of the condyles, was completely bared of cartilage in the third week. This lamina first presented a dark gray aspect; some small gray conical elevations soon after made their appearance on its surface, and shortly grew into florid healthy granulations to which, and to other granulations which sprang from the ends of the conical (*crucial*) ligaments, the cutaneous flaps were ultimately firmly united." (*Markoe, on Amputation at the Knee-Joint. New York Journ. of Med.* Jan. 1856, p. 33.)

In another case of amputation at the knee joint, by Dr. Markoe, of New York, on a healthy labouring man, aged 22, it was observed, on the eleventh day after the operation, "that at the bottom of the wound, where the flaps were a little drawn apart by retraction, there was exposed to view about three-fourths of an inch square of the cartilaginous covering of the outer condyle; at first it looked white and shining like healthy cartilage; but gradually the peripheral portion became converted into a soft pultaceous layer of a grayish colour, looking like soaked greasy leather. This change spread in about a week over the whole exposed surface; and in this soft substance granulations rapidly sprung up, which soon converted it into a florid suppurating surface. The exposed cartilage all underwent this change, except a small piece, about as large as a three cent piece, where the transformation seemed to go on under it, and between it and the bone, so that it was detached in a thin layer unchanged. This process was completed about the twenty-second day. On removing the loose sequestrum of cartilage on the twenty-fifth day, it was found to be connected with a larger piece remaining under the anterior edge of the wound. The whole was as large as a shilling piece, and came away easily, leaving a healthy granulating surface beneath." (*New York Journal of Med.* Jan. 1856, p. 25.)

These observations fully bear out the description given by M. Velpeau of the processes by which removal of the cartilage is sometimes effected. (*Med. Oper.* vol. ii. Mott's Translation, p. 488.)

When the cartilage is healthy, then, it does not appear that any advantage is gained by interfering with it; since, even where immediate union does not take place, the delay caused by its separation, need not, judging by the above cases, be of any great moment even in a large joint like the knee; the process having been completed in one at the end of the third, and in the other during the fourth week. On the other hand, the practice of sawing off a thin slice of the bone seems deserving of condemnation, since it exposes a large surface of the cancellated texture, which has suffered more or less mechanical injury by its division with the saw; and which may possibly necrose or become carious, and give as much or more trouble than the exfoliation of the cartilage could possibly do. But, what is more important, the bone cannot be sawn near its articular extremity without injury to numerous large veins, and the consequent risk of phlebitis and purulent absorption; while this risk is avoided altogether, so far, at least, as the vessels of the bone are concerned, by leaving them covered with a layer of cartilage in a healthy condition, which has not been subjected to mechanical injury, and which is, besides, in itself an inert and nonvascular tissue.]

Arrest of Bleeding after Amputation.

After the removal of the limb, the main artery is to be immediately taken hold of with a pair of forceps, or with Assalini's double tenaculum, and tied with a firm, round, smallish ligature. (See LIGATURE.)

None of the surrounding flesh ought to be tied, but the ligature should be placed round the artery, just where it emerges from its lateral connections. The late Mr. Hey was accustomed to tie the femoral artery twice, leaving a small space between the ligatures. Strong reasons against this plan will be found in the article HEMORRHAGE. The smaller arteries are usually taken up with a tenaculum. The tenaculum is not so well suited for the larger arteries, because it readily tears their coats: but it answers excellently for the smaller ones, which it draws out with great promptitude. It has also the advantages of not letting the vessel slip away, as the common forceps does; and of admitting of being held by any body, even a child, while the surgeon applies the ligature; a consideration of importance in places where no professional assistant is at hand. (*Dupuytren, Leçons Orales de Clinique Chir.* t. iv. p. 396.) After tying as many vessels as require it, the best practice is to cut off one half of each ligature, near the knot on the surface of the stump. One portion is quite sufficient for withdrawing the ligature, when this becomes loose; and the other, being only an extraneous body, and productive of irritation and suppuration, should never be allowed to remain.

The plan here recommended is founded upon that valuable principle, which teaches us to lessen, as much as possible, the quantity of extraneous matter in a wound; and as one half of the ligature answers for withdrawing the noose, as soon as loosened, I never follow a method occasionally advised, viz. that of leaving both ends, and twisting them together into one cord, by means of which, when further twisted at the proper period, it is alleged that the detachment may be more quickly brought about.

Dr. Veitch seems to merit the honour of having been the first to set the example of *tying every vessel, the femoral, as well as the smaller arteries, with a single silk thread,* taking care to include, as far as was possible, nothing but the artery; and when this has been done he took off one half of each ligature, as near as possible to the knot, "so that the foreign matter introduced was a mere trifle compared with what I had been accustomed to see." (*Edinb. Med. and Surg. Journ.* vol. ii. p. 178.)

Mr. Alanson directed the ends of the ligatures to be left hanging out at the two extremities of the wound. But when a ligature is situated in the centre of the wound, it is best to bring it out between the sutures, at the nearest part of the surface; otherwise its running across one half the wound to get at either angle would create a great deal of unnecessary irritation and suppuration.

Baron Dupuytren, and M. Roux declare their preference to the method of bringing out all the ligatures at the lower angle of the wound; the benefit of having them brought out thus low, so as to keep up a drain for any pus that may form, being in their opinion greater than that of arranging them at the points of the wound nearest to them. (*Mém. sur la Réunion de la Plaie après l'Amp.* p. 12.) Dupuytren, who only approved of endeavouring to procure union by the first intention at every point, when amputation had been performed without delay, for a gunshot wound or other bad accident, on a person otherwise healthy, used in all cases to leave the lower part of the wound unclosed. Here he brought out the ends of the ligatures well twisted together into a single cord; and, for the purpose of still farther insuring an outlet for the pus, if the cord was small, he occasionally introduced a small cylinder of charpie into the posterior angle of the incision; for as it was his custom, after circular amputation of the thigh, to bring the sides of the wound partly together (see *Leçons Orales, &c.* p. 416), so as to render the line of it transverse, I infer that he selected the inner angle of the incision as the outlet for the discharge and the place for the cord of ligatures.

As Dr. Hennen observes, the reducing the immoderate size of ligatures, the separating the threads of which they were composed, and placing them at convenient points along the face of the stump, or wound, and the actual removal of one half of each ligature, were amendments very slowly made; "but," says he, "an improvement which appears to me of great consequence was the last of introduction, and is now the slowest of adoption, although, the artery once secured and the value of adhesion duly acknowledged, it is the most obvious of all. I allude to the plan of removing the ends of the ligature altogether, and thus leaving to an extensive wound the greatest possible chance of immediate union." The first printed mention of this practice, as far as Dr. Hennen's investigations have discovered, was in a letter written by Mr. Haire, dated Southminster, Essex, Nov. 1786. "The ligatures," says this gentleman, "sometimes became troublesome, and retarded the cure. An intimate friend of mine, a surgeon of great abilities, proposed to cut the ends of them off close to the knot, and thus leave them to themselves. *By following this plan, we have seen stumps healed in the course of ten days. The short ligature, thus left in, commonly made its way out by a small opening in a short time, without any trouble, or the patient being sensible of pain.* (See *Lond. Med. Journ.* vol. vii.) Certainly, considering the thickness of the ligatures in use at the above period, this testimony of the success of the method, as Dr. Hennen remarks, is very satisfactory. (*Principles of Military Surgery*, p. 181, ed. 2.) In a letter received by me from Mr. Dunn, surgeon at Scarborough, and dated June 3, 1819, he tells me, "My predecessor, Mr. J. Wilson, the late partner of Mr. Travis, amputated a limb in 1792 or 1793, and cut off the ligatures close to the arteries, and no trouble ensued. He did this at the recommendation of Dr. Balcombe, of York, who had seen the method practised on the Continent." In September, 1813, Dr. Hennen, who was serving with the army in Spain, began the adoption of this plan, which, he expected, would not only prove useful in promoting immediate union, but in obviating any accidental violence to the ligatures, and the wrong interference of the younger dressers in trying to pull them away. Between September and January, thirty-four cases were treated in this way without any inconvenience following, or the small particles of silk left behind giving rise to any apparent irritation. Dr. Hennen also presented to Sir J. M'Grigor some of the small circles of silk, a part of which had come away with the dressings, while others had floated out on opening the little pustules, which formed over the face of the stump at the points where the arteries had been tied. Some few of the ligatures never made their appearance, and the patients complained of no uneasiness whatever. Convinced of the utility of the method, Dr. Hennen afterwards published an account of it. (See *Lond. Med. Repository*, vol. iii. p. 177, and vol. v. p. 221.) This gentleman subsequently found that Dr. Maxwell, of Dumfries, had adopted the plan as far back as 1798; and Dr. Ferguson, who was at Stockholm during the peace of Amiens, saw it also then followed by some of the surgeons of that city, without any ill effects. (*Hennen's Military Surgery*, p. 175—178. ed. 2.) In July, 1814, Mr. Lawrence communicated to the Medical and Chirurgical Society of London, some cases and observations highly in favour of the practice; and the particularity which he lays much stress upon, is using for the purpose minute firm ligatures, composed of what is called dentist's silk; a material which has been previously recommended by Dr. M'Sweeney in one of the volumes of the *Edin. Med. and Surgical Journ.* (See *Med. Chir. Trans.* vol. vi. p. 156.) In a paper of later date, he says, his further experience had confirmed the usefulness of the method; "that this plan, by diminishing irritation and inflammation, and simplifying the process of dressing, materially promotes the comfort of the patient, and the convenience of the surgeon, while it has not produced ill consequences, or any unpleasant effect, in the cases which have come under his own observation." According to Mr. Lawrence, the small knots of silk generally separate early, and come away with the discharge; where the integuments have united by the first intention, the ligatures often come out rather later, with very trifling suppuration; and, in some instances, they remain quietly in the part. (Op. cit. vol. viii. p. 490.)

When this plan is tried, single strong threads and silk, or rather the kind of ligature which will be described in another place (see LIGATURE), should be employed: for, otherwise, the knots would be large, and likely to create suppuration and future trouble. The practice was tried by Delpech at Montpellier; but it is not explained whether he used single threads, or silk, or whether any inconveniences resulted from the method. (See *Rélation d'un Voyage fait à Londres en* 1814, *ou Parallèle de la Chirurgie Anglaise avec la Chirurgie Française, par P. J. Roux*, 8vo. 1815.) Yet candour requires me to state that the method has gained but few advocates in this country. By Sir Astley Cooper, the practice was found to occasion suppuration, and he therefore gave it up. (*Lancet*, vol. i. p. 149.) Mr. Guthrie, in two or three instances, had also seen some ill-looking abscesses arise from the presence of the bits of ligature, though he approved of the plan where the wound will not unite by the first intention, which, however, can rarely be known beforehand. (*On Gunshot Wounds*, p. 941.) When amputation is performed in crowded hospitals, where hospital gangrene is prevailing, Delpech was an advocate for the plan, because it enabled the surgeon to bring the lips of the wound more perfectly together. By this means, as his experience had taught him, the risk of the wound being infected was materially lessened. (*Chirurgie Clinique*, t. i. p. 83.) The small particles of the ligatures, enclosed in the stump, he says, are discharged at a period when the patient has regained strength enough to be removed into a healthy atmosphere; little openings being produced for their escape, which heal up in twenty-four hours.

Sometimes, the sawn surface of the bone itself bleeds rather profusely. When this happens, it is an excellent plan to hold a compress of lint over the end of the bone, during the time requisite for securing the rest of the vessels. The bleeding from this source will then give no further trouble. At the end of this period, the compress may generally be taken away, the bleeding from the bone having entirely ceased. The surgeon ought not to be content with tying only such vessels as he observes throwing out blood, while the patient is faint with pain; he should endeavour to rouse him from that faintish state by a cordial, and then, wiping off the coagulated blood with a sponge wet in warm water, he should examine narrowly all the surface of the stump; for otherwise he may expect to be obliged by a fresh hemorrhage to undo all the dressings. (*On Amputation of the Larger Extremities*, p. 475, *Monro's Works.*)

When there is merely an oozing from small vessels, Bromfield's advice to loosen the tourniquet completely is highly proper, as this measure, and washing the stump with a little cold water, will put an entire stop to such bleeding, without any occasion for more ligatures. A good deal of blood is sometimes lost from the mouths of the larger veins; and where they bleed much in debilitated subjects, I think Dr. Hennen is right in recommending them to be tied. (*On Military Surgery*, p. 264.) There is no necessity for doing so, however, in ordinary cases; nor should I be disposed to imitate Mr. Hey, who, in consequence of having seen a few instances of bleeding from the femoral vein, generally enclosed that vessel in the ligature along with the artery. (*Practical Obs. in Surgery*, p. 530, ed. 2.) This method was sanctioned by the eminent Desault, who says, that if the vein be left open, and the bandage at the upper part of the limb be too tight, the blood regurgitates downwards, and hemorrhage takes place, as this surgeon assures us he has often seen. When the vein and artery lie close together, as often happens, he recommends one branch of the forceps to be introduced into the artery, and the other into the vein; which being done, the two vessels are to be drawn out together, and included in one ligature; but if they are not so near together, they must be tied separately. (*Œuvres Chir. de Desault, par Bichat*, t. ii. p. 550, 8vo. Paris, 1801.) In the hospitals of London, it is not the usual practice to tie veins, and, except in particular cases, I consider the custom wrong, because a ligature on a large vein sometimes excites a dangerous and fatal inflammation within the vessel, while the intervention of the vein between the one side of the circle of the ligature and the artery, must rather tend to hinder the thread from operating in the most desirable manner upon the latter vessel. For further remarks on venous bleeding during operations, see HEMORRHAGE.

OF DRESSING THE STUMP.

The wound is now to be evenly closed with strips of sticking-plaster, and in general, after circular amputations, in such a manner that the edges of the skin may form a straight line across the face of the stump. This was the mode commended by Alanson, and is what is preferred by the generality of surgeons in this country. Over these plasters and the ends of the ligatures, it is best to place some pieces of lint, spread with the unguentum cetacei, in order to keep such lint from sticking, which becomes an exceedingly troublesome circumstance when the dressings are to be removed. I am decidedly averse to the plan of loading the stump with a large mass of plasters, pledgets, compresses, flannels, &c.; and I see no reason why the strips of adhesive plaster, and a pledget of simple ointment, should not suffice, when supported by two cross bandages, and a common linen roller, applied spirally round the limb, from above downward. The first turn of the roller, indeed, should be fixed round the trunk, while the lower circles secure the cross bandages, often called the Malta cross, over the end of the stump. It is also an excellent method to leave some little interspaces between the plasters, and in summer to keep the linen bandages constantly wet with cold water. In this way, any discharge will readily escape, and the parts, being kept cool, will be less disposed to hemorrhage and inflammation.

Sir Astley Cooper states, that he has seldom succeeded with his stumps above the elbow or knee, when a roller was not employed, which, he says, prevents retraction of the muscles and extensive suppuration. After applying the roller, and bringing the integuments together, he merely puts three strips of adhesive plaster over the wound, and one round the stump, to keep the ends of the plaster in their place: in hot weather he applies a lotion of spirit of wine and water. (*Lancet*, vol. i. p. 150.)

I am completely of opinion with Mr. Alanson, that the elastic woollen cap, sometimes placed over all the bandages and dressings, if not put on with a great deal of care, has a tendency to push the skin backward from the extremity of the stump; and, as it must also heat the part, its employment should be discontinued. In the North London Hospital, stumps are very lightly dressed, and, for the first few hours, Mr. Liston, who always practises flap amputation, merely keeps the flaps together with two or three sutures, and lays over the stump linen or lint wet with cold water. The best position for the stump is that in which it is supported on a small pillow, and moderately raised.

[Points of interrupted suture, at a distance of about an inch from each other, are now very generally employed in the union of wounds after amputation, the principal objection to their use, namely, the pain which they occasion, having been removed by the introduction of anæsthetics. If additional support seem necessary, two or three strips of adhesive plaster may also be applied, but as a general rule a light bandage round the limb, and a piece of lint wetted in cold water over the end of the stump, is all that is requisite. The piece of lint can be readily changed without disturbing the wound, and if any hemorrhage take place, it cannot fail to be immediately discovered.]

As a general rule the dressings should not be changed before the third or fourth day, not reckoning the one on which the amputation is performed: by which time, if sutures have been employed, it will be advisable to remove them, though occasionally, if they are not causing irritation, the alternate stitches only may be taken out, and the remainder left for twenty-four or forty-eight hours longer; and Sir Astley Cooper did not change the dressings till the sixth or eighth day; merely removing on the fourth one strip of plaster, in order to let out any confined matter. (See *Lancet*, vol. i. p. 150.) Monro also set down the fifth, sixth, or seventh day, as sufficiently early. He allowed, however, that, if the smell of the wound should become offensive, the outer dressings might be removed sooner. Even when the dressings are to be taken away, it will frequently be found useful to leave one strip of plaster: but the stump must be made clean, and any discharge washed away. These, and other valuable precepts, derived from the eminent Dr. A. Monro, senior, are worthy their great source, and the correctness of them promises to be acknowledged for ever.

The manner of renewing the dressings of stumps is, indeed, a very important business, which should never be intrusted to mere novices; for in removing off the straps of sticking plaster, if great care be not taken, the slight and newly formed adhesions may be torn asunder. Thus, as Mr. A. Hutchison has remarked, if the strap be pulled off by holding one end of it at nearly a right angle with the adhering part, the flap will be raised up with it, and thus a separation of the newly united parts will be produced. "My plan," says he, "is to reflect the raised end of the strap close down upon the adhering parts, and to bring it gently forward with one hand, while the removing part of the strap is followed by two fingers of the other placed upon the skin, &c.; and when one end is detached from its adhesion, as far as the line of incision on the face of the stump, in like manner the other end is brought down and wholly removed." (*Practical Obs.* p. 46.)

In order to facilitate the removal of the plasters and save the patient a great deal of pain, I follow the plan of letting warm water drop over them from a sponge for a few minutes previously to the attempt to remove them. In the early part of the treatment, it is also a valuable rule never to let every strip of plaster be off at once, so as to leave the flesh quite unsupported. Some skill and care are also invariably necessary to avoid pulling away the ligatures with the dressings.

At the end of five or six days, the surgeon may begin to try, in a very gentle manner, whether any of the ligatures are loose; observing rather to twist, than suddenly pull them directly outward. However, he should not use the smallest force, nor persist if the trial create pain. One would hardly try whether the ligature on the main artery were loose, before the tenth or twelfth day; from the femoral artery it rarely comes away before the expiration of a fortnight. If minute ligatures made of dentist's silk be employed, and both their ends cut off close to the knot, of course, this delicate business of trying to get rid of the irritation of these foreign bodies is entirely superseded.

Though, in the above account, I have directed the edges of the wound, to be brought together in such a way that the wound shall appear as a line across the face of the stump, yet there are instances in which the bone seems most easily and conveniently covered, by making the line of the wound in a perpendicular direction. Mr. B. Bell, indeed, generally approved of it, as affording a ready outlet for matter; it is likewise directed by Sir C. Bell (*Op. Surgery*, vol. i.), by Roux (*Mém. sur la Réunion immédiate de la Plaie après l'Amp.* p. 11), and by Dr. Hennen (*On Military Surgery*, p. 265, ed. 2).

Mr. Hey, referring to amputation of the thigh, has noticed this subject as follows: "the integuments and muscles may be brought into contact by pressing either the anterior and posterior parts, or the sides of the thigh, together. The former method, by the gradual retraction of the posterior muscles, causes the integuments of the anterior part of the stump to cover more completely the extremity of the bone. The latter method causes the integuments and muscles to meet each other the more readily, and therefore is to be preferred when the quantity of soft parts preserved is somewhat deficient." (*Pract. Obs. on Surgery*, p. 533, ed. 2.)

Velpeau states, that the French surgeons prefer having one angle of the wound forward, the other backward, in order that fluids may have a ready outlet. (*Nouv. Elém. de Méd. Chir.* t. i. p. 509; also *Dupuytren*, t. iv. p. 416.) As a general maxim, observes this very distinguished surgeon, the soft parts should be brought together in the direction of the lesser diameter of the stumps, if circular amputations have been performed; and so as to bring the bleeding surfaces of the flaps together, if flap amputations have been done: the wound is to be brought together with its line in the direction of the great diameter of the oval, if the oval or oblique mode of amputation has been selected.

M. Malgaigne observes, that, whether the line of the wound be transverse or perpendicular, the inconveniences are equal. The former plan leaves a *cul-de-sac* below, in which pus lodges; in the latter method, one angle of the wound is pressed against the cushion, which supports the stump. Perhaps, says M. Malgaigne, the oblique direction should be preferred. (See *Malgaigne, Manuel de Méd. Op.* p. 298.)

The plan of bringing the edges of the wound together after amputation, so that they may unite by the first intention, has received, for many years past, the universal approbation of British surgeons. It is their general practice, in the treatment of all incised wounds. It may be said to be the pride of English surgery; for in nothing does it display more convincingly its superiority. Baron Larrey, however, in cases of amputation, disapproves of the attempt to unite the wound by the first intention, and merely brings forward its edges somewhat towards each other with a piece of linen that covers the whole of the wound, and has small holes cut in it for the passage of the discharge. (*Mém. de Chir. Mil.* t. iii. p. 379.) This piece of linen is supported with a moderately tight roller.

M. Roux, on his arrival in this country, wondered to see British surgeons so prejudiced in favour of union by the first intention, as to adopt it after all amputations. "*C'est pareillement abuser de la réunion immédiate que de l'appliquer en toute circonstance à la plaie qui résulte de l'amputation des membres. J'entends parler de l'amputation dans la continuité des membres, et plus particulièrement encore de l'amputation circulaire.*" (*Parallèle de la Chirurgie Anglaise avec la Chirurgie Française*, p. 128, 8vo. Paris, 1815.) But M. Roux has curiously omitted to explain, in his book, what are the advantages of not bringing the edges of the wound together, and why he calls prejudice the partiality to a method the superior efficacy of which is continually demonstrated in every hospital of London. He does not, indeed, presume to condemn the practice altogether; on the contrary, he allows it to be proper in certain cases; yet he contends that it ought to be confined within particular limits. (P. 130. See, also, *Mém. et Obs. sur la Réunion immédiate de la Plaie après l'Amputation, &c.* 8vo. Paris, 1814.)

In this tract, M. Roux proves most convincingly the benefits of union by the first intention, after amputation of the thigh by the circular incision; but, strangely enough, his prejudices hinder him from advising the practice to be extended to other amputations. He does not positively condemn it in the arm, though he thinks the method less necessary, because amputation there is less dangerous than in the thigh, &c. (P. 45.) To such futile reasoning is this author reduced by the unsoundness of his doctrine. He also deems the attempt at union by the first intention counterindicated, where limbs are amputated for injuries which violently contuse and crush the parts (p. 48), and where the limb is much wasted (p. 50). In the latter condition, however, he thinks Desault's flap amputation may be done, and an effort made to heal the wound by adhesion. In one case, he did this with success (p. 51). The opinions of Dupuytren on this subject lead him also to be an advocate for reform in the practice of aiming constantly at complete union by the first intention, after all amputations. He was for *un sage milieu.* The facts and arguments, which form the basis of his precepts, will be noticed with the subject of union by the first intention in the article WOUNDS.

Dubois has tried the plan with a success equal to that of the London surgeons. "The method is preferable," says Richerand, "to the old one, in whatever point of view it is considered. This union is more expeditious, a few days being sufficient for its completion. Besides the advantage of a quick cure, and such quickness is especially of great importance where the patient has been much reduced, so that he would hardly be able to bear a long suppuration, union by the first intention has the recommendation of saving the patient from a great deal of pain, the flap of integuments with which the bleeding surface of the stump is covered being much less irritating to the flesh than the softest charpie would be, &c.—Three years have elapsed since the publication of the third edition of this book. During this interval, I have performed more than a hundred and fifty amputations, and the utility of immediate union has been more and more proved to me." (*Nosographie Chirurg.* p. 475, 477, ed. 4.)

But, notwithstanding these and other encomiums on the practice, Richerand, like other French surgeons, is not an advocate for it in certain cases; as, for instance, limbs shattered by gunshot wounds, or affected with hospital gangrene. Here he maintains that it hardly ever succeeds. (P. 478.) But, though it be true, that amputations after gunshot wounds do not generally heal so well as many other cases, it cannot be denied that they do sometimes unite more or less by the first intention; and why should not the chance be taken? It is productive of no danger; there is nothing better to be tried; and if it fail, what is the harm? Why, the wound will then heal by suppuration and the granulating process, just as soon as if the hollow of the stump had been filled with charpie, or left open; it will, in fact, heal in a way, which is less advantageous than union by the first intention, but which is the best which can now happen. The very cases which Richerand condemns as unfit for union by the first intention, are those particularly specified as most favourable for it by Dupuytren (see *Leçons Orales*, t. iv. p. 419); while Delpech is so convinced of the necessity of the perfect closure of the wound, where hospital gangrene is prevailing, that in order to let this object be most completely fulfilled, he advises both ends of each ligature to be cut off close to the knot.

From what has been said, it appears that the practice of healing the wound by the first intention, after amputation, is less general in France than it is in England; a circumstance which may perhaps be explained by the fact of its being much newer to the French than to us. Every improvement must encounter for a time the opposition of prejudice; but one so important as that which we are considering must at length prevail and meet with universal adoption. The observations of MM. Roux and Richerand tend to prove that they are not altogether unaware of its advantages, and they therefore recommend it for certain cases; but their backwardness to extend it to all amputations is little in favour of the comparison which they are so fond of making of French with English surgery. Even the eminent Dupuytren had great apprehensions about lodgments of matter, if union by the first intention were completely attempted; and, for the prevention of them, left the lower angle of the wound open, sometimes placing a tent in it, and always the ends of all the ligatures twisted into one cord, as already explained. This cord of ligatures serves to conduct the discharge out of the unclosed angle of the wound, and abscesses in the deep part of the stump are prevented. A great portion of the wound unites by the first intention; suppuration only takes place in the track of the ligatures, and, in general, as soon as these have been detached, it soon ceases. (See *Leçons Orales*, t. iv. p. 416.)

However, that stumps may fall into a state in which the pressure of all plasters and bandages whatever should be most carefully avoided, and emollient poultices used, is a truth of which every surgeon of experience must be fully convinced. This happens whenever the parts are affected with considerable tension, inflammation, and swelling, or painful acute abscesses. There is also no utility in keeping the edges of the wound very closely compressed together when all chance of adhesion is past, and the parts must heal by the granulating process. My friend Mr. Guthrie, after amputations performed from necessity in parts not in a healthy state, as in most secondary amputations after compound fractures of the thigh, does not insist upon the edges of the wound being brought into close contact by sticking plaster, compress, and bandage. In these cases, he also recommends the bone to be sawn an inch shorter than usual, or than would be necessary under other circumstances, in order to prevent its protrusion, and the ligatures to be cut off close to the knots, so as to lessen irritation. The integuments and muscles are to be brought forward, and retained so by a moderately tight roller, but not laid down against the bone. Some fine lint, smeared with cerate or oil, is to be put between the edges of the wound: and a piece of linen and a Malta cross over it, supported by a few light turns of the roller. "In some cases," says Mr. Guthrie, "I have put one, and even two straps of plaster over the stump, to keep the edges approximated, without being in contact, and where the parts are but little diseased this may be attempted; but, if the stump becomes uneasy, they should be cut, and a poultice applied. When only a part of the stump has appeared to slough, I have found the spiritus camphoræ alone, or diluted with a watery solution of opium, applied with the lint, very useful." (*On Gunshot Wounds,* p. 104.)

The reasons which led Mr. Guthrie to incline to the plan of not bringing together the edges of the wound, in cases of this description, must be learned by reference to his own valuable work. His cases and arguments are entitled to serious consideration; and though they, as well as the observations of M. Roux (*Mém. sur la Réunion immédiate de la Plaie après l'Amputation,* 8vo. Paris, 1814), leave me unconvinced of the usefulness of not bringing the edges of the wound together immediately after the amputation of bad compound fractures, there are some of his observations, respecting the injurious effects of pressure in certain conditions of the stump, perfectly agreeing with my own sentiments. At present, I have never seen any case of amputation, in which I should not have thought the surgeon wrong, had he not brought the sides of the wound together directly, or within a few hours after the operation, so as to afford the chance of union by the first intention.

VARIOUS BAD CONSEQUENCES MAY FOLLOW AMPUTATION;

As, for instance, spasms of the stump, tetanus, hemorrhage, severe inflammation of the stump, abscesses and extensive sinuses, inflammation of the medullary membrane, necrosis (see *B. Phillips,* in *Lond. Med. Gaz.* for 1833—34, p. 189), protrusion of the bone, phlebitis, and suppuration in internal organs, and in various other parts of the body, hospital gangrene, neuromata, &c. Of these several complications, which may either interrupt cicatrisation, or subject the patient to great and protracted suffering, or even lead to a fatal termination, some are common to many operations; others restricted to that which is now under consideration; some arise from external causes; others from internal. (See *Dupuytren, Leçons Orales,* t. iv. p. 425.) It is only necessary to enter into a part of these topics in the present place, because the others more properly belong to the articles HOSPITAL GANGRENE, NECROSIS, PHLEBITIS, PYÆMIA STUMPS, SUPPURATION, and TETANUS.

SECONDARY HEMORRHAGE.

Bleeding, after the operation, is of two kinds in regard to the time when it occurs. The first takes place within twenty-four hours after the operation. Hence an assistant should always be left with the patient, with directions carefully and repeatedly to look at the stump, and if any bleeding should arise, to apply the tourniquet until further aid be obtained. In case no assistance can be spared for this purpose, as must frequently happen in country practice, the tourniquet should be left slackly round the limb, and the nurse, or patient himself, directed to turn the screw of the instrument, in order to tighten it, in case of need. A slack tourniquet, left round the limb after amputation, cannot do harm, and its not having been ready in this way has cost many patients their lives.

If the bleeding should not be from an artery of consequence, the application of linen dipped in cold or iced water will sometimes check it, and the disagreeable necessity for removing the dressings and opening the wound may thus be avoided. But it often happens that the wound must be opened, and the bleeding vessel tied. This is a very painful proceeding; for when the dressings have been applied some hours, and the stump has had time to imflame, nothing can exceed the suffering to which the patient is subjected by their removal. Here we see the prudence of being particularly careful at first to tie every suspicious vessel.

A few years ago, directly after the ligature of the vessels, the stump was always closed and dressed. Such, indeed, is still the general practice. Dupuytren deviated from this custom by letting one or several hours elapse before he dressed the stump. The vessels having been secured, the patient was conveyed into bed again, with merely a single compress and slack bandage placed on the stump. Dupuytren's reasons for this practice are that, notwithstanding every possible attention, hemorrhage will frequently take place shortly after operation, and compel the surgeon to remove the dressings; and that these often conceal the bleeding, till it has gone on to a fatal extent. Arteries are frequently prevented for a time from throwing out blood by the patient's syncope or mental depression; but, in two or three hours, they begin to bleed profusely, on the circulation recovering its force. From the period when Dupuytren commenced the custom of deferring the dressing for a time, no consecutive hemorrhage of this kind occurred in any of his patients. (See *Leçons Orales, &c.* t. iv. p. 412.) The regular dressing of stumps is also deferred by Mr. Liston for six or eight hours, or till all oozing has ceased; merely lint wetted with cold water being at first placed over the wound. (See *Liston's Elem.* part iii. p. 368.)

The second sort of hemorrhage, after amputation, arises from ulceration of arteries, and may occur a few days, or even some weeks or months, after the operation, when all the ligatures have come away, and the patient seems nearly well. Two such cases are related by Mr. Bromfield. (Vol. i. p. 307.) J. L. Petit saw an instance in which the hemorrhage came on twenty days after amputation of the thigh very high up; and Baron Dupuytren refers to an example in La Charité, where the bleeding took place two months after an amputation of the leg, from a fistulous opening in the stump, in consequence of ulceration of one side of the popliteal artery. (See *Leçons Orales*, &c. t. iv. p. 426.) Now that the plan of covering the stump with sound skin is adopted, this kind of bleeding is less common than formerly. When the bleeding vessel is large, there is no chance of putting the patient out of danger, except by cutting down to the vessel, and tying it. The trunk of the vessel, however, may sometimes be more conveniently tied than the bleeding branch itself.

Mr. Hey mentions a particular sort of hemorrhage after the operation: "I have seen," says he, "a few instances of the integuments becoming so contracted after the operation, as to compress the veins just above the extremity of the stump, and bring on after some hours a copious hemorrhage. When it has appeared clear to me that the hemorrhage was venous, I have made a division of integuments on one side of the thigh, sufficient to remove the stricture, and this method has immediately suppressed the hemorrhage." (P. 530, edit. 2.)

I have never met with a case where hemorrhage was unequivocally produced by a contraction of the integuments. Dr. Hennen states that he had seen only one example, and it was successfully treated by loosening the bandage, and moistening the dressings with cold water. (*On Military Surgery*, p. 264, ed. 2.) Here I infer, from the mode of relief, that the cause was not the pressure of the integuments, but that of the roller on the veins.

In Mr. Guthrie's practical work there are some excellent remarks on those hemorrhages, which, in an irritable and sloughing state of a stump, frequently take place from the small branches, or from the main trunks of the arteries, in consequence of ulceration. It is (says he) not always easy to discover the bleeding vessel, or, when discovered, to secure it on the face of the stump; for, as the ulcerative process has not ceased, and the end of the artery, which is to be secured, is not sound, no healthy action takes place. The ligature very soon cuts its way through, or is thrown off, and the hemorrhage returns; or some other branch is opened, and another ligature is required, which is equally uncertain; and, under this succession of ligatures and hemorrhages, the patient dies. Here, cutting down to the principal artery, in preference to another amputation, has often succeeded; but, under other circumstances, it fails, and amputation becomes ultimately necessary. At the same time it is allowed that this operation may also fail. On the whole, Mr. Guthrie professes himself to be an advocate in most cases for tying the artery in the first instance; and if this proceeding should not answer, he would then amputate. However, the practice of taking up the artery, he thinks, should not be adopted indiscriminately, the doctrines of aneurism not being here applicable, because there is a wounded vessel, with an external opening. "In the thigh, the operation is less certain than in the arm, and especially if it is not the main artery that bleeds; for the branch from which the hemorrhage proceeds may come from the profunda, and tying the artery in the groin on such opinion would be doing a serious operation, and one which probably would not succeed; for, the anastomosing branches would restore the circulation in the stump in a short time, and again establish the bleeding. If it is the femoral artery that bleeds, and the ligature is applied high, it is very liable to a return of hemorrhage. To obviate these difficulties, the part from which the bleeding comes should be well studied, and the shortest distance from the stump carefully noted at which compression on the artery commands the bleeding; and at that spot the ligature should be applied, provided it is not within the sphere of the inflammation of the stump." (*On Gunshot Wounds*, p. 105, 106.) Thus far the advice seems to me correct and valuable; but, where the hemorrhage could be restrained by taking up the artery in the groin, though not lower down, I doubt the propriety of preferring amputation to this other less severe operation, provided the efficiency of a ligature above the profunda be proved in the manner judiciously recommended by Mr. Guthrie, viz. by means of pressure.

Inflammation and suppuration in the arteries of a stump have a particular tendency to loosen the clot in them, and thus produce secondary hemorrhage. Ulceration of an artery may also be excited by an inflammation, which keeps up suppuration directly around the vessel. At the period when the ligatures are expected to be detached, the utmost vigilance should always be exerted to guard the patient from the risk of secondary hemorrhage. (See *Dupuytren*, *Leçons Orales*, t. iv. p. 428.)

These kinds of secondary hemorrhage, as Baron Dupuytren justly observes, are much more difficult to stop, than such as come on immediately or soon after amputation. The cellular tissue is deprived of its natural suppleness and flexibility; and is so thickened and changed that every fresh ligature cuts through it. Generally, also, the direct application of a ligature to the bleeding part of the arteries is impracticable; because, as the coats of the vessel adhere to the neighbouring textures, it either cannot be taken hold of, or is torn with the least effort being made with the forceps to draw it out. As for permanent compression, this is frequently ineffectual, and attended with too much pain. Under these circumstances, it is better to expose and tie the principal artery at some distance above the stump. (Op. vol. i. cit. p. 429.) Thus, in a case of secondary hemorrhage after amputation of the leg, where the bleeding returned notwithstanding the repeated application of the ligature, and even the actual cautery, Baron Dupuytren took up the femoral artery in the upper third of the thigh, and the result was perfectly successful. The same practice has succeeded with others. Mr. Liston informs us, that he has had recourse to it in many cases, and uniformly with success. (See *Elements*, part iii. p. 371.) This gentleman notices a kind of secondary hemorrhage, which does not consist in an arterial and rapid flow, but in a slow and continual oozing from the dark ulcerated cavities round the end of the bone. This case is ascribed by Mr. Liston to diseased action in the cancellated texture of the bone; and the treatment which he recommends is that of removing the coagula, filling the cavity with lint, and applying firm pressure. (See *Liston's Elem.* part iii. p. 372.)

ON PROTRUSION OF THE BONE.

It appeared to M. Louis, that this disagreeable consequence may generally be prevented by taking care to divide the loose muscles first, and after their complete retraction, unresisted by any band or tourniquet, by observing to divide with a bistoury the muscles which adhere to the bone. By this method, the bone may be sawn considerably higher than it could be if no attention were paid to beginning with the division of the loose muscles, and concluding with that of others attached to the bone. M. Louis argues, that the protrusion of the bones will never take place, so long as they are immediately encompassed with the fleshy substance of the muscles: this proposition is incontestable. But, with regard to another assertion, that whether the skin saved by the operation be long or short is a circumstance that has no influence in preventing or promoting the protrusion, I believe that this part of his statement is less correct. (See *Mém. sur la Saillie de l'Os après l'Amputation*, in *Mém. de l'Acad. de Chirurgie*, tom. v. p. 273, edit. in 12mo.)

As Mr. Guthrie has observed, a protrusion of the bone, after sloughing of the stump or other accidental circumstances, will sometimes happen, without any fault on the part of the operator; but he thinks it may almost always be prevented by attention to the following rules: — 1. To leave the integuments attached to the muscles, instead of turning them back. 2. When the muscles are cut through in a slanting direction, upwards and inwards, or even directly downwards, to separate them from the bone, so that it may appear at the bottom of the cone as a depressed point. 3. To cut the bone short, and to keep the limb constantly bandaged from the trunk during the cure, so as to prevent the retraction of the muscles. If a surgeon find, directly after the operation, that the bone cannot be well covered, he should immediately saw off as much more of it as will reduce it to its proper length. The error may be remedied at this moment with very little inconvenience, in comparison with what must afterwards be encountered if the opportunity be neglected. (*On Gun-shot Wounds*, p. 109.) This last piece of advice perfectly agrees with the view which I entertain of the subject.

When the end of the bone protrudes, it of course hinders cicatrisation, and becomes itself affected with necrosis. By the process of exfoliation, the dead portion of bone is sometimes thrown off, and a cure follows. But, in general, this desirable change is extremely tedious, and the result uncertain; because it frequently happens, that, after the piece of bone has separated, the rest yet projects too much, and the stump still continues too conical to heal firmly enough to be capable of bearing the necessary pressure. When, however, the end of the bone forms only a slight projection, and the stump is not too conical, it is always best to leave nature to throw off the redundant exfoliating portion. In the opposite circumstances, the removal of all such parts of it as cannot be covered by the integuments is the best practice, and, if well executed, will effect a cure.

The second operation is exceedingly unpleasant to the surgeon, because patients are apt to suspect, and not without reason, that the first was not properly managed. Let me therefore repeat, that the surest way of avoiding the evil is to cut the deep muscles rather higher than the superficial ones, as inculcated by M. Louis, by which means the bone will certainly lie within the level of the surface of the divided flesh. If the soft parts are found to be deficient, let another piece of the bone be exposed and sawn off at once, before the patient is removed from the operation table.

[Sometimes, although a sufficiency of covering may have been left in the first instance, a portion of bone will become necrosed, in consequence probably of the mechanical injury it has suffered, together with its periosteum and medullary membrane, from the application of the saw. In such a case, notwithstanding the end of the bone may have been well covered at first, it will often ultimately protrude, in consequence of the gradual retraction of the soft parts during the long delay in the healing process, which is the necessary result of the presence of the dead piece of bone. In a case of this kind, where we may infer the protrusion to be the consequence of the necrosis, rather than the necrosis of the protrusion, it will obviously be better to leave the separation to the efforts of nature.

Mr. Syme believes that it is not the local injury which is alone concerned in causing death of the bone after amputation, but that inflammation of the medullary membrane may cooperate, if it does not sometimes act exclusively, in its production. The most conclusive evidence in support of this opinion, he remarks, is presented by those conical-shaped exfoliations, extending up the interior of the bone, sometimes to the length of several inches, which are occasionally extracted from stumps. Mr. Syme has one in his possession, extracted from the humerus, which is five inches in length. He believes further "that if the medullary membrane be liable to inflammation, suppuration of its texture and inflammation of the veins cannot fail to be the frequent consequence, especially in hospitals where, notwithstanding every precaution, certain descriptions of injuries will always be apt to excite phlebitis and other forms of spreading inflammation. But when the bone is divided through the condyles" (he is speaking of amputation just above the knee joint) "nothing more than the epiphysis being concerned, the medullary membrane is not at all disturbed, while the cancellated texture is not liable to exfoliate, either from its proneness to die from injury, or through inflammation of any other texture." (See *Ed. Monthly Journal*, May, 1845, p. 537.) So impressed was Mr. Syme with these opinions, that he thought it preferable in all cases to amputate through the cancellated extremities of bones, and he believed it to be an error to divide the thigh bone through its shaft instead of through the condyles or trochanters.

These views may be correct so far as regards necrosis of the bone, which is probably less likely to occur in the cancellated texture on account of its greater vascularity; but with respect to the risk of phlebitis being lessened by amputating in the immediate neighbourhood of a joint, this must be extremely problematical; on the contrary, we should expect that the danger would be increased, on account of the large number of veins always distributed within the articular extremities of the bones; and, moreover, if injury to the medullary membrane has anything to do with the production of phlebitis, the risk must also be greater from this cause in the cancellated texture, since every cell is lined by a membrane continuous, and in every respect identical, with the medullary membrane of the shaft.

It is necessary, however, to state that Mr. Syme, having become dissatisfied with the results of his amputations through the condyles of the femur, has since ceased to perform this operation or to resort to amputation through the trochanters as a place of election; having satisfied himself "that the operation by circular incision, if performed with due care, on proper principles, may be employed in the lower third of the thigh safely and advantageously." (*Ed. Monthly Journal*, Nov. 1846, p. 225.)

Dr. Markoe does not agree with Mr. Syme, in attributing the formation of the tubular sequestra above alluded to, to inflammation of the medullary membrane, though he admits this as a possible explanation. He regards them "as produced by the severing of the nutritious artery of the bone, either by the saw, while it is passing through its bony canal, or by the catlin before it has reached the nutritious foramen. The supply of blood," he observes, "thus cut off from the medullary membrane, can only be restored by the anastomosis which it has with the vessels of the spongy portion above. These vessels, however, are contained in unyielding canals, and the necessary increase in their calibre can take place but slowly; in the meantime therefore, the small vessels which the medullary membrane sends into the bone are not properly filled, and the death of the bone is produced up to the points where the anastomotic supply is sufficient to save it." (See *N. Y. Journ. of Med.* vol. xvi. 1856, p. 41.)

These observations are made by Dr. Markoe with reference to the thigh bone, where, it will be remembered, the direction of the canal for the nutritious artery is invariably from below upwards, but the explanation loses much of its value when we consider that these sequestra form also in the humerus, in which bone the nutritious artery has, with equal constancy, an exactly opposite direction.]

Spasms of the Stump

Constitute another afflicting occurrence, as they put the patient to the greatest agony, tend to cause a protrusion of the bone, or sugar-loaf stump, and in some cases extend to the whole body, and ultimately prove fatal. But this unfortunate affection, which was rather frequent after amputations performed in the ancient manner, is infinitely less so, after the modern improved plans of operating, tying, the vessels, and dressing the wound. When, however, it does occur, the stump must be kept from starting, by binding it down with a broad band, placed across it a little way above the wound. The flesh is to be properly supported with a bandage applied from above downwards, and opiates should be liberally exhibited.

Of Neuromata after Amputation.

Sometimes amputation has been found necessary a second time, in consequence of a morbid protuberance of the nerves of the stump, — a change noticed by Molinelli, Morgagni, Lower, Arnemann, and Prochaska, and always attended with excruciating pain and great irritability of the part, and sometimes with retraction of the skin and protrusion of the bone. According to Mr. Liston, neuromata are more frequent after amputation of the arm and forearm than other amputations. The disease seems to him however, to be less common than formerly, which he refers partly to flap amputations having been more extensively adopted, and partly to the method of tying arteries, so as to include nothing else in the ligature. In the forearm I have never seen a neuroma follow amputation, and yet almost all the operations were circular. Sir Astley Cooper, in his Lectures, relates one instance of such a stump high up the arm, where, upon examination of the part near the axilla, a tumor was felt, which, when touched, made the patient jump as if he had been electrified. In this case, as the bone protruded, amputation at the shoulder was performed. In another example, where a leg-stump was in a painful irritable state from a similar cause, Sir Astley Cooper effectually relieved the patient by removing the diseased end of the posterior tibial nerve. This plan should always be preferred to amputation, when it presents any chance of being efficient. In a third instance, amputation was repeated at the patient's desire, and the nerves were found enlarged, forming a ganglion which partly rested upon the extremity of the bone. Such a degree of irritation had been produced by it, that no part of the stump could be touched without exciting a kind of electric shock. In a case that occurred in the Middlesex Hospital, amputation of the thigh was performed a second time, in consequence of the first stump being thus diseased. A complete ganglion, or plexus of nerves, was found closely adhering to the removed portion of bone, having almost the appearance of cartilage. The os femoris was of an unusally small size, but the linea aspera larger than natural. (See *Lancet*, vol. i. p. 115; vol. iii. p. 192.) In the same hospital, Mr. Mayo also amputated at the hip, on account of the extreme sufferings caused by a diseased state of the nerves of a thigh stump. (See Neuroma.) For some observations on the changes which occur in stumps after cicatrization, see Stumps.

The following works may be consulted for information on diseases of the bones of Stumps: *Bonn*, Thesaurus Ossium Morborum, Amst. 1788; *Weidmann*, De Necrosi Ossium, Francof. 1798; *Macdonald*, De Necrosi ac Callo, Edinb. 1799; the above mentioned Essays of M. *Louis; Léveillé*, Sur les Mal. des Os après l'Amputation, Mém de la Société d'Emulation, t. i. p. 148; *Van Hoorn*, De iis, quæ in partibus membri, præsertim osseis, amputatione vulneratis, notanda sunt, Lugd. 1803; *Roux*, De la Résection des Os Malades, Paris, 1812; Mém de Physiologie, &c. par *Scarpa*, et *Léveillé*, Paris, 1804; *B. Phillips* on Inflammation of the Medullary Membrane after Amputation, Lond. Med. Gaz. 1833-34; *G. Lungstaff* on the Healthy and Morbid Conditions of Stumps, in Med. Chir. Trans. vol. xvi.; *Crookes* on a Neuralgic Affection of Stumps, Lond. Med. Gaz. 325.

OF PARTICULAR AMPUTATIONS.

UPPER EXTREMITY.

Amputation of the Fingers.

Amputation of the fingers, or parts of them, is performed with one, or with two flaps, or with a circular or an oval incision, and is frequently required, either primarily or secondarily, on account of various accidents and diseases, as comminuted fracture, onychia maligna, necrosis, &c. The operation is most conveniently performed in the articulations, though exceptions sometimes occur in which it may be done elsewhere, and the phalanx divided with the cutting pliers. Thus it occasionally happens that either the distal or the middle phalanx is torn off, and the end of the proximate phalanx exposed: here it will often suffice to take away the denuded portion of it with the cutting pliers, and save a proper flap for covering the end of the remaining part. It is sometimes desirable to save as much as possible of the proximal phalanx, when amputation is rendered necessary by disease of the middle articulation, or of the distal extremity of the bone. In such cases, after saving the requisite skin in the same way as recommended below for amputation in the articulations, the bone is divided either with a small saw or the cutting pliers.

Amputation of the Distal and Middle Phalanges.—The phalangeal articulations are but loosely supported in front by the anterior ligament, and behind by the extensor tendon: at the sides, however, they are much more closely held together by the lateral ligaments. Consequently, it is these which must be divided in order to open the joint freely. The line of the articular interval is nearly transverse. Between the first and second phalanx, it is on a level with the palmar cutaneous furrow; but, in the articulation of the second with the third phalanx, it is from half a line to a line below the palmar furrow. (See *J. F. Malgaigne, Manuel, &c.* p. 275.) In either of these joints the operation may be done, either with a single flap, taken from the palmar surface of the finger, or with two flaps, one formed from the palmar, and the other from the dorsal surface of the finger.

Amputation by the single palmar flap is performed, according to Lisfranc, in the following manner. The surgeon, taking hold of the finger and placing it in the bent position, makes a semicircular incision across the joint on the dorsal surface, half a line in front of the angle produced by flexion, cutting through the skin and opening the capsule by the same stroke; he then proceeds to divide the lateral ligaments, one after the other; and the knife being conveyed through the articulation, the operation is completed by the formation of the palmar flap, which is to be long enough to cover the entire surface of the stump.

Another method, also ascribed to Lisfranc, consists in attacking the joint on its palmar side. All the fingers, except that which is about to be amputated, are bent and held out of the way by an assistant. The point of a narrow straight bistoury is introduced from half a line to a line beyond the palmar cutaneous wrinkle, if we are amputating the distal phalanx, and exactly at the base of this wrinkle if we are removing the middle phalanx. The knife is to pass through the finger from one side to the other, and close to the anterior surface of the bone, along which it should be carried to the extent of rather more than half an inch, and then brought out, so as to complete a semilunar flap. The knife is then carried again to the base of the flap to divide the anterior ligament. In this operation the lateral ligaments scarcely require a separate division, for the same stroke of the knife which cuts the anterior ligament usually cuts them also, making room for the knife to pass through the articulation, and to divide the textures on the dorsal aspect, without forming any posterior flap. By this method, a more regular and better nourished flap is produced, and the operation is more sure of being effected with precision; but the extensor tendon is apt to remain too long, in which event its projecting end should be cut off with scissors. (*Malgaigne, Méd. Opér.* ed. 5, p. 277.)

[*If two flaps* are to be made, that from the palmar surface may be cut by transfixion, in the manner described in the last operation, only it may, of course, be considerably shorter than is there recommended; while that on the dorsum will be more conveniently made, not by transfixion, but by incision from without inwards, a few touches with the point of the knife enabling the surgeon to reflect it upwards to the level of the joint. Both flaps should be made before opening the articulation.]

The *circular method* of amputating a finger is the oldest. The finger is put in an extended posture; a circular incision is made three or four lines beyond the articular interspace, the situation of which is denoted by the position of the palmar cutaneous furrow. The skin is dissected up as far as necessary, and the joint opened either in front or behind, as in the flap operation already described. Or, if the disease or injury will admit of it, the integuments may be drawn up before the circular cut is made, and thus little or no dissection of them from the subjacent parts will be necessary.

[*A single flap from the dorsal surface* may be thus formed. A semilunar incision should be made so as to form a flap about three quarters of an inch in length, the angles of which should be placed on each side of the articulation opposite to the commencement of the palmar furrow. This flap is to be dissected up to the joint, which is next opened from its dorsal surface by division of the lateral ligaments and extensor tendon. The operation is completed by causing the knife to cut its way out straight through the remaining tissues, situated on the palmar surface. This latter operation is only applicable to the articulation between the first and second phalanx. In the joint between the second and third, the proximity of the nail will prevent a flap being formed of sufficient size.

In general, after amputation of the distal and middle phalanges, no ligature is required; the bleeding ceases as soon as the wound is brought together, which should be effected by means of one or two sutures and narrow strips of adhesive plaster.

The operation by the single palmar flap, or by flaps cut partly from the palmar and partly from the dorsal surface, are those most commonly recommended and practised. The circular incision has fallen almost entirely into disuse. The single flap from the dorsal surface is unnoticed by many writers; it has been mentioned, however, by Lisfranc, Delpech, Velpeau and others, and more recently by Mr. Skey. (*Op. Surg.* p. 349.) It is applicable to those cases where the palmar surface of the finger has been injured, but it possesses also the advantage that the flap is composed of the skin of the knuckle, which falls conveniently, of its own accord, over the end of the phalanx; and that the position of the cicatrix renders the loss of the finger less evident than when the flap has been cut from the palmar side. What is gained in appearance, however, is, perhaps, lost in utility; for the cicatrix though more out of sight, is more exposed to pressure from substances held in the hand.]

AMPUTATION AT THE METACARPO-PHALANGEAL ARTICULATIONS.

Each of these joints is of the enarthrodial kind, and furnished only with loose ligaments. The articular prominence, seen when the phalanx is bent, is formed by the head of the metacarpal bone. The joint is from three quarters of an inch to an inch above the digital commissure. The operation may be performed by lateral flaps, or by an oval incision.

1*st Method, by Lateral Flaps.*—The hand being placed in the prone position, and the other fingers held apart from the one about to be removed, the phalanx is to be bent, as Lisfranc directs, to an angle of 45°, and an incision begun over the head of the metacarpal bone, about a quarter of an inch behind the articulation, and extended obliquely down the side of the finger, as far as the digital commissure, care being taken to divide as completely as possible the extensor tendon. The incision is then carried round to the palmar surface and continued backward, so as to terminate opposite the articulation, thus completing the first flap, which is to be reflected. The knife is now pushed into the exposed side of the articulation, the ligaments cut, and the operation finished by the formation of the opposite flap, which is cut from within outwards and ends like the first at the digital commissure.

When this operation is done on the index finger, the outer flap should be the larger; when on the little finger, the inner flap should have the greater size. (*Malgaigne*, *Manuel*, *&c.* ed. 5, p. 279.)

The following is Mr. Liston's description of this method: — The operator seats himself before the patient; grasps the finger so as to manage its movements with the left hand; and holding the knife perpendicularly, with its point upwards, lays it over the knuckle, and carries it obliquely upwards, so as to open that side of the articulation. He then pushes the finger towards the opposite side, and with the point of the knife completes the loosening of the articulation, which should never be done with the blade, as it would cross-cut and mangle the skin. After the separation of the base of the phalanx with the point, the blade is passed behind; and, being carried downwards and outwards, it forms a flap similar to the first. They are retained in contact by bringing the neighbouring fingers towards one another. In general, this will also stop the bleeding, but sometimes one or both digital arteries will require ligature. (See *Liston's Elements*, part iii. p. 375.)

[It will be found preferable to make both these flaps by incision from without inwards, and to complete both before opening the joint; in this way it is easier to make them correspond accurately than by the former methods.]

2nd Method, by Oval Incision. — The incision commences in the same way as in the first operation, and like it passes obliquely downwards as far as the digital commissure; but now, instead of being continued backward into the palm, it is carried transversely across the under surface of the finger, following exactly the cutaneous fissure which separates the finger from the hand. It is now made to pass obliquely upwards again on the opposite side of the finger, to join the original incision a little in front of the point where it commenced. The skin is held aside by an assistant, while the surgeon opens the joint on its dorsal surface, and then divides the lateral and afterwards the anterior ligaments to complete the disarticulation. This operation is not effected quite so rapidly as the former, but the wound made is a little less extensive, and does not encroach at all upon the palmar surface of the hand.

Dupuytren found that, when the ring or middle finger had been removed, without taking away the head of the corresponding metacarpal bone, the adjoining fingers remained widely separated at their base, but obliquely approximated to one another at their extremities, so as to produce a considerable deformity, and an imperfection in their functions; he used, therefore, not to be content with amputating the phalanges, but made it a rule to apply a retractor, and saw off the head of the metacarpal bone. (See *Leçons Orales, &c.* t. iv. p. 309.) Sir Astley Cooper has advocated the same practice, which is most readily accomplished with a pair of cutting pliers. Mr. Fergusson also strongly recommends the removal of about an inch of the metacarpal bone, as greatly lessening the deformity and not tending materially to diminish the strength of the hand. He advocates the extension of the same principle to the fore and little fingers. (See *Practical Surgery*, p. 216.) The portion of the metacarpal bone may either be removed together with the phalanges, or separately after these have been taken away, at the choice of the operator. The extension of disease to one of the metacarpo-phalangeal articulations may also be another reason for taking away more or less of the metacarpal bone along with the finger. If merely the distal end of the bone is affected, either of the above mentioned plans of operation will suffice, only the incisions should commence a little further back than is there laid down. And even when a considerable portion of the metacarpal bone is to be taken away, an extension of the incision backwards on the dorsal surface will be found sufficient without interfering further with the palm of the hand. "With this view the knife is entered over the dorsal centre of the bone, above the diseased part, and carried straight downwards till near the articulation, when it is made to diverge for the formation of lateral flaps. The integuments in the track of the wound are then dissected backwards, so as to expose the bone completely, and the bistoury is passed round it throughout its whole extent, the edge being kept close to it. Then the bone is clipped at the proper point by the cutting pliers; or the section of the bone may be performed before the separation of the soft parts from its under surface, as by raising the cut end this part of the operation may be facilitated." (See *Liston's Elements*, part iii. p. 377.)

[*Two, three, or, perhaps, all four fingers may require removal at their metacarpal articulations.* — When all four are to be taken away, a transverse incision, slightly convex forwards, should be made completely across the dorsum of the hand, from one end to the other, a quarter of an inch in front of the metacarpo-phalangeal joints. Disarticulation of these joints, one after the other, is now to be effected, when the knife may be made to cut a flap from the palm, which should extend forwards quite to the digital commissure. Care must be taken to leave the flap as large as possible at each side, otherwise there will not be sufficient covering for the heads of the second and fifth metacarpal bones. *The elliptical incision*, recommended by M. Soupart, seems well adapted to obviate the inconvenience just alluded to. He makes the dorsal incision convex upwards, its middle part reaching as high as the level of the articulations to be opened, and its extremities terminating at each side, at the commencement of the digito-palmar furrow. The hand being supinated, he makes a palmar incision, which follows exactly the digito-palmar fold, and joins the extremities of the one first made. The palmar flap is then dissected up, and the flexor tendons divided, after which, the hand being again placed in the prone position, the extensor tendons and lateral ligaments may be cut through, one after the other, and the joints disarticulated. (See *Malgaigne*, op. cit. p. 281.)]

[AMPUTATION OF THE PHALANGES OF THE THUMB.]

[*Amputation of the last phalanx* will not need a special description.

In amputation of both phalanges from the metacarpal bone, it should be remembered that here the head of the metacarpal bone is of a somewhat square shape, and broader than in the fingers. It will require, therefore, a larger covering to be left for it. This amputation may be done by lateral flaps, or by the oval incision, as in the fingers; but, perhaps, the best operation is that by an *elliptical incision*, as recommended by M. Malgaigne. He makes a dorsal incision convex *upwards*, the middle part of which passes a little above the level of the articular interspace, while its extremities terminate at each side at the commencement of the palmar cutaneous fold. The thumb being now forcibly extended, he makes on the palmar aspect a second incision convex *downwards*, which, joining at each side the extremities of the first, descends by its middle part as low as midway between the cutaneous fold, above referred to, and the fold which corresponds to the interphalangeal articulation. (Op. cit. p. 282.) The result is a palmar flap which, when it is applied over the end of the bone, has a convex edge, corresponding exactly with the concavity of the dorsal portion of the incision. M. Malgaigne prefers this mode of proceeding because it leaves the cicatrix well out of the way of injury from hard substances held in the hand. He removes at the same time the two sesamoid bones; but the reason for so doing, unless they happen to be implicated in the disease or injury which necessitates the operation, is not sufficiently apparent. If the anterior extremity of the metacarpal bone were diseased or injured, it might be removed with the cutting pliers; but if sound, it should always be allowed to remain.]

AMPUTATION OF THE THUMB AT THE ARTICULATION BETWEEN THE METACARPAL BONE AND THE OS TRAPEZIUM.

The metacarpal bone is almost subcutaneous at its posterior and external aspect, but covered by a thick mass of muscle on the side towards the palm. The articulation will be found about an inch below the styloid process of the radius; its direction is oblique, corresponding to a line, which, if carried far enough, would cross the root of the little finger. It has a loose capsule, which may be opened with great facility from its posterior and external surface. Upon this surface lie the tendons of the two first extensors of the thumb. The radial artery runs over its ulnar side on its way to the palm to form the deep palmar arch. The place of the joint is readily determined by passing the finger along the dorsal aspect or the sides of the metacarpal bone, from before backwards, for it is situated immediately behind the first bony tubercle. (See *Velpeau*, op. cit. p. 390.)

1*st Method, by External Flap.* — While the thumb is held in the position of abduction, the knife is applied to the middle of the commissure; an incision is made at once down to the carpus, dividing all the soft parts between the metacarpal bones of the thumb and forefinger, and terminating against the ulnar side of the articulation. This is to be opened by cutting outwards, the fibrous textures being divided rather with the point than with the blade, so as not to mangle the skin; the thumb may now be dislocated, and a flap formed from behind forwards, by carrying the knife close to the outer side of the bone as far as a few lines beyond the metacarpo-phalangeal joint. If the radial artery has been wounded, it will require a ligature; but if not, bringing the flap accurately over the wound will most probably stop the bleeding. The edges should be maintained in apposition by two or three sutures and adhesive plaster, and contact of the surface of the flap with the parts beneath should also be secured by a compress and bandage. The operative procedure may be reversed as follows:— An assistant takes hold of the thumb, while the surgeon takes as much of the soft parts as possible with the fingers of his left hand, and draws them outwards. The latter then transfixes them with a straight narrow knife from behind forwards, or towards the palm, directing the blade close to the radial side of the articulation. A flap is then formed; and while this is held up by the assistant, the surgeon takes hold of the thumb, cuts through the joint from without inwards, luxates the bone, and with the knife cuts through the middle of the commissure. This method leads to the same result as the former, but, being more difficult, ought not to be preferred.

2*nd, or Oval Method.* — The incision is commenced upon the os trapezium, a little above the articulation, and is carried on the back of the thumb downwards, and to the ulnar side as far as the digital commissure; it should now pass round to the palmar surface of the thumb, and ascend obliquely on the radial side of the bone towards the original incision, which it should join about half an inch in front of its commencement. The point of the knife is next introduced into the articulation, which is cut through from its dorsal towards its palmar boundary. All that now remains to be done is to detach the bone from any fibres which may yet adhere to it, by carrying the knife in front of it from behind forwards. The wound, when brought together, represents a straight line, and is much less extensive than by the first method, which leaves a cicatrix on both aspects of the hand.

3*rd Method.*—Velpeau has frequently amputated the thumb in the following manner:—An incision is made along the back of the thumb from the styloid process of the radius to the commissure of the thumb and forefinger. This divides the integuments, the tendon of the long extensor, and a portion of the first interosseous muscle, so as to expose the joint. While an assistant holds aside the edges of the wound, the surgeon opens the capsule and dislocates the bone, which is then removed, care being taken to preserve as much of the flesh on the palmar side as will be required to close the wound immediately. Thus the palm of the hand is not at all wounded. (Op. cit. p. 392.)

AMPUTATION OF THE LITTLE FINGER TOGETHER WITH THE WHOLE OF ITS METACARPAL BONE.

[The articulation of the fifth metacarpal bone with the os unciforme is situated nearly an inch and a half below the styloid process of the ulna. Its direction is oblique, corresponding to a line, which, if prolonged, would cross the centre of the metacarpal bone of the forefinger. Amputation may be performed here, as in the thumb, either by a flap or by an oval incision.

1st Method, recommended by Lisfranc, by a flap from the ulnar side.—The soft parts are to be drawn towards this side and transfixed opposite the articulation; the knife is to be carried forwards, being kept as close as possible to the bone, as far as about half an inch beyond the metacarpo-phalangeal joint. The flap thus made is held back, and the joint opened; the bone is then separated from the soft parts, and its detachment completed by division of the commissure.

2nd Method, by Oval Incision.—This is done on the same principle as in the thumb. A straight incision is commenced a little behind the articulation, and is carried forwards on the dorsal surface of the metacarpal bone as far as its centre; from it two diverging incisions should pass so as to form a sort of loop round the root of the little finger. The edges of the wound being held apart, the bone may then be disarticulated and separated from the soft structures still adhering to it.]

[Amputation of the First, Second, or Third Fingers at their Carpal Articulations.]

[It is not often that removal of one only of these fingers with its metacarpal bone will be required; but, if necessary, it will be most conveniently effected by a straight incision along the back of the metacarpal bone, forming a loop round the root of the finger, as recommended in the last case. This will admit of disarticulation and separation of the bone, without interfering in any way with the palm of the hand. The proceeding will be attended with very considerable difficulty from the closeness of the joints and the proximity of the other metacarpal bones on each side; it will, therefore, be essential that the operator should have an exact knowledge of the position of the joints and of the direction of the articular surfaces. Care should be taken not to wound the deep palmar arch when the knife is being applied to the palmar aspect of the bone.]

[Amputation of all the Fingers at the Carpal Articulations.]

[Modern surgeons never amputate the whole of the hand when there is a chance of saving any portion of it. A single finger should, if possible, be preserved; and if the thumb and one finger can be retained, a very useful member, comparatively speaking, will be the result. On this principle it has even been thought desirable, in cases requiring it, to remove all four fingers with their metacarpal bones, leaving only the thumb. In the latter case, the hand being prone, a transverse incision should be made upon its dorsal aspect, half an inch in front of the carpo-metacarpal joints. This incision should commence over the metacarpal bone of the forefinger, and, after passing across the hand, should be carried round its ulnar border, and made to traverse its palmar surface at the same level. There remain to be divided the structures between the thumb and forefinger, which may be done by passing the knife through them from behind forwards. The skin being drawn up by an assistant, the metacarpal bones may be disarticulated one by one, commencing from the ulnar side.]

Amputation at the Wrist or Radio-carpal Articulation.

The hand should be amputated at the joint of the wrist, whenever the disease does not extend too high, and a sufficient covering can be preserved either from the integuments of the back of the hand, or from those of the palm. Amputation may also be done here by the circular incision, or by anterior and posterior flaps as recommended by Lisfranc. The circumstances of the case will often determine the choice; but whenever it is practicable the circular incision should be preferred, as it will be found to provide a better covering for the projecting styloid processes.

The scaphoid, semilunar, and cuneiform bones form a convexity, which is almost entirely received in the concavity of the radius, the ulna having no connection with this joint, except through the intervention of the triangular ligament, and to the extent of about four lines. The styloid processes of the radius and ulna can be readily felt, and they overlap the articulation on either side, so that to enter the joint the knife should be directed obliquely upwards beneath them. In this way the articulation will be arrived at with greater certainty than from its dorsal surface, for in attempting to enter it from the latter direction the surgeon might erroneously carry his knife into the medio-carpal articulation, over the head of the os magnum, instead of into the wrist joint itself.

The projection of the pisiform bone beyond the level of the palmar surfaces of the radius and ulna, must be remembered in the operation.

Amputation by the circular method is performed as follows:—An assistant draws up the integuments, and the surgeon, holding in his left hand the part he is about to remove, makes an incision all round the wrist, about an inch below the styloid processes. The skin may now be easily retracted nearly as high as the joint; a second incision, made so as to leave the pisiform and cuneiform bones just beyond it, divides all the tendons on a level with the retracted skin. The joint is then to be cut into on one side or the other, under the guidance of the corresponding styloid process, and the knife directed through the articulation in a line answering to the posterior convexity of the scaphoid, lunar, and cuneiform bones. The radial and ulnar arteries are now to be tied, but the interosseous here seldom requires a ligature. The wound is to be closed with the line of it in the transverse direction.

[*Flap amputations at the wrist* should be performed by cutting from without inwards; transfixion of the soft parts being difficult anteriorly, in consequence of the prominences of bone in the neighbourhood of the joint; and next to impossible posteriorly, on account of the convexity of the posterior surface of the carpus. The incisions should commence opposite the styloid processes, and two semilunar flaps should be formed rather more than an inch in length, from the integuments on the anterior and posterior surfaces of the wrist. These should be dissected up to the requisite extent and the tendons divided, after which the disarticulation may be completed in the same way as in the circular operation. Or the dorsal flap may be first formed and the joint then opened on its posterior aspect by division of the posterior and lateral ligaments, after which the knife can be carried through the joint, to complete the operation by the formation of the second flap from the palm. The latter part of this proceeding is, however, rendered difficult by the projection of the pisiform bone; and care must be taken to carry the knife over it, so as not to include it in the flap. In forming the flaps, care must be taken to leave enough integument on each side, otherwise, the styloid processes will be likely to protrude at the angles of the wound. M. A. Guérin recommends a single flap large enough to cover the ends of the bones to be made from the palmar surface, the angles of which are to be united across the dorsum of the wrist by an incision slightly convex upwards, this he thinks preferable to the circular method, as it will leave a cicatrix more out of the way of irritation from pressure. (*Elém. de Chir. Opér.* 1855, p. 122.) This, it will be observed, is another application of M. Soupart's elliptical incision.]

Amputation of the Fore-Arm.

This operation may be performed at any point between the elbow and the wrist; but it is now always considered desirable to retain as much of the limb as possible, notwithstanding the objections entertained by Larrey and some other surgeons to amputation through the tendinous structures in the lower third of the fore-arm. The usefulness of the member will be increased if the amputation can be performed below the attachment of the supinator radii brevis, and pronator radii teres, because the movements of pronation and supination will be thereby preserved. (*Skey, Op. Surg.* p. 339.)

Circular Method.—A tourniquet is to be applied over the brachial artery, or if preferred the vessel may be compressed by the fingers of an assistant. A second assistant should steady the limb and retract the skin upwards. A circular incision is now to be made down to the fascia, and as much skin is to be detached, reflected, and saved as will be required to cover the ends of the bones. The muscles should next be cut through down to the bones on a level with the reflected skin, and a narrow double-edged knife should be passed between and around them to divide the interosseous membrane and completely isolate the bones from any of the deep fibres which may remain attached to them. This having been carefully accomplished, the soft parts are to be protected from the saw by a linen retractor. If the operation is in the upper third of the fore-arm, it may, perhaps, be sufficient, in consequence of the greater abundance of soft parts, to retract the skin only, without reflecting it back; and in this situation, after the first division of the muscles in the manner above recommended; a second incision may be made at a somewhat higher level through the deeper fibres which are adherent to the bone. It is usually recommended that both bones should be sawn together; but that the division of the radius should be first completed, as the ulna, in consequence of its connection with the humerus, is better adapted to bear the weight of the saw. The ulnar, radial, and two interosseous arteries, will usually require ligatures.

Amputation by Flaps.—Graefe removed the fore-arm by making a flap from the flesh in front of the limb, and then extending the wound quite round the member. (*Normen für die Ablösung grösserer Gliedm.* p. 138, &c. 4to. Berlin, 1812.) Mr. Guthrie made two flaps, one in front, the other on the back of the fore-arm: but above the middle of this part of the limb he preferred the circular incision. (*On Gunshot Wounds*, p. 373, 374.) Dr. Hennen also expressed his approbation of amputating the fore-arm, so as to make two semilunar flaps (*Principles of Military Surgery*, p. 265. ed. 2), which is the method recommended and practised by Klein (*Practische Ansichten bedeutendsten Operationen*, heft i. p. 45); and Lisfranc also operated in this way at the lower third of the fore-arm. Amputation with *one flap* should be confined to those cases where the soft parts are destroyed to a greater extent on one side of the limb than on the other.

[In the amputation with *two flaps* the arm should be held in the supine position and a flap should be formed of the requisite length from the anterior surface by transfixion; the limb should then be pronated so as to bring the dorsal surface into view, and a posterior flap formed of a semilunar shape by incision from without inwards, or from the skin towards the bones. Both these flaps should be reflected up by an assistant, and the operation then completed in the same way as in the circular method. In the lower half of the fore-arm the tendons are liable to be drawn out over the edge of the knife and to be left longer than the integument. When this is the case, they must be cut off with the scissors to the requisite level. This is an application to the fore-arm of the mode of amputation recommended for the thigh by Mr. Luke. It will be found more convenient to proceed in this way than to form both flaps by transfixion, on account of the proximity of the bones to the posterior surface of the limb.]

Amputation at the Elbow-Joint.

Dupuytren, convinced of the correctness of the principle, that as much as possible of the upper extremity should always be saved, revived the practise of amputating at the elbow, whenever the state of the joint and of the soft parts admitted of such operation. This operation was performed by Dupuytren in ten or twelve examples with great success, and the method is also highly commended by Mr. Liston. (See *Elem. of Surgery*, part iii. p. 381.) Notwithstanding these authorities, however, it is not much in favour at the present time, and is rarely practised by English surgeons.

[It must be borne in mind that the joint is placed at some distance below the condyles of the humerus, and that its direction is oblique, extending lower down on the inner than on the outer surface of the limb. The articulation will be found nearly an inch below the prominence of the internal, and about half an inch below that of the external condyle.]

The circular method is recommended by M. Velpeau and also by Dupuytren when there is not a sufficiency of soft parts for an anterior flap. The incision should be made three fingers' breadth below the level of the joint and should extend through the integuments only; these should be drawn upwards, or reflected if necessary, as high as the articulation; the muscles should then be cut through, the joint opened and the disarticulation completed. The brachial artery will be divided before its bifurcation, and will be the only vessel requiring a ligature.

Anterior Flap.—The fore-arm being slightly bent, the soft parts in front should be transfixed opposite the joint, and a flap should be cut of sufficient extent to form an ample covering for the end of the bone; the flap should be of large size, in consequence of the retractibility of the skin opposite the flexure of the elbow. A transverse incision across the posterior half of the limb should unite the angles of this flap. The joint is then opened, and the ligaments and remaining tendons divided. The knife will be found to enter the joint more readily on the outer side, between the external condyle and the head of the radius, than elsewhere. The olecranon will be firmly fixed by the attachment of the triceps; this tendon may be divided, or the bone may be sawn through. Dupuytren practised both methods, but without any material difference in the result; most surgeons would probabably prefer to remove the whole of the bone. The operation last described was that practised by Dupuytren, excepting that he transfixed the limb at the level of the condyles, which is nearly an inch higher than is necessary, and tends to leave them uncovered afterwards. The ulnar, and radial, and probably also the interosseous arteries will require to be ligatured. M. A. Guérin recommends an *external flap*, which may be cut by transfixion of the limb on the outside of the neck of the radius; the angles of the flap to be united by an incision convex downwards, round the inner half of the circumference of the fore-arm. This would obviate all risk of protrusion of the condyles; and M. Guérin considers that it also provides a better covering for the articular surfaces. (See *Elém. de Chir. Opér.* p. 130.)

AMPUTATION OF THE ARM.

The arm, like the thigh, contains only one bone, round which the muscles are arranged. The deep muscles are attached to the humerus, while the superficial extend along the limb without being adherent to the bone. The first consist of the brachialis anticus and the two short heads of the triceps: the second of the biceps and long head of the triceps. The arm may be amputated by the circular incision or by antero-posterior or lateral flaps, at the option of the surgeon, or as the nature of the disease or injury may indicate.

Circular Operation.—The patient being placed in the recumbent position, with the shoulders raised, the arm should be separated from the side, if the disease will allow it, so as to form a right angle with the trunk of the body. A tourniquet is to be placed on the brachial artery as high as possible; or, if it be preferred, an assistant, standing behind the shoulder, makes pressure on the axillary artery with his four fingers. The skin and muscles, which are about to be divided, are to be drawn up and made tense. The surgeon, usually standing on the outside of the limb, makes a circular incision through the integument and fascia down to the muscles. There will be no necessity to dissect the skin back from the subjacent parts, unless it has become thickened and adherent from disease; under ordinary circumstances, its effectual retraction by an assistant will be found sufficient. When it has been drawn up as far as possible, the knife may be carried through all the remaining soft parts down to the bone. The superficial muscles will contract and recede upwards, but the deeper fibres are prevented doing so by their adhesion to the bone, and should therefore be divided about an inch higher up by a third circular sweep of the knife. The retractor is to be applied, the bone sawn through with the usual precautions, and the bleeding stopped in the ordinary way. The wound is then to be closed so as to form a tranverse line; the dressings are to be applied, and the patient put to bed, with the wound a little elevated from the surface of the bedding. Dupuytren recommends a circular incision to be made at once through the skin and biceps, and loose part of the triceps. The edge of the knife is then applied close to the margin of the retracted muscular fibres, and the brachialis, the rest of the triceps, &c., divided by a circular incision down to the bone, directed sometimes perpendicularly, sometimes obliquely. Lastly, the muscular fibres, closely adherent to the part of the bone above the incision, are detached from it some way upwards with a scalpel, so that the saw can be applied higher up than would otherwise be practicable. This plan combines all the quickness of a flap amputation with another advantage ascribed to the latter, namely, that of no risk of a subsequent protrusion of the bone.

Flap Operation.—The arm may be amputated with two semilunar flaps, the one anterior the other posterior. The surgeon with his left hand raises the soft parts from the front of the bone, transfixes the limb with a sharp pointed knife, and cuts an anterior flap about three inches in length; then passing the knife behind the bone, he makes a similar flap from the posterior surface. These being held back by an assistant, the muscular fibres are divided all round and the saw used. Three strokes of the knife, as M. Velpeau observes, one for each flap, and another for the division of the muscular fibres adherent to the bone, and then the use of the saw, bring the operation to a conclusion. Yet it is contended, that flap amputations of the arm are followed by more inflammation of the stump than circular ones, for which the round shape of the limb, and the moderate size of its single bone, seem admirably to adapt it. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 425.) Langenbeck, instead of making the flaps in the preceding way, by transfixion, forms two lateral ones by cutting in the opposite direction, or from below obliquely upwards, and from the skin towards the bone.

Amputation in the Upper Third of the Arm.—If the disease should require the arm to be taken off at its upper part, there would be no room for the application of the tourniquet. Here, instead of putting a compress in the axilla, and having it held firmly upon the artery by a bystander, as advised by Sabatier, it is more eligible to make pressure on the artery as it passes over the first rib; of which method I shall speak in treating of amputation at the shoulder-joint. With a straight bistoury, the surgeon is now to make a transverse incision down to the bone, a little above the lower extremity of the deltoid muscle. Two other longitudinal incisions, made along the front and back edge of this muscle, now form a flap, which must be detached, and reflected. Lastly, the rest of the soft parts of the limb are to be divided by a circular cut, made on a level with the base of the flap, and the operation finished like a common amputation. (*Sabatier, Méd. Opér.* t. iii. p. 375, &c. ed. 2.) [There is no advantage in the square shape of the flap recommended by Sabatier, it would therefore be better to employ transfixion, and to make it of the usual semicircular form.]

When the arm is injured very high up, Baron Larrey prefers amputation at the shoulder-joint to preserving a short stump, containing the upper end of the humerus: for, says he, if this bone cannot be divided at least on a level with the tendinous insertion of the deltoid, the stump is retracted towards the armpit by the pectoralis major and latissimus dorsi; the ligatures on the vessels irritate the brachial plexus of nerves; great pain, and nervous twitchings, often ending in tetanus, are produced; the stump continues swelled; and, in the end, the humerus is fixed by anchylosis to the shoulder, so that this portion of the arm remains altogether useless, and renders the patient liable to accidents. "I have seen (says Larrey) many officers and soldiers, who, on these accounts, were sorry that they had not undergone amputation at the shoulder." (*Mém. de Chir. Mil.* t. iii. p. 53, 400.)

Mr. Guthrie also states, that when amputation by the circular incision is attempted at the insertion of the pectoralis major, the bone will generally protrude after a few dressings. However, he entirely dissents from Larrey, respecting the necessity of taking off the limb at the shoulder, and prefers doing it from half an inch to an inch and a half below the tuberosities of the humerus, as the state of the injury may require. He recommends amputation here by an oval incision, similar to that presently recommended, for removal of the limb at the shoulder-joint, excepting that it should commence about two inches lower down. Without detaching the skin from the muscles, these are cut through; the soft parts are held out of the way of the saw; the bone is sawn; the vessels secured; and the flaps brought together, so as to form a line from the acromion downwards. (*Gunshot Wounds*, p. 337, &c.) I am decidedly of opinion that, in the description of cases referred to, either this method or Sabatier's operation should be preferred to the removal of the whole limb at the shoulder-joint.

[The only advantage possessed by the oval over the circular incision in this situation is that it permits the bone to be exposed at a higher level. In the circular method, it is often difficult, on account of the proximity to the trunk, to retract or reflect the skin sufficiently; the bone is therefore not sawn through high enough up, and protrusion takes place in consequence.]

Amputation at the Shoulder-Joint.

[Amputation at the shoulder-joint will be necessary in cases of severe injury to the arm from gunshot wounds, in some cases of compound fracture extending into the joint, laceration of the arm by machinery, mortification, &c., also, occasionally, in consequence of extensive disease of the humerus, and in some cases of tumors, malignant or otherwise, involving the bone or the soft parts of the arm, and extending high up in the direction of the shoulder, so as to approach near to or implicate the joint.]

Amputation at the shoulder has been partly superseded of late years by a preferable operation, even in cases in which it would formerly have been deemed indispensable, such as considerable gun-shot fractures of the head of the humerus, a caries of the substance of this part, &c. Boucher, in 1753, proved that considerable wounds, extending into the shoulder-joint, might be successfully treated by extracting the fragments and splinters of bone. (*Mém. de l'Acad. de Chir.* t. ii. p. 287 et 461.) For further information on this subject, and for the selection of cases in which the practice may be followed with advantage, see *Excision of Shoulder-joint.*

The head of the humerus represents nearly the half of a sphere, scarcely one-third of which is received by the glenoid cavity of the scapula, the rest being contained in the exceedingly loose capsule of this articulation. The articular surfaces are held together principally by the deltoid, supra-spinatus and infra-spinatus, teres minor, and subscapularis muscles. The joint is also very much strengthened by the tendon of the long head of the biceps and by the coraco-humeral ligament. Above the articulation is a kind of osseo-fibrous arch, formed by the acromion, the coracoid process, and the ligament stretched between them. This arch projects more than an inch over the glenoid cavity, and descends further in the direction backwards than in that forwards. (See *J. F. Malgaigne*, *Manuel de Méd. Opér.* p. 294.) If we examine the anatomy of the shoulder, from above downwards, we first meet with the deltoid muscle, covered by the integuments, some fibres of the platysma, and a very thin fascia. Then we come to a loose cellular tissue, the tendons of the supra-spinatus, infra-spinatus, subscapularis, and teres minor, the accessory ligament and fibrous capsule, and the tendon of the long head of the biceps. Lower down we arrive at the scapular portion of the triceps; and then the brachial plexus of nerves, the axillary vessels; and, under the skin, the pectoralis major, the latissimus dorsi, and the teres major. The apex of the acromion is very perceptible just above the cushion of the shoulder, and the coracoid process may be felt more towards the chest. Between these bony points is situated a triangular interval, useful to be recollected by the practical surgeon, bounded outwards and downwards by the head of the humerus; above by the clavicle and acromion, or rather by the coraco-acromial ligament; and inwardly by the coracoid process. This is the place where the joint may be at once cut into without any impediment from the bones; and it is on the knowledge of this fact that Lisfranc proposed one of his methods of amputating at the shoulder. When the posterior border of the axilla is reflected towards the scapula, as Velpeau observes, the knife may be made to pass below the acromion, into the superior and external part of the joint. In some persons the acromion is much more prominent than in others; and occasionally it is considerably depressed, so that its humeral aspect forms a deep concavity. In childhood it is cartilaginous; and Velpeau found it in two adult bodies separable by a very slight effort, as an epiphysis from the spine of the scapula. (*Velpeau, Nouv. Elém.* t. i. p. 428.) The course of the circumflex arteries and of the circumflex nerve; the origin and track of the tendon of the long head of the biceps, between the fibrous capsule and the synovial membrane into the bicipital groove of the humerus; the mode in which the capsule is attached to the humerus just beyond its anatomical neck; the very open angle formed by the junction of the head with the shaft of the bone; and the circular shape of its head, requiring an incision of corresponding figure for the prompt division of the fibrous capsule, — are all interesting points of surgical anatomy, without a due knowledge of which a surgeon cannot amputate at the shoulder with skill and judgment.

Whether the operation done by Laroque, in 1686, was truly an amputation at the shoulder-joint, or merely the separation of a gangrenous limb by a natural process, and a little assistance of the surgeon, may admit of dispute. I believe that H. F. Le Dran performed the first operation of this kind of which the particulars are clearly recorded. It was in a case of caries and exostosis, reaching from the middle to the neck of the humerus. Le Dran began with rendering himself master of the bleeding, for which purpose he introduced a straight needle, and a strong ligature under the artery. This was passed from the front to the back part of the arm, as closely to the axilla and bone as possible. The ligature, then, including the vessels, the flesh surrounding them, and the skin covering them, was tightened over a compress. Le Dran, with a straight narrow knife, then made a transverse incision through the skin and deltoid muscle down to the joint, and through the ligament surrounding the head of the humerus. An assistant now raised the arm, and dislocated the head of the bone from the cavity of the scapula. This allowed the knife to be passed with ease between the bone and the flesh. Le Dran then carried the knife downward, keeping its edge always somewhat inclined towards the bone. In this manner he gradually cut through all the parts, as far as a little below the ligature. As there was a large flap, Le Dran made a second ligature with a curved needle, which ligature included a great deal of flesh, the redundant portion of which was cut off together with the first ligature, which had become useless. The cure was completed in about ten weeks. (*Obs. de Chir.* t. i. p. 315, Paris, 1731; and *Traité des Opér.* p. 365.) Le Dran (the son), who published this memorable case, does not state that the operation was a new one; and it appears from the *Recherches Critiques sur l'Origine, &c. de la Chirurgie en France,* and from La Faye's notes on Dionis, that it had been previously practised by Morand the father.

Garengeot thought that the ligature might be applied by means of a curved needle, with sharp edges; and, in order to lessen the wound, he directs the incision to begin two or three finger-breadths below the acromion, across the deltoid muscle, so as to form one flap; then a lower one was made in the axilla; and after the second ligature had been applied, the two flaps were brought into contact. (*Traité des Opér. de Chir.* t. iii. p. 350; *Mém de l'Acad de Chir.* t. ii. p. 261.)

La Faye extended the improvements further. After placing the patient in a chair, and bringing the arm into a horizontal position, he made a transverse incision in the deltoid muscle down to the bone, four finger-breadths below the acromion. Two other incisions, one in front and the other behind, descended perpendicularly to this first, and made a large square flap which was detached, and turned up towards the top of the shoulder. The two heads of the biceps, the tendons of the supra-spinatus, infra-spinatus, teres minor and subscapularis, and the capsular ligament, were next divided. Now, when the assistant, who held the lower part of the limb, made the bone describe the motion of a lever, upward, the head of the bone was easily dislocated. La Faye next carried his incision downward, along the inner part of the arm, until he was able to feel the vessels, which he tied as near the axilla as possible. The separation of the limb was then completed, a finger's breadth below the ligature. The flap was then brought down over the glenoid cavity, and the wound dressed. (See *Nouvelle Méthode pour faire l'Opération de l'Amputation dans l'Articulation du Bras avec l'Omoplate, par M. La Faye,* in *Mém. de l'Acad. de Chirurgie,* t. v. p. 195, ed. in 12mo.)

The advantages of La Faye's plan are obvious. As only one ligature was applied, the patient was saved a great deal of pain: the flap connected with the acromion was capable of covering the whole surface of the wound, and was more easily applied and kept on the stump than the lowermost of the two flaps which Garengeot recommended; and the discharge found a ready outlet downwards. The amputation by external flap formed from the deltoid muscle is yet regarded as one of the most approved, where the state of the soft parts will admit of it.

In 1760, P. H. Dahl published at Gottingen a dissertation on amputation at the shoulder. In this tract a tourniquet was proposed, the pad of which was calculated to press upon the subclavian artery under the clavicle, and enabled the operator to dispense with tying the vessels in the first instance. Camper had observed, that if the scapula were pushed backward, and the axillary artery pressed with the finger between the clavicle, coracoid process, and great pectoral muscle, the pulse at the wrist might be instantly stopped.

Dahl's tourniquet was obviously constructed, in consequence of what Camper had observed. It is made of a curved elastic plate of steel, to the shortest end of which a pad is attached, capable of projecting further by means of a screw. The instrument embraces the shoulder from behind forward, while the pad presses on the hollow under the clavicle, between the margins of the deltoid and pectoral muscles. The long extremity of the steel plate, which descends behind the shoulder, is fixed to the body by a sort of belt. The pad is depressed until the pulsation of the axillary artery is stopped.

Further experience has proved, however, that this tourniquet may be dispensed with, and the flow of blood in the axillary artery commanded, by properly compressing this vessel with the end of a key covered with soft materials, or even with the fingers alone, as some operators prefer, at the place where the vessel emerges from between the scaleni muscles, above the middle part of the clavicle. Thus the artery is pressed between the pad or fingers and the first rib, across which it runs. In certain plans of operation hereafter to be described, all compression of the artery either above or below the clavicle, is dispensed with.

The principal methods of amputating at the shoulder-joint, may be comprised under four varieties; 1st, the operation with the *circular incision;* 2nd, with *one flap;* 3rd, with *two flaps;* 4th, by the *oval incision;* but it will be obvious that no mode of amputating at the shoulder can be exclusively employed in all the cases requiring the operation, because the soft parts around the joint are frequently destroyed, or very much injured, to a greater or lesser extent, so that the surgeon is obliged to save skin and muscles wherever he can find them.

Circular Method.—In 1774, Alanson amputated at the shoulder-joint, as follows:—The subclavian artery was compressed by the fingers of an assistant. An incision was made about a hand's breadth below the acromion, and carried through the integuments all round the limb. The deltoid and posterior muscles were then obliquely divided up to the capsular ligament. The tendon of the biceps, and the capsular ligament upon the anterior and posterior part of the joint, were now cut through. One of the circumflex arteries, which bled a good deal, was next tied. The great pectoral muscle, the rest of the capsule, and all the other parts, except the vessels and nerves, were then divided; but previously to cutting the vessels, a temporary ligature was put round them. Thus the separation of the limb was completed. The mouths of the vessels were drawn out and tied, and the temporary ligature taken away. Lastly, the sides of the wound were brought together, so as to make a transverse line. Graefe, seeming not to recollect that amputation by the circular incision, directed obliquely upwards, had been practised by Alanson, and even by some surgeons spoken of by Garengeot, mentions it as a new proposition. In one case, after operating in this manner, his patient was quite well in three weeks; and, with the particular sort of knife which he uses, and which is broadest towards its point, he pretends to be able to make the oblique incision through the muscles all round the limb with one sweep. He is careful to make pressure on the artery, both with Mohrenheim's compressor applied under the clavicle, and the fingers of an assistant above it. (See *Normen für die Abl. grösserer Gliedm.* p. 110, &c.) M. Cornuau and M. Velpeau have also suggested modifications of circular amputation at the shoulder. In the method of the former, the integuments, being drawn up by an assistant, are divided four inches below the acromion, and the muscles next cut through transversely by one stroke of the knife, from the coraco-brachialis to the tendon of the teres major. The muscles are then raised, the joint opened, the knife passed through it from above downwards, close to the neck of the humerus, and a second transverse incision made, which joins the extremities of the first, divides the artery, and leaves a circular wound. This would not be a disadvantageous method, were the soft parts all tolerably sound.

M. Velpeau informs us, that he has tried on the dead subject every variety of the circular method, and he believes that no other plan is more expeditious, or leaves a more regular wound, or one more disposed to union by the first intention. He prefers dissecting up, and reflecting the integuments for two inches, without meddling with the artery; and then cutting the muscles in M. Cornuau's way, as close as possible to the joint through which the knife is to be carried; and finally, the triceps divided, together with the artery, which is first to be taken hold of by an assistant. (See *Velpeau, Nouv. Elém.* t. i. p. 430.)

External Flap.—The formation of an external flap of square shape from the deltoid muscle, as recommended by La Faye, has already been described, and this was the plan which I adopted after the battle of Waterloo, excepting that I did not cut the brachial artery till I had made the last stroke of the knife, which separated the limb, and consequently I did not tie that vessel till the time when I had nothing but the hemorrhage to occupy my attention. The circumflex arteries I tied as soon as the external flap was made.

Richerand describes nearly the same plan as that advised by La Faye, and he seems to have been one of the first to dispense with compression of the axillary artery, for instance, after making the deltoid flap, cutting the tendons, and dislocating the bone, he dissects down close to the inside of the humerus, so as to enable an intelligent assistant to put his thumb on the cut surface behind the artery, which, with the aid of the fingers, applied to the skin of the axilla, can then be grasped and compressed, so as to command the flow of blood through the vessel. The operator now, fearless of hemorrhage, completes the internal or inferior flap. (*Richerand, Nosographie Chir.* t. iv. p. 509—511, edit. 4.)

Baron Dupuytren made a semicircular flap from the deltoid muscle by transfixion. The arm being raised and held at a right angle with the trunk, Dupuytren stood at the inside of the limb, with one hand grasped and elevated the mass of the deltoid muscle, and plunged under it a two-edged knife, from before backward, on a level with the end of the acromion. Cutting in this way close to the head of the humerus, he continued the incision downward between this bone and the deltoid, and, at length bringing out the knife, completed the external or superior flap. The rest of the operation did not essentially differ from Richerand's, except that Dupuytren took hold of the lower flap himself, before dividing it, and compressed the artery, until he had cut through it and tied it.

Instead of transfixing, the surgeon may form a flap of this shape by incision from without inwards, after which the soft parts can be dissected from below upwards, towards the joint.

Anterior and Posterior Flaps.— Desault recommended the formation of two flaps, one of which was anterior, the other posterior. The axillary artery was compressed from above the clavicle, at its coming out from between the scaleni muscles, whilst the integuments and flesh of the upper and internal part of the arm were pushed away from the humerus. A knife was plunged between these and the other soft parts behind, to make the anterior flap. The arm being inclined backward and outward, the humeral artery was tied, the articulation opened, and the head of the bone dislocated. The knife was then carried downward and backward, so as to form the posterior flap, the incisions meeting in the axilla. (See *Sabatier, Méd. Opér.* t. iii. p. 393—399, ed. 2.)

Larrey, who had frequent opportunities of amputating at the shoulder-joint, aimed at the same object which Desault did; but, in his earlier operations, he was in the habit of beginning with the formation of the external or posterior flap, for the following reason: by proceeding in this way, the surgeon can tie the humeral artery more safely, because the ligature is applied after the operation is entirely finished, and consequently at a time when there is nothing to be attended to but the hemorrhage. Thus, the patient being placed on a stool, and well supported, the arm is to be raised from the side, and the axillary artery compressed from above the clavicle. The integuments and other soft parts of the upper and outer portion of the arm are then to be pushed away from the humerus, and the posterior flap formed. It is now very easy to cut the tendons of the infra-spinatus and teres minor, and open the outside of the joint. The limb is to be carried inward, and luxated backward. The tendons of the supra-spinatus and biceps are to be divided; and as soon as the head of the bone is out of the glenoid cavity, the knife is to be carried along the internal part of the head and neck of the humerus, with its edge close to the bone. An anterior flap, equal to the posterior one, is to be formed, consisting of a portion of the deltoid, great pectoral, biceps, and coraco-brachialis muscles, and including the brachial vessels and nerves. The artery is to be taken hold of with a pair of forceps, and tied. Any other vessels which require a ligature are also now to be secured. (See *Mém. de Chir. Militaire*, t. ii. p. 170.)

When Larrey published his campaign in Egypt, he had operated in this way on nineteen patients, thirteen of whom recovered. But, at a subsequent period, he and his colleagues had amputated at the shoulder in upwards of a hundred cases, more than ninety of which recovered. (*Mém de Chir. Mil.* t. iv. p. 432, 8vo. Paris, 1817.)

In Dupuytren's second method, which he preferred, whenever the state of the soft parts admitted of it, he formed an anterior and a posterior flap. The arm being raised to a right angle with the trunk, the heel of the interosseous knife or catlin, is placed below and a little in front of the acromion. Thence the operator cuts with a firm hand, and by one stroke, all the soft parts at the back of the shoulder down to the posterior border of the axilla. The flap being raised, exposes the back of the articulation. The elbow is now carried to the front of the chest, so as to make the head of the humerus prominent, and the tendons and capsule are divided upon it. The bone having been disarticulated, the knife is carried round its head from behind forwards, is conveyed from above downwards along the anterior surface of the humerus, so as to form the second flap, the detachment of which is completed as soon as an assistant has taken hold of its base, and compressed the artery included in it between his finger and thumb. Unless the surgeon were an ambidexter, he should stand in front of the patient in operating on the left shoulder, and commence with the anterior flap. Dupuytren regarded this last method as particularly advantageous. The two flaps extend in the direction of the longest diameter of the wound, and can be brought together with exactness and facility. The ligatures, twisted into a single cord, and brought out downwards, form a kind of conductor for the purulent matter outward. The cicatrix resulting from the operation is linear, and promptly formed, with less risk of axillary abscesses than after the other method. (See *Leçons Orales de Clin. Chir.* t. iv. p. 326.) These observations are subject to the consideration, that, when the patient is put to bed after the removal of the arm at the shoulder, the most depending point of the wound may be in some degree regulated by the position in which he lies. If an anterior and posterior flap were formed, he should lie with his chest raised forwards ; if a flap had been formed above, and the line of the wound were transverse, he should be placed with the shoulder less elevated.

Another plan of amputating at the shoulder has been proposed by Lisfranc. Supposing the left extremity is to be removed, the patient is placed on an elevated seat, one assistant pressing the artery against the first rib, whilst another draws the arm forwards ; the operator, standing behind the patient with a long-bladed catlin, pierces the integuments on the inner edge of the latissimus dorsi muscle, opposite the middle of the axilla, and pushes it obliquely upwards and forwards, till its point strikes against the under surface of the acromion ; then, by raising the handle of the knife, its point is lowered, and protruded just in front of the clavicle at its junction with the acromion. By cutting downwards and outwards, he then forms a flap from the superior and posterior part of the arm, including the whole breadth of the deltoid muscle, and a part of the latissimus dorsi, dividing also the tendons inserted into the great tuberosity, and opening the capsule by the same stroke. This flap being held back by the assistant, the joint is cut through from behind forwards, and a corresponding flap is formed by cutting downwards and outwards, between the muscles and bone, on the inner side of the arm. When the operation is on the right side, the patient should be seated on a low chair, and the catlin thrust from above downwards, from the part just in front of the point where the clavicle is connected with the acromion, the surgeon raising his hand as the instrument proceeds downwards and backwards, until its point has come out at the inner edge of the latissimus dorsi, when the flap is to be made, and the operation finished as above directed. (See *Averill's Operative Surgery*, p. 135. Also *Lisfranc de St. Martin, et Champesme, Nouveau Procédé Opératoire pour l'amputation du bras dans son articulation scapulo-humérale.* Paris, 1815.) [This method is very rapid and brilliant when well performed, but it requires a practised hand and considerable dexterity to prevent the knife becoming fixed between the head of the humerus and the acromion. This embarrassment is all the more likely to occur if the acromion is prominent, and especially if it projects forwards over the shoulder more than usual, which is sometimes the case.]

Oval Incision.—Mr. Guthrie, who was one of the first to recommend this mode of operation, commences the first incision immediately below the acromion, and, with a gentle curve, extends it downwards and inwards, through the integuments only a little below the anterior fold of the armpit. The second incision outwards is made after the same manner; but is carried rather further down, so as to expose the long head of the triceps at the under edge of the deltoid. The third incision, commencing at the same spot as the first, but following the margin of the retracted skin, divides the deltoid on that side down to the bone, and exposes the insertion of the pectoralis major, which must be cut through. This flap is now to be raised, so as to expose the head of the bone. The fourth incision outwards divides the deltoid muscle down to the bone, when the posterior flap is to be well turned back, so as to bring into view the teres minor and infra-spinatus passing from the scapula to the great tuberosity of the humerus. The outer and inner flap being now raised, the head of the bone may be rolled a little outwards, the teres minor and infra-spinatus cut, and an opening made into the joint. The capsular ligament, supra-spinatus, and long head of the biceps are then divided. The inner side of the capsule is now cut through, together with the subscapularis muscle, as it approaches its insertion into the lesser tuberosity of the humerus. The long head of the triceps is next divided; and, lastly with one sweep of the knife, the rest of the soft parts are cut, together with the axillary artery, veins, and nerve. (*On Gunshot Wounds*, p. 274—276.)

The plan adopted by Larrey in his latter operations, produces a result essentially similar to that just described. Larrey first makes a longitudinal incision from the acromion to about an inch below the neck of the humerus, down to the bone, so as to divide the fleshy part of the deltoid into two even parts. This cut, he says, facilitates and renders more exact the rest of the operation. From this wound, the incisions for the flaps are continued. Having made the foregoing incision, " I direct an assistant to draw up the skin of the arm towards the shoulder, and I form the anterior and posterior flaps by two oblique strokes of the knife made from within outwards and downwards, so as to cut through the tendons of the pectoralis major and latissimus dorsi. There is no risk of injuring the axillary vessels, as they are out of the reach of the point of the knife. The cellular connections of these two flaps are to be divided, and the flaps themselves raised by an assistant, who, at the same time, is to compress the two divided circumflex arteries. The whole joint is now exposed. By a third sweep of the knife, carried circularly over the head of the humerus, the capsule and tendons running near the articulation are cut; and the head of the bone being inclined a little outwards, the knife is to be carried along its posterior part, in order to finish the section of the tendinous and ligamentous attachments in that direction. The assistant now applies his forefingers over the brachial plexus, for the purpose of compressing the artery, and commanding the current of blood through it. Lastly, the edge of the knife is turned backwards, and the whole fasciculus of axillary vessels is cut through, on a level with the lower angles of the two flaps, and in front of the assistant's fingers. The patient does not lose a drop of blood; and ere the compression is remitted, the extremity of the axillary artery is readily seen, taken up with a pair of forceps, and tied. The circumflex arteries are next secured, which completes the operation." (*Mém. de Chir. Mil.* t. iv. p. 428. Paris, 1817.)

Larrey takes no measures in the first stage of the operation for commanding the flow of blood, as the assistant merely presses the axillary artery between his fingers just before it is divided.

Larrey affirms, that the above described way of operating is applicable to almost every case met with in military practice. First, because all gunshot wounds, generally, which mutilate the arm, so as to create the necessity for the operation, partly, or entirely destroy the centre of the deltoid, while there is always enough flesh left at the sides for making the two flaps. Secondly, because, in the very rare instances where the lateral parts of the shoulder are destroyed, and the middle untouched, no advantage would be gained by operating in La Faye's manner, as Larrey conceives that the detached flap would slough, or become, as he terms it, disorganised. He now prefers dividing the middle piece of flesh, and giving the flaps the same shape as if they were uninjured. He even asserts, that the operation, done without any flaps at all, answers better than any method in which the surgeon preserves flaps not naturally intended for the part. Thus, when all the flesh of the shoulder has been shot away, he has seen surgeons cover the glenoid cavity with a flap saved from the soft parts of the axilla; but such flaps invariably sloughed, hemorrhages ensued, and the patients died. (P. 430, 431.) Some of these latter observations are, clearly enough, the result of great partiality to a particular method of operating; because who can doubt, when the lateral parts of the shoulder are injured, as they frequently are (and not very rarely, as Larrey asserts), by the passage of a musket-ball through the shoulder, from before backwards, that the right method is that of La Faye; or the same operation, with the slight difference of making the flap of a semicircular shape? It was for cases of this description that Mr. Collier and the author of this Dictionary operated after La Faye's plan, with perfect success, after the battle of Waterloo: and a poor fellow of the rifle brigade, who was brought in too late for operation, and died of sloughing, had his shoulder injured in the same way, the middle of the deltoid being untouched, and shot-holes existing behind, and in front of, the articulation. The cases which have fallen under my own personal observation, and numerous others on record, furnish an adequate proof, that, excellent as Larrey's method is for many cases, La Faye's answers very well in others. After the storming of St. Sebastian, nine shoulder-joint amputations were done with success; seven of them by raising the deltoid as a flap. (See *Guthrie on Gunshot Wounds*, p. 108.)

The oval operation is described by M. Scoutteten, for the left arm, as follows: —The surgeon first takes hold of the middle of the arm with his left hand, and raises it four or five inches from the side. With his right hand he then applies the point of the scalpel immediately below the acromion, and passes it into the flesh until it touches the head of the humerus. He then depresses the handle, and forms the first incision, which extends downwards four inches from the point of the acromion, and divides the posterior third of the deltoid, and the greater part of the fibres of the long portion of the triceps down to the bone. The second incision is next commenced with the point of the knife directed downwards upon the inner side of the limb, and in front of the biceps, on a level with the place where the first incision ended. The wound is then extended inwards and upwards to the acromion, where it terminates by joining the first. These two wounds form a triangle, which partly consists of relinquished integuments, and has its base downwards.

In order to find the joint with greater ease, the surgeon may now detach a little of the deltoid from the bone. An assistant can also keep the edges of the incision asunder, so that the operator may be enabled to see and divide the capsular ligament and the tendons of the supra-spinatus, infra-spinatus, and teres minor, which are inserted into the greater tubercle of the humerus, and the tendon of the subscapularis, which is inserted into the lesser tubercle. The operator, who constantly keeps hold of the arm, now communicates to it some rotatory movements, in order to bring the above tendons, one after another, under the knife, and divide them with the capsule. Immediately the capsule and tendons have been cut through, the head of the bone readily quits its socket. The surgeon luxates the bone by pushing it a little upwards, and, at the same moment, inclining the condyles towards the side. The next proceeding is to divide the flesh on the inner side of the limb, as closely as possible down to the bone ; but, when the knife approaches the artery, this vessel is to be taken hold of and compressed by an assistant, before the incision is completed. In this way, no hemorrhage need be apprehended.

When it is the right limb, the only difference is, that the first incision is made at the inner side of the arm, and extended up to the acromion. Scoutteten considers a single assistant sufficient, and compression of the subclavian artery unnecessary. (*H. Scoutteten, La Méthode Ovalaire, ou Nouvelle Méthode pour amputer dans les Articulations.* Paris, 1827, 4to.)

[With respect to the choice between the different methods of amputation proposed for the shoulder-joint, it is scarcely necessary to repeat, that no one operation can be employed exclusively in all cases, but the selection must be influenced by the state in which the soft parts are found in each particular instance; for example, when the tissues on the outside of the joint are much injured, a flap from the deltoid would be impossible, and anterior and posterior flaps, or Larrey's or Guthrie's oval incisions must be resorted to instead. On the other hand, when a musket-ball has passed through the shoulder so as to injure the parts in front and behind, the operations just alluded to must give place to the external flap formed from the deltoid muscle, as recommended by La Faye, Dupuytren, &c.

The double flaps and the oval incisions have the advantage of leaving a smaller cicatrix, which forms merely a single vertical line of wound, and is less extensive than after the single flap operation, where it is either square or semicircular in outline. The circular operation is more difficult of performance than the other methods, and, notwithstanding the recommendation of M. Velpeau, is very rarely practised. In cases of tumors of the arm requiring amputation at the shoulder, the oval incision will be found most convenient, as the disease which necessitates the operation will almost always extend too high to admit of the formation of flaps by transfixion. In a case of extensive disease of the humerus, in which the tumor was equal in size to the trunk of the patient's body, the present editor removed the limb, with great facility, by incisions of this kind, and notwithstanding the magnitude of the disease, the wound healed by first intention, and left a very small cicatrix.]

When the scapula is shattered, of course the loose fragments should be taken away ; and, if the acromion be broken, and the remnant of it pointed and irregular, this sharp rough portion should be sawn off, as was practised long ago by M. Faure. (See *Mém. de l'Acad. de Chir.* t. vi. p. 114.) In one case, indeed, Larrey found it necessary to take away more than two thirds of the scapula, and the humeral end of the clavicle. (*Mém. de Chir. Mil.* t. iv. p. 432.) Sawing off part of the acromion, and coracoid process, as a general rule, seems to me quite unnecessary and improper, not only as producing delay, but wounding other parts which should not be at all disturbed. (See *Guthrie on Gunshot Wounds*, p. 285, 286, &c.) The practice of scraping away the cartilage of the glenoid cavity, except when it is diseased, is not of greater value.

[Cases have occurred in which it was necessary to remove the *whole* of the scapula with the upper extremity. This was done successfully by Mr. Cuming in 1808, at Antigua, in a case of gunshot wound. In 1830, Gaetani Bey, at Cairo, removed the whole of the scapula and half of the clavicle in a boy fourteen years of age. The case was one of extensive injury ; after amputation at the glenoid cavity the scapula being much shattered was cut away, and then the clavicle, being found to project too much, was partially removed. The patient recovered. (See *Fergusson, Op. Surg.* p. 338.) In 1844, M. Rigaud of Strasbourg, removed the entire scapula, with the external extremity of the clavicle, with complete success, in a soldier aged 51, for an osseous tumor on the anterior angle of the left scapula. In this case the arm had been removed at the shoulder-joint eight months previously for a tumor on its upper portion. (See *Velpeau, El. de Méd. Opér.* vol. ii. p. 471, Mott's Translation.) Several cases also are recorded of recovery taking place after the arm with the scapula had been completely torn away by machinery. (*Fergusson*, loc. cit., and *Ed. Med. Journ.* Feb. 1845.)]

LOWER EXTREMITY.

[Amputation of the Toes.]

[Amputation of the phalanges of the toes may be performed in the same way as in the fingers.

Amputation of the toes at the metatarso-phalangeal joints may also be performed, as in the fingers, either with *lateral flaps*, or by the *oval method*.

In the *great toe* the large size of the head of the metatarsal bone should be remembered, or the operator may find that he has not left sufficient skin to cover it without an undue tension of the flaps. In this joint *upper and under flaps* will be found to answer remarkably well, and the thick pad of skin under the ball of the great toe will then be preserved uninjured. A method suggested by Mr. Skey produces a very similar result. He makes a longitudinal incision along the inner side of the toe, commencing about half an inch behind the articulation, and carried onwards to the middle of the first phalanx. At the end of this line he makes a circular incision round the toe down to the bone and then reflects back the integuments. (*Op. Surg.* p. 378.) The head of the metatarsal bone when implicated in the disease or injury should be removed with the saw or with the cutting forceps. If this is to be done, the incision may commence a little more posteriorly, but the head of the bone should always be retained if possible, as it forms the principal point of support at the anterior part of the foot.

All the toes may be separated from their metatarsal bones by a proceeding similar to that recommended for the fingers.]

[Amputation of the Toes together with their Metatarsal Bones.]

[*The great toe with its metatarsal bone* may be removed by the oval incision recommended for the thumb or little finger. The point of the oval should commence half an inch behind the joint, or it will be difficult to disarticulate the metatarsal bone from the internal cuneiform without notching the skin. To avoid this inconvenience M. A. Guérin suggests that an incision should be made from the point of the oval downwards towards the inner margin of the sole of the foot, and over the articulation, thus forming an angular flap which may be turned down. (*Chir. Opér.* p. 146.)

In this operation it will be necessary to bear in mind that the base of this metatarsal bone has a tubercle projecting downwards in the sole of the foot, and that this tubercle receives the insertion of the peroneus longus tendon.

The fifth toe with its metatarsal bone, may be disarticulated by a like method from the cuboid. The joint between these bones has an oblique direction forwards and inwards across the foot, and the base of the metatarsal bone has a large tubercle projecting backwards beyond it which may be very readily felt along the outer margin of the foot. This tubercle receives the insertion of the peroneus brevis tendon; the point of the knife should be passed behind it and then carried obliquely forwards, so as to divide the tendon and enter the joint.

The first and second toes with their metatarsal bones may be removed together; and so also may the fourth and fifth, or perhaps even the third, fourth and fifth; but if more than these should require to be taken away, it would be better to amputate across the foot at the tarso-metatarsal joints.]

AMPUTATION AT THE TARSO METATARSAL ARTICULATIONS.

Mr. Hey proposed a new mode of removing the metatarsal bones, which on repeated trial fully answered his expectations. By the term *new*, I here mean a particular method, which had not been previously described, though it may have been performed by others sooner than by Mr. Hey himself; for the merit of having first done it is imputed to the late Mr. Turner, of North Yarmouth, who did it with success about the year 1787. (See *Hutchison's Prac. Obs.* p. 70.) On the first entrance of the French army into Holland after the revolution, Paroisse met with many cases in which the toes, and more or less of the foot were attacked with mortification from cold. Here he found it sufficient merely to take away the diseased portion of the foot, and all the patients operated upon in this manner were cured; walking afterwards with more or less difficulty, according as the portion of the foot taken away had been greater or smaller. (*Opuscules de Chir.* p. 218.)

Mr. Hey made a mark across the upper part of the foot, to denote where the metatarsal bones are joined to those of the tarsus. About half an inch from this mark, nearer the toes, he made a transverse incision, through the integuments and muscles covering the metatarsal bones. From each extremity of this cut, he made an incision along the inner and outer side of the foot to the toes: he removed all the toes from the metatarsal bones, and then separated the integuments and muscles forming the sole of the foot, from the inferior part of the metatarsal bones, keeping the edge of the knife as near the bones as possible, in order to expedite the operation, and preserve as much muscular flesh in the flap as could be saved. He then separated the four smaller metatarsal bones, at their junction with the tarsus, and divided with a saw the projecting part of the first cuneiform bone, which supports the great toe. The arteries being tied, Mr. Hey applied the flap, which had formed the sole of the foot, to the integuments which remained at the upper part, and kept them in contact with sutures. The cicatrix being situated at the top of the foot, is in no danger of being hurt; while the place, where the toes were situated, is covered with such strong skin, viz. what previously formed the sole of the foot, that it cannot be injured by any moderate violence. (See *Practical Observations in Surgery*, p. 535, &c.)

[Lisfranc, who gave very minute instructions for the performance of this operation, did not saw off the internal cuneiform bone, nor is it usual to do so in the present day; but the first metatarsal bone is separated, like the others, at its line of union with the tarsus. Before attempting this operation, the surgeon must make himself thoroughly acquainted with the anatomy of the tarso-metatarsal joints, which are very closely and firmly held together by ligaments, so that very little movement is permitted to them.

The general direction of the articulation is convex towards the toes, but it is also oblique forwards and inwards across the foot. This should be remembered in making the first incision, which should be slightly convex, and should have a corresponding obliquity instead of being transverse as recommended by Mr. Hey. Before making this incision the operator should determine to his satisfaction the points opposite to which the articulation commences, both on the inner and on the outer side of the foot. On the outer side he will have no difficulty in recognising the tubercle of the fifth metatarsal bone, but on the inner side there is no equally evident projection belonging to the first metatarsal; he might, therefore, unless he were well acquainted with the anatomy of these joints, fall into the error of opening the articulation between the scaphoid and cuneiform bones, instead of that between the cuneiform and first metatarsal. The principal prominence along the inner margin of the foot belongs to the tuberosity of the scaphoid bone, the joint between the metatarsal bone and the internal cuneiform is an inch and a quarter or an inch and a half in front of this prominence.

The outline of these articulations is very irregular in consequence of the manner in which the second metatarsal bone projects backwards and is wedged in between the three cuneiform bones. This point should be specially noticed, as it constitutes the chief difficulty in disarticulating the bones. There are very strong ligaments in the sole of the foot binding the bones together, passing both in a transverse and longitudinal direction, and the tendon of the peroneus longus crosses the sole of the foot to be inserted into the base of the first metatarsal bone. The French surgeons describe an interosseous ligament passing from the outer surface of the internal cuneiform to the base of the second and third metatarsal bones, and Lisfranc believed this ligament to be the principal obstacle in separating the bones. He recommended, therefore, that the point of the knife should be thrust downwards towards the sole of the foot, between the internal cuneiform and second metatarsal bones so as to divide this ligament, immediately after the joint had been opened above. This plan is not generally recommended by English writers, probably from fear that the point of the knife might pass too far into the sole of the foot, and injure vessels at a distance from the surface of the wound and beyond the reach of a ligature. A little practice on the dead subject will enable the surgeon to separate the bones with tolerable facility without resorting to this expedient. The plantar flap should be large; it should extend forwards on the inner side nearly to the root of the great toe, but it need not be quite so long towards the outer border of the foot.

In cutting this flap from within outwards after he has separated the joints, (which is the plan usually recommended,) the operator will find it difficult to make it of the exact shape required, and to give it an even and regular edge. He may avoid this difficulty by making an incision through the integuments of the sole to determine the outline of the flap, at the commencement of the operation.

To avoid the difficulties connected with the disarticulation of the second metatarsal bone, Mr. Skey suggests that it should be divided with the cutting forceps, and its posterior extremity be allowed to remain. (*Op. Surg.* p. 376.) M. Baudens has proposed that the first metatarsal bone only should be separated at the joint, the four others being sawn off in a transverse line at the level of the internal cuneiform bone. (*Bourgéry, Méd. Opér.* t. i. p. 267.)

Any additional length which can be given to the foot will be of the greatest advantage to the patient; it should therefore be understood that in any case which would admit of the preservation of the posterior half or posterior third of the metatarsal bones, amputation in the continuity of these bones should always be preferred to their disarticulation.]

Amputation through the Mediotarsal Articulations, or Chopart's Operation.

The method of removing a part of the foot at the junction of the two halves of the tarsus, or Chopart's operation, is one of considerable merit. It is performed in the nearly parallel articulations of the os calcis with the os cuboides, and of the astragalus with the os naviculare. Thus the heel is preserved, on which the patient can afterwards walk. The performance of it is simple. The tourniquet having been applied, the surgeon is to make a transverse incision through the skin which covers the instep, two inches from the ankle joint. He is to divide the skin, and the extensor tendons and muscles, in that situation, so as to expose the convexity of the tarsus. He is next to make on each side a small longitudinal incision, which is to begin below and a little in front of the malleolus, and is to end at one of the extremities of the first incision. After having formed in this way a flap of integuments, he is to let it be drawn upward by the assistant who holds the leg. There is no occasion to dissect and reflect the flap; for the cellular substance connecting the skin with the subjacent aponeurosis is so loose, that it can easily be drawn up above the place where the joint of the calcaneum with the cuboides, and that between the astragalus and scaphoides, ought to be opened. The surgeon will penetrate the last most easily, particularly by taking for his guidance the eminence, which indicates the attachment of the tibialis posticus muscle to the inside of the os naviculare. The joint of the os cuboides and os calcis lies pretty nearly in the same transverse line, but rather obliquely forward. The ligaments having been cut, the foot falls back. The bistoury is then to be put down, and the straight knife used, with which a flap of the soft parts is to be formed under the tarsus and metatarsus, long enough to admit of being applied to the naked bones so as entirely to cover them. It is to be maintained in this position with three or four sutures and strips of adhesive plaster, which are to extend from the heel, over the flap, to the inferior and anterior part of the leg. On the instep, the continuation of the anterior tibial artery will require a ligature; and in the sole, the internal and external plantar arteries, in the thickness of the flap of soft parts, must generally be taken up. I have seen several patients who had undergone Chopart's operation, and afterwards walked exceedingly well. A black man was lately shown to me by my friend, Mr. Copland Hutchison, who had performed the operation; and in reality scarcely any limping was perceptible. I mention these facts, because Dupuytren may have expressed himself rather too strongly against Chopart's operation, when he says, that the removal of a part of the tarsus deprives the patient of a point of support essential in walking and standing, and renders the limb nearly useless. He asserts likewise, that, as the attachments of the tibialis anticus and tibialis posticus, the antagonists of the gastro cnemius and soleus, are divided, the heel becomes drawn considerably upwards.

[The operation is still practised very much in the manner just described, excepting that the superior incision is commonly made slightly convex and not square in shape. It should commence on each side near the margins of the sole of the foot and a little in front of the articulations. On the inner side of the foot the tuberosity of the scaphoid forms a sure guide to the joint between that bone and the astragalus, while on the outer side the joint between the cuboid bone and the os calcis will be found with tolerable certainty three-quarters of an inch behind the prominence of the fifth metatarsal bone. Should the condition of the parts in the sole not permit the formation of a sufficient flap from that region, part of the covering might be obtained from the dorsal surface of the foot; but the large flap from the sole is much to be preferred, because it removes the cicatrix from the lower end of the stump, where it is most exposed to injury. Some surgeons saw off a thin slice of the astragalus and os calcis. M. Malgaigne, with more reason, thinks it advisable to remove the projecting anterior and external angle of the os calcis, which rests on the ground when the heel is retracted, and causes painful pressure upon the flap. He is doubtful even whether, on account of this tendency to retraction, it would not be always preferable to take away the os calcis and leave only the astragalus. (*Méd. Opér.* p. 310.)

The retraction of the heel by the unopposed action of the muscles of the calf is no doubt one of the principal objections to this operation. Mr. Fergusson relates one case, where he found it necessary, principally on account of this retraction, to amputate a second time at the ankle joint. (See *Pract. Surg.* p. 487.) Nevertheless, excellent stumps do frequently result from Chopart's operation, and if any tendency to retraction of the heel should become manifest during the progress of the cure, it may be prevented by the subcutaneous section of the tendo achillis. This expedient has been frequently resorted to, and with perfect success. The retraction of the heel is spoken of by M. Velpeau as an exceptional occurrence; he states that it did not occur in any of the cases (five in number) operated on by him; and M. Blandin says that he met with it but once out of the eleven of these amputations which he has performed. The case above alluded to was also the only instance of painful stump, after Chopart's operation, which Mr. Fergusson has met with.

Cases sometimes occur in which the scaphoid bone can be preserved; others in which both scaphoid and cuboid can be retained. For these it is almost impossible to lay down rules with precision, but the necessary modifications in the incisions will suggest themselves to every intelligent surgeon.

Mr. Syme objects to partial amputations through the tarsus in cases of caries, on account of the liability to recurrence of the disease in those bones which remain, although they may appear perfectly sound at the time of the operation. He states that he once performed three secondary amputations, within a period of twelve months, upon stumps in which Chopart's operation had been practised. (*Lancet*, vol. i. 1855, p. 307.) This objection, does not hold good in cases of injury, in which these partial amputations through the foot have, perhaps, their most valuable application.]

[Amputation at the Ankle-Joint.]

[In cases of caries of the tarsal bones, beyond the limits of Chopart's operation, and in many cases of injury to the foot, amputation at the ankle-joint is now performed.

This amputation has during the last fifteen years been brought prominently into notice by Mr. Syme, and the name of this gentleman is now very commonly associated with it. Previously to this, it had been practised occasionally by continental surgeons; in the last century by Sedillier, Rossi, and others, and in the present century by M. Baudens; so little, however, was it thought of, that in former editions of this work, it was passed over altogether without notice.

The principal novel feature in the method adopted by Mr. Syme, was the procuring a flap "from the sole of the foot and thick integument of the heel, so that the dense textures provided by nature for supporting the weight of the body, might be still employed for the same purpose."

Previous to this, the thin skin from the sides of the joint or from the instep, had been made use of to form the flaps, and, consequently, the stump was not well adapted to bear continuous pressure. Originally too the malleoli were allowed to remain, so that it is not surprising that the results were unsatisfactory. The removal of the malleoli was first suggested by M. Baudens ; but in his operations the flap was cut in the form of a gaiter from the skin on the dorsum of the foot, and was turned downwards over the ends of the bones. The delicate integument from the dorsum of the foot was not likely to answer well as a covering for a stump, which must necessarily have to bear the whole weight of the body.

The following is Mr. Syme's account of his first operation, Sept. 8, 1842, on a patient aged sixteen, with caries of the tarsal bones. "I cut across the integuments of the instep in a curved direction, with the convexity towards the toes, and then across the sole of the foot, so that the incisions were nearly opposite to each other. The flaps thus formed were next separated from their subjacent connections, which was easily effected, except at the heel where the firmness of the texture occasioned a little difficulty. The disarticulation being then readily completed, the malleolar projections were removed by means of cutting pliers. The patient suffered no constitutional disturbance or alarming symptom after the operation. A small slough separated from the edge of the lower flap, in which, as well as the upper one, I found it necessary, during the healing process, to make a counter opening for the free discharge of matter." The patient left the hospital on the 2nd December. The wound was soundly healed ; "and any degree of pressure could be borne by the stump, which had a round form well suited for the adaptation of a boot or artificial foot, and was strongly protected from external injury by its thick integuments." (*Lond. and Ed. Month. Journ.* Feb. 1843).

In 1844, Mr. Syme published the following further directions, having found that in his first operations, the flap was made unnecessarily long. "The incisions across the instep and sole of the foot should be curved, the convexity forwards, and exactly opposite each other. A line drawn round the foot, midway between the head of the fifth metatarsal bone and the malleolus externus, will show their extent anteriorly, and they should meet a little further back, opposite the malleolar projections of the tibia and fibula. Care should be taken to avoid cutting the posterior tibial artery before it divides into its plantar branches, as in two cases where I did so there was partial sloughing of the flap. If the ankle-joint is sound, the malleolar processes should be removed with cutting pliers, but if the articular surfaces of the tibia and fibula be diseased, a thin slice of these bones should be sawn off. The edges of the wound should be stitched together and lightly dressed. When the cure is completed, the stump has a conical shape, and has for its apex or central point of pressure, the thick integument which covered the heel." (*Edin. Med. Journ.* Aug. 1844.)

Subsequently to this he again slightly modified his incisions so as further to reduce the size of the flap. "The foot being placed at a right angle with the leg, a line drawn from the centre of one malleolus to that of the other, directly across the sole of the foot, will show the proper extent of the posterior flap. The knife should be entered close up to the fibular malleolus, and carried to a point on the same level on the opposite side, which will be a little below the tibial malleolus. The anterior incisions should join the two points just mentioned at an angle of 45° to the sole of the foot and long axis of the leg. In dissecting the posterior flap, the operator should place the fingers of his left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and the tuberosity of the os calcis, so as to avoid lacerating the soft parts, which he, at the same time, gently, but steadily presses back, until he exposes and divides the tendo achillis. The foot should be disarticulated before the malleolar projections are removed, which it is always proper to do, and which may be most easily effected by passing a knife round the exposed extremities of the bones, and then sawing off a thin slice of the tibia connecting the two processes." (*Ed. Monthly Journ.* 1846.)

"It is of the greatest importance in separating the flap of skin fromthe os calcis, to cut parallel to the bone, since when the flap is detached from the bone, its only supply of nourishment must be the branches which run through it parallel to its surface, and if instead of keeping parallel to the surface, the operator cuts on the flap, he will by scoring it in this way necessarily cut across these branches." Very light dressings should be used for the first few days, as it is important to avoid as much as possible the application of pressure ; "tight bandaging would of itself be sufficient to kill the flap." (See *Lancet*, vol. i. 1855, p. 307.) Mr. Syme insists that the flap should be completely separated from the os calcis before the joint is disarticulated; he strongly disapproves of the plan which some have adopted of first cutting through the joint, and then dissecting the flap from behind forward off the os calcis, believing that the vessels are more likely to be injured by so doing.

Some modifications in the operative procedure have been since suggested. Mr. Quain, in order to facilitate the dissection of the flap, proposes, "after the incision from malleolus to malleolus under the os calcis, to make a straight incision at right angles with the first, to the back part of the heel on the outer side of the foot, a little above and parallel with its outer margin." (See *Med. Times*, Oct. 10, 1857, p. 370.) Dr. Handyside has suggested "antero-lateral flaps," the incisions commencing in front of the joint and terminating in the centre of the sole of the foot, just in front of the ball of the heel. The cicatrix would be vertical in direction and placed anteriorly. The thick integument of the heel would still form the basis of support. The late Dr. R. J. Mackenzie proposed to form an internal lateral flap in the following manner:—"The point of the knife is entered in the mesial line of the posterior surface of the ankle on a level with the articulation, carried down obliquely across the tendo Achillis towards the external border of the plantar surface of the heel, along which it is continued in a semilunar direction. The incision is then curved inwards across the sole of the foot, and terminates on the inner side of the tendon of the tibialis anticus, about an inch in front of the inner malleolus. The second incision is carried across the outer aspect of the ankle in a semilunar direction between the extremities of the first incision, the convexity downwards, and passing half an inch below the external malleolus. The flap is now dissected up, care being taken that the knife cuts close to the bones, so as to preserve the whole thickness of the soft parts. By holding the base of the flap between the fingers and thumb, as it is detached from the bones, all risk of wounding the artery is avoided. The foot is then severed at the articulation, and the ends of the tibia and fibula cleared, so as to allow of the application of the saw, by which a thin slice of the extremities of the bones is removed, as in Syme's operation. The stump which is left differs from that formed by Syme's operation only in the situation of the cicatrix, which is here on the fibular side of the stump. With an artificial foot, the patients are able to walk with ease, and with slightly perceptible lameness, the weight of the body resting on the face of the stump." (*Ed. Monthly Journal*, Aug. 1849.) Dr. Mackenzie had operated in this way twice, and Dr. Maclagan three times, with satisfactory results, but in one case in which the posterior tibial artery was wounded the flap sloughed. The only merit claimed for this operation over that of Mr. Syme is its greater facility of performance, and its adaptation to cases where the integuments on the outer side of the foot are diseased, as they not unfrequently are. M. J. Roux has also proposed an operation very similar to that just described. (See *Malgaigne*, *Méd. Opér.* p. 314.)

Mr. Syme believes amputation at the ankle-joint to be applicable to many cases of disease or injury of the bones of the foot, or even of the ankle-joint itself, in which formerly it was customary to remove the leg just below the knee. An extended experience of it has convinced him, that a very useful stump will be obtained, well calculated for bearing pressure in consequence of the thick integuments of the heel being made use of to cover the ends of the bones, and that with the aid of an artificial foot the patients will be able to walk without difficulty, and with no very serious degree of lameness.

The principal advantages claimed for this operation by Mr. Syme are; first, that no more of the limb is removed than is absolutely necessary, the diseased portion alone being taken away, and consequently the danger to life is reduced to the lowest possible degree; secondly, that the risk of exfoliation of bone from inflammation of the medullary membrane and of phlebitis is lessened, because cancellated instead of dense bone is sawn through, and the medullary canal is not exposed; thirdly, that the stump is able to bear the weight of the body in progression, without pain or inconvenience. The first of these advantages would be of greater importance, if amputation through the calf of the leg were necessarily the alternative, for Mr. Syme is no doubt correct in thinking, that the risk to life is much less in amputating at the ankle-joint than in amputating below the knee at the usual place of election; and it is with amputation at this level that he has always drawn the comparison. The comparison, however, should rather be made between amputation at the ankle and amputation in the *lower third* of the leg, and then the difference in risk will not be very appreciable, or will even be in favour of the amputation in the lower third of the leg. In fact, in this latter situation, although an inch or two more bone is taken away, the wound is considerably smaller than in amputating at the joint, and it will certainly heal with much greater facility. Neither will many surgeons attach much importance to the alleged advantage of sawing through the bone in its cancellated texture; Mr. Syme himself does not now persist in advocating it in all cases. (See AMPUTATION OF KNEE-JOINT.) The main advantage then of amputation at the ankle consists in the usefulness of the stump which is formed, and in this particular it seems to be deserving of all that has been said in its favour by Mr. Syme and others. The stumps after ankle-joint amputations are in fact almost the only ones that can be at all relied on, for supporting the weight of the body.

The principal objections which have been urged against it are, its difficulty of performance, the tendency to sloughing of the flap, and the slowness with which the wound is found to heal even under the most favourable circumstances. The first of these objections, namely, *difficulty in the operative procedure*, is not one of any great moment, since any surgeon with moderate powers of manipulation will, with a little practice, be enabled to perform it with ease. The liability to *sloughing of the flap* is a more important disadvantage; it has seldom, however, been of any great extent, and though it has of course delayed the cure, it has not much interfered with the subsequent usefulness of the stump. According to Mr. Syme it is more frequently the fault of the operator than of the operation. *The delay which often occurs in the healing of the wound* is another, and perhaps more serious inconvenience; for it is useless to anticipate that so extensive a flap will unite by the adhesive process. Apposition of its edges may be obtained, but contact throughout its interior is manifestly impossible, and collections of matter to a greater or lesser extent are nearly certain to take place.

In these respects then amputation at the ankle-joint is inferior to amputation in the lower third of the leg; and for these reasons, the latter operation should be preferred in persons of broken down constitution or in those advanced in life, where sloughing of the flap would be more likely to take place; and in whom either the presence of a sloughing wound, or the long delay in the healing process might be attended with dangerous consequences. But in young persons, and in those whose state of health is tolerably good, the inconveniences attending amputation at the ankle-joint are more than compensated for by the preservation of a limb on the end of which the patient can support the weight of his body, and which will enable him to wear a much less cumbersome and expensive artificial contrivance.

Capability of supporting pressure, however, being the main advantage of amputation at the ankle, it is obvious that it ought never to be done unless the skin of the heel can be obtained to form the flap. When this is impracticable, the lower third of the leg should be preferred; for if the stump be left longer than this, it will not only interfere with the mechanism of the artificial limb, but it will also be difficult so to construct the latter that it shall not cause painful pressure on the end of the stump.

Very many surgeons have now adopted this operation, but the opinion of the profession respecting it is, nevertheless, still somewhat unsettled. Mr. Quain says, the operation appears to him "to be free from any valid objection, and, what is more important, the result in practice has been found to be good. A person who has undergone this operation is enabled to bear his whole weight upon the end of the stump without inconvenience; and, on this account, the facility of progression is, with a proper apparatus, decidedly greater than when the amputation is performed at any higher part of the limb. (*Med. Times*, Dec. 27, 1851, p. 659.) Mr. Erichsen thinks it "constitutes one of the greatest improvements of recent date in operative surgery, as by its performance amputation of the leg may often be avoided, and the patient being left with an exceedingly useful stump, the covering of which being ingeniously taken from the heel, constitutes an excellent basis of support." (*Science and Art of Surg.* 1853, p. 71.) Mr. Fergusson stated (in 1851), that he had operated eight times, and that Mr. Busk, had had a like number of cases. Mr. Fergusson was then strongly in favour of it, believing the stump to be "the best that can be made in the lower extremity" (see *Med. Times*, vol. i. 1851, p. 640), and subsequently he says, "I have now had considerable personal experience in this operation, and do not hesitate in giving it my strongest recommendations." (See *Prac. Surg.* ed. 3, 1852, p. 491.) He has since, however, greatly modified these opinions, and he now says, "what with violent inflammation extending up the leg, sloughing, secondary hemorrhage, death immediately dependent on the operation, tardy healing of the wound, and defective condition of the stump from languid circulation and tenderness, so that it could not be pressed upon, I have formed a most unfavourable impression against it." (See *Prac. Surg.* ed. 4, 1851, p. 487.) Mr. Butcher, of Dublin, mentions a case, in which he amputated at the ankle-joint, and was obliged three months afterwards to remove the leg below the knee, in consequence of ulceration of an excessively painful character taking place in the stump. "He thinks it still remains to be proved that the operation at the ankle-joint affords the most comfortable and useful stump to the labouring man, and promises less risk to life. He has seen the operation performed three times, and in no one case was it attended with success." (*Dublin Quarterly Journal of Med. Science*, August 1851.)

Mr. Simon has modified the operation at the ankle-joint in two cases, by allowing the astragalus to remain. His first case was in May, 1848, in a patient aged fifteen, with scrofulous caries and necrosis affecting the front and outside of the tarsus, extending even to the os calcis, but sparing the astragalus. The operation was performed in the same way as is generally adopted for amputation at the ankle-joint, the knife being passed between the astragalus and os calcis instead of between the astragalus and the lower extremity of the tibia and fibula. The flap was taken in the same manner as in the ordinary amputation of the ankle-joint, and the stump turned out remarkably good and useful. Mr. Simon considers that it was better than the stump left after Chopart's operation, because it was undisturbed by muscular contraction, and better than Syme's because of its greater breadth, its mobility in the joint, and its additional inch and a half in length. This stump has been seen for several years, and it was found that it had worked very advantageously for the patient. The second case was for a railway injury of the foot, in 1853. The same operation was performed as in the preceding case, but the man died of tetanus. When he was seized with this affection, a fortnight after the operation, the entire stump had very nearly healed, and, in prospect of firmness and position of cicatrix, was as near a model stump as any one could have wished to see. (*Lancet*, vol. i. 1854, p. 100.)

M. Malgaigne, also, has amputated beneath the astragalus on two occasions, and with successful results. His mode of proceeding, however, was different. He made a large internal flap, composed of the parts from the inner concave surface of the os calcis, together with about two-thirds of the breadth of the sole of the foot. This flap must extend forwards, some distance in front of the astragalo-scaphoid articulation, in order to leave a sufficient covering for the rounded head of the astragalus. (*Méd. Opér.* p. 310, ed. 5.)

M. Pirogoff, of St. Petersburg, has proposed another modification, the effect of which is to preserve the posterior portion of the os calcis in the flap. After the incisions have been made in the manner proposed by Mr. Syme, the ankle-joint is opened in front, and the foot disarticulated. The os calcis is then sawn through from above downwards, behind its articulation with the astragalus. The portion of bone forming the heel remains, therefore, in the flap, and is to be brought forward and turned up, with the view of making it unite with the sawn surface of the lower end of the tibia.

This operation has been performed in London by Messrs. Ure, Simon, and Partridge, and six times in the Dreadnought Hospital Ship by Messrs. Busk and Tudor. Mr. Ure's patient died from cerebral disease before the stump had healed. Mr. Simon's case and Mr. Partridge's case were attended with successful results. Of Messrs. Busk and Tudor's cases four are said to have recovered with excellent stumps, but the other two terminated fatally. In the four successful cases operated on by those gentlemen, "the posterior part of the os calcis was united firmly with the tibia, generally in about three weeks; but in one instance, union was good at the end of twelve days." The os calcis was sawn obliquely downwards and forwards "in a line from the posterior margin of its upper articulating surface to the under edge of the articulating surface of the cuboid." (See *Remarks on Pirogoff's operation*, by J. Croft. *Lancet*, Feb. 6, 1858, p. 136.) In the only case witnessed by the writer, the heel was strongly drawn backwards by the unopposed action of the muscles of the calf, and no amount of force would produce the required contact between the osseous surfaces.

Mr. Syme has objected to this proposal; first, that the os calcis is a bone predisposed to caries, and it is therefore undesirable to leave any part of it; secondly, that the operation is not facilitated; thirdly, that union of the osseous surfaces is not likely to take place easily; fourthly, and principally, that the integuments of the heel are necessarily carried forwards, and the end of the stump is covered by skin, which is not destined for sustaining the weight of the body. (*Lancet*, vol. i. 1855, p. 307.) M. Pirogoff himself is said now to have abandoned it, in favour of the ordinary amputation at the ankle-joint. (See *Fergusson*, *Pract. Surg.* ed. 4, p. 487.)

Mr. Syme also objects to the retention of the astragalus, "on account of its predisposition to caries; one of the great recommendations of amputation at the ankle being, in his opinion, that it removes all the bones which are liable to the disease." (*Lancet*, vol. i. 1855, p. 307.)]

AMPUTATION OF THE LEG.

In treating of amputations in general, it has been remarked, that as much of the limb as possible should be preserved. The longer it is after the operation, the stronger and more useful will it be found. But when the leg is to be amputated, it has been a very general custom to operate a little below the knee, even though the disease for which the limb is removed may be situated in the foot or ankle, and would allow the operation to be done much further down. The common practice has been to make the incision through the integuments, just low enough to enable the operator to saw the bones about four inches below the lowest part of the patella. This has been termed the place of election. About six inches below the patella would therefore be an eligible place for the first circular cut through the skin. It has been alleged as a reason for this mode of proceeding, that it is quite sufficient to preserve a few inches of the leg, in order to afford the body a proper surface of support in walking with a wooden leg; whereas, if a larger portion were saved, the superfluous part would be a great inconvenience both in walking and sitting down, without being of the smallest utility in any respect whatever. However, as I shall presently notice, experience proves that where the injury or disease require it, amputation may be performed at a *much higher* level than was formerly sanctioned; and also, that in many cases of disease of the foot, or ankle-joint, amputation *near the ankle* may be substituted with advantage for the old operation a hand's breadth below the knee. It will be necessary to speak separately of amputation at each of these three situations, viz. 1. at the ordinary place of election; 2. between this and the knee-joint; 3. between this and the ankle-joint.

Amputation of the Leg at the "Place of Election."

Circular method. — The patient is to be placed on a firm table, and the sound limb fastened to the nearest leg of the table. The tourniquet is applied either to the femoral or popliteal artery; and the leg which is about to be removed being properly held by one assistant, while the integuments are drawn upward by another, the surgeon, with one quick stroke of the knife, is to make a circular incision through the integuments all round the limb. Some recommend the operator to stand on the inside of the leg, in order that he may be able to saw both bones at once. This is the old manner, which is still very generally followed. Many suppose that it diminishes the chance of the fibula being splintered, which is completely divided rather sooner than the tibia. But splintering the bones generally arises from the assistant depressing the limb too much, or the surgeon pressing too heavily on the saw. If this mismanagement were to occur, it would be difficult to explain why the tibia should not be splintered instead of the fibula, when a certain thickness of it had been sawn through. Velpeau considers that it would be a better rule to let the surgeon's position be such as will constantly enable him to take hold of the limb below the knee with his left hand; while Liston, on the contrary, preferred always to stand so that the left hand should steady the part to be removed during the application of the saw. [It is in reality a matter of no great importance on which side the surgeon stands, for if the one position gives him the advantage of his left hand to retract the soft parts, the other certainly enables him to hold the limb more steadily while he is sawing the bones.]

A circular cut having been made through the integuments, about two inches below the place where it is intended to saw the bones, the skin is dissected from the muscles and bones equally all round the limb, to the extent of about a couple of inches. The integuments are then turned up, and a division of the muscles made all round down to the bones, on a level with the line where the detachment of the skin has terminated. Any remaining muscular fibres are then to be divided together with the interosseous membrane, at a somewhat higher level, if possible, with the catlin, or long, narrow, double-edged knife, which is to be carried between and around the bones, until they are completely isolated; and it should also divide their periosteum at the point where it is intended to apply the saw. The soft parts are next to be protected from the teeth of the saw by a linen retractor, made with two slits to receive the two bones, care being taken to let the unslit part be applied to the muscles of the calf.

Reckoning from before backward, the arteries requiring ligatures are:—1st. The anterior tibial, which lies close to the nerve, and in front of the interosseous ligament. 2ndly. The posterior tibial, with the nerve on its fibular side. 3rdly. The peroneal; both these arteries being situated behind, between the soleus and the deep stratum of muscles,—the posterior tibial behind the external edge of the tibia, on the posterior surface of the flexor communis digitorum pedis, and the tibialis posticus; the peroneal behind the fibula, amongst the fibres of the long flexor of the great toe. 4thly. Sometimes two or more branches in the calf, termed sural. 5thly. Now and then the nutrient artery of the tibia. Frequently the anterior tibial artery retracts so far that it cannot be taken up without first dividing the soft parts concealing it. The occurrence is ascribed by M. Ribes to the double curve which the artery describes to get in front of the interosseous ligament; by M. Gensoul, to the retraction of the artery exceeding that of the muscles which adhere to the bone.

When the soft parts have been cut, the bones sawn, and the arteries tied, the wound is to be closed by bringing the flap of the skin over the stump, so as to form a line of wound corresponding to the transverse diameter of the limb. This should be done without letting any tight strap of plaster press the skin against the sharp edge of the tibia; a serious and hurtful practice, which has often occasioned ulceration and sloughing of the integuments, and protrusion and necrosis of the bone. It is this danger which led Mr. Guthrie to prefer closing the wound vertically, or nearly so, and applying the adhesive straps from side to side. And where a great deal of skin is saved all round the limb, and the muscles of the calf are not calculated upon for covering the bones, the perpendicular line of the wound will answer very well.

The practice is sometimes adopted of sawing off the sharp upper ridge of the tibia. It is advocated by A. C. Hutchison, Marjolin, and Ballard. It has the sanction of Mr. Guthrie, who says that, in thin persons, where the spine of the tibia is very sharp, this part should be removed with the saw (p. 222). In France, the removal of the front angle of the tibia is generally approved. (*J. F. Malgaigne*, op. cit. p. 291.)

Occasionally, surgeons have also removed the small remnant of the fibula, and such was sometimes the practice of Larrey, when he amputated nearer the knee than common. (*Mém. de Chir. Mil.* t. iii. p. 389.) This plan, however, is objectionable, as will be hereafter explained.

[The foregoing is the usual method of amputating the leg a hand's breadth below the knee by the circular incision. The late author, however, preferred the following method, which is in some measure a combination of the flap and circular operations; a flap being made from the muscles after the circular division of the skin:]—A circular cut having been made through the integuments, about two inches below the place where it is intended to saw the bones, the next object is to preserve skin enough to cover the front of the tibia, and the part of the stump corresponding to the situation of the tibialis anticus, extensor longus pollicis pedis, and other muscles between the tibia and fibula and those covering the latter bone. Throughout this extent there are no bulky muscles which can be made very serviceable in covering the end of the stump, and consequently the operator must take care to preserve sufficient skin in this situation, by dissecting it from the parts beneath and turning it up.

On the back part of the leg, on the contrary, the skin should never be uselessly detached to a great extent from the large gastrocnemius muscle, which, with the soleus, will here form a sufficient mass for covering the stump. I am disposed to think it best, however, when the calf is bulky, to let a small quantity of skin be detached and saved at the back part of the leg, so that there may be a certainty of having enough to cover well the extremity of the divided gastrocnemius. As soon as the skin has been separated in front and on the outside of the leg the surgeon is to detach the skin from the calf for about an inch; and having reflected or drawn this preserved portion out of the way, he is to place the edge of the knife close to the edge of the retracted or reflected skin at the back of the limb, and cut obliquely upwards through the muscles of the calf, from the inner edge of the tibia quite across the fibula, supposing the operator to be on the outside of the right leg, and that it is this member which is undergoing removal. In performing this last incision, as M. Louis well observes, it is essential to incline the edge of the knife obliquely upwards. Thus the skin will be longer than the muscles, and the cure accelerated. (*Mém. de l'Acad. de Chir.* t. v. edit. in 12mo.) The flap, formed of the integuments and muscles of the calf, is then to be held back by one of the assistants, while the surgeon completes the division of the rest of the muscles, together with that of the interosseous ligament, by means of the double-edged knife.

Amputation by an oblique or oval incision.—The method recommended by M. Sedillot consists in dividing the integuments on the outer side of the leg obliquely, from before backwards, and from below upwards. The knife is then carried round the posterior part of the limb to its inner side from behind forwards, and from above downwards. The division of the integuments is next completed in front by a transverse incision, leaving an oval wound, with its anterior angle truncated.

The plan adopted by M. Baudens differs only from that of M. Sedillot in making the incision through the skin entirely oval, and letting the knife descend about an inch lower down in front than behind.

"One reason," says M. Malgaigne, "not mentioned by any writer, makes me prefer the oval even to the circular method. In the latter, the principle is to leave the integuments sufficiently long on every side to cover one half of the stump. Now the posterior integuments, on the retraction of the muscles, reach the centre of the wound more readily than the integuments in front, which have to pass and bend over the end of the tibia. The object then can only be fulfilled by allowing a greater length to the skin in front." (*Manuel de Méd. Opér.* p. 293.) Dr. Pancoast slopes the incision backward towards the popliteal region, about an inch higher than the incision on the tibia. He has less flabby skin, a neater junction, less suppuration, and makes a better stump. (See *Reese*, Amer. ed. 1851, Appendix, p. 20.)

Oval amputation of the leg can never be necessary, if care be taken in the other methods to save a sufficiency of the integuments in front of the limb, as advised in the descriptions already given of those operations.

Flap Amputation of the Leg.—[Amputation with a single flap cut from the posterior surface was originally proposed by Verduin, and is the method which, with some modifications, is now commonly adopted by those who prefer flap amputations. The surgeon, passing his knife close behind the bones, transfixes the limb at or a little below the level at which he intends to apply the saw, and cuts a flap from the calf of the leg four or five inches in length. The angles of this flap are united by an incision, slightly convex downwards, across the anterior half of the leg. The skin in front is then dissected up for about half an inch, and retracted by an assistant, who also holds back the flap. The remaining muscles are divided and the operation finished as in the circular method. The soft parts are so readily held out of the way of the saw, that the retractor is usually dispensed with. The anterior incision may be made either before or after transfixion, at the option of the surgeon.]

The following was Mr. Liston's method. If the right leg was to be removed, he placed himself on its inner side, and grasped the lower part of the limb with his left hand, an assistant supporting the foot at a proper height. The knife was introduced over the outer side of the fibula, and carried upwards along that bone, for an inch and a half or two inches. It was then brought across the limb in a semicircular direction ; and as soon as it reached the inner and lower part of the tibia, transfixion was performed by pushing the knife across the posterior surface of the bone, and out at the upper part of the fibular incision. By then carrying the knife downwards, a posterior flap was formed sufficient to cover the bones. The integuments on the fore part were then dissected upwards a little, with the same knife, so as to form a small semilunar flap. The muscles in the interosseous space were next cut through, and the knife carried round the bones in order to divide the soft parts.

[These amputations might be made to partake more of the character of double flap operations by not cutting so long a flap from behind, and by saving more skin at the anterior part of the leg ; but they will then have the disadvantage that the cicatrix will be near the middle of the stump instead of at its anterior part ; and also that the covering for the ends of the bones will not be of uniform thickness, in consequence of the greater bulk of the soft parts comprised in the posterior flap. Flap amputation of the leg is open to the objection that the flap will contain a thick unwieldy mass of muscle, which can with difficulty be kept applied over the surface of the stump, and in which the muscles will generally be cut at a lower level than the skin, so as to prevent the edges of the wound being brought into good apposition, unless some of the redundant muscular substance be removed. This is especially the case if the muscles are well developed ; and if transfixion is practised close behind the bones, which is the plan most commonly recommended. For this reason, many surgeons who are not averse to flap operations in other parts, consider them unsuited to this region, and in this opinion the writer entirely coincides.]

Dr. Bushe, as already mentioned, conceives that it is only in amputating below the knee that the circular incision is decidedly preferable to the flap operation. He "never saw a case, where a flap was formed from the calf of the leg, in which considerable retraction of the remaining muscles did not ensue, attended with great induration of the flap, separation of its edge from the skin on the front of the tibia, sometimes exfoliation of the bone, and generally tedious suppuration." (*Lancet*, No. 246, p. 208.) [Mr. South says, that "so far as his experience proves, flap operations in the continuity of the bone may be performed as successfully as circular operations on every limb but the leg, in which the calf muscles are so bulky that it is often difficult to get the skin well over them, if they be left, and he does not think the cure so quick as with the circular." (*South's Chelius*, vol. ii. p. 903.) And Mr. Syme, who was at one period a very strong advocate for amputation by flap in this situation, has, for reasons similar to those above stated, changed his opinion, and now employs the circular operation. Mr. Syme's incisions are, however, not exactly circular, but he forms a short anterior and posterior flap of integuments only, which being dissected up the muscles are cut by circular incision. He now divides the bone somewhat higher than usual (an inch or an inch and a half below the tuberosity of the tibia.) (*Lancet*, Feb. 1855, p. 203.)

To obviate the inconvenience arising from the presence of too much muscle, Mr. Skey recommends that a part only of the thickness of the calf should be included in the flap. "The leg being raised, the calf should be supported on the open palm of the left hand of the operator, by which it is flattened out considerably in breadth. The knife is then introduced through the skin at a depth of not more than half or three quarters of an inch above the palm of the hand, and passed straight across to the opposite side, and the posterior flap, which in addition to the integuments will thus include a small thin portion of the gastrocnemius, is formed of sufficient length to pass forwards around the end of the tibia. The anterior flap is now cut, but of small dimensions. A circular sweep of the knife round the limb is then made, which divides the rest of the calf, and the catlin is introduced through the deep muscles and interosseous membrane. (*Op. Surg.* p. 368.)]

[*External Flap.*—Some of the French surgeons recommend the formation of a flap composed of skin and muscle from the external side of the leg, and the result is stated to be satisfactory. The soft parts being drawn outwards, the limb is transfixed from before backwards and a flap is cut about four inches in length. In transfixing, the knife must be kept as close as possible to the outer side of the bones, due care being taken that it does not pass between the tibia and fibula. The angles of the flap are united by an incision slightly convex downwards on the inner side of the limb. (See *A. Guerin El. de Chir. Opér.* tom i. p. 176.)]

Amputation above the Place of Election.—The principal reasons have already been specified for the general custom of amputating the leg about four inches below the patella; and it was formerly the custom if the disease or injury would not admit of the operation being done thus low, to remove the limb above the knee-joint. In the Egyptian campaign, however, Baron Larrey performed two amputations very near the knee-joint, almost on a level with the head of the fibula, which he judged proper to extirpate. The successful result of these operations dispelled the fear which this experienced surgeon previously entertained about amputating in the thick part of the upper head of the tibia; for no caries of this spongy portion of the bone, no bad effects on the knee-joint, and no anchylosis of the stump ensued : and, with the difference of a few days, the wound healed as readily as that made in the common place of election, viz. three or four finger-breadths below the tuberosity of the tibia. Since the above-mentioned campaign Larrey has adopted this practice in many cases, where it was impossible to have operated at the usual place; and he assures us, the success fully equalled what attends operations done at the ordinary distance from the knee. In 1806, another French military surgeon, who had tried this method himself, published a dissertation, in which he commended operating, where circumstances required it, much higher than the point allowed by generally received rules. Larrey differs, however, from Garrigues, in forbidding amputation higher than the level of the tuberosity of the tibia, the thick portion of which may be sawn, but not above the insertion of the tendon of the patella. A transverse line, drawn from this point, usually passes below the articulation of the fibula, and over the lower portion of the uppermost part of the condyles of the tibia; but, as the relative positions of the heads of the two bones to each other differ somewhat in different individuals, Larrey makes the tuberosity of the tibia the point above which the bone should never be sawn. By cutting higher, the ligament of the patella is separated from its insertion; the bursa mucosa, situated underneath it, is wounded; and the ligaments at the sides of the joint are injured: whence arise retraction of the patella, effusion of the synovia, and such disease of the knee-joint as may render another amputation indispensable. By making the division on a level with the tuberosity of the tibia, the attachment of the ligament of the patella is preserved as well as that of the flexor tendons of the leg, which are requisite for the motion of the stump. The bursa mucosa is left untouched; and the head of the bone is sawn low enough to avoid creating a risk of caries. But, says Larrey, if this mode of amputating below the knee be compared with amputation of the thigh, as recommended by authors for the cases in which the new method is proposed, the advantages of the latter are considerable. In the first place, life is less endangered, because a smaller portion of the body is removed. The operation is as easy in one situation as the other. The stumps heal with equal facility. Larrey has never seen the spongy part of the tibia become carious, nor preceptibly exfoliate. When the remaining portion of the fibula is very short, as usually happens, he recommends it to be taken away, as it is a useless body, inconvenient for the employment of a wooden leg. He directs as much skin as possible to be preserved, and a perpendicular incision, through that part of it which covers the tibia, in order to hinder the bone from making its way through it by ulceration. As M. Malgaigne particularly remarks, the exact situation of the tuberosity of the tibia should always be precisely ascertained before the operation is begun, so as to avoid cutting through the insertion of the ligament of the patella, and opening the synovial membrane behind it. The tibial tuberosity presents a triangular surface, the inferior angle of which is continuous with the crista of the tibia. As the ligament of the patella is inserted into the whole of the triangular surface, Malgaigne sanctions, where circumstances call for it, a bold division of it nearly as high as its base, the remaining connection of the patella with the tibia by the latter part being sufficient. I fear this plan would too often be followed by injuries and disease of the knee-joint, to merit adoption.

With a stump thus formed, comprising the knee and one or two finger-breadths of the leg, the patient has a firm point of support, on which he can securely walk without a stick. The stump admits also of an artificial leg of the natural shape being worn, the knee being always bent, provided the length of the stump do not exceed the diameter of the calf of the artificial limb. (*Mém. de Chir. Mil.* t. iii. p. 386—394.) From a passage quoted by Mr. Guthrie, it would seem that Mr. Bromfield (*Chir. Obs. and Cases*, vol. i. p. 185) advised amputating as near to the knee as could be done without risk of cutting the ligament of the patella, so that the stump might not extend beyond the wooden leg. On the whole, Mr. Guthrie's own observations are favourable to this practice; but he candidly acknowledges his belief, that "it would not succeed when indiscriminately done in the hospitals of large cities," though it may frequently be practised in the army with advantage, provided the surgeon saw through the tibia below its tuberosity. (*On Gunshot Wounds*, p. 223 and 227.) Upon looking over the details of the cases recorded by Larrey in confirmation of the above statement, I was struck with one important fact, which does not justify a part of his commendations; viz. that most of the stumps were above four months in healing; and that which healed most quickly was not well before the sixty-eighth day. (See *Mém. de Chir. Mil.* t. iii. p. 57, 397, 398, &c.) Hence, unless it be supposed that the wounds produced by amputation below the knee in the ordinary manner are generally thus long in healing, as treated by the French surgeons, the inference is rather unfavourable to the method so highly commended by Larrey.

One advantage of this operation is, that frequently only the popliteal artery requires a ligature, this vessel not dividing till lower down. Before adjusting the flaps, Mr. Liston sometimes cuts off the sharp anterior edge of the tibia with the pliers, for the purpose of preventing it from injuring the integuments. Mr. Liston objects to Larrey's method of cutting away the head of the fibula, because, in several cases where he tried it, a discharge of synovial fluid occurred on the second day, followed by profuse long-continued suppuration. In more than one case, the joint became anchylosed, and one patient died from the copiousness of the discharge. Mr. Liston found, from repeated examination of the parts on the dead subject, that in cutting out the head of the fibula, the capsular ligament was wounded, or the bursal cavity beneath the popliteus muscle, communicating with that of the knee-joint. (*Elements*, part iii. p. 391—393.) [Amputation about an inch below the tuberosity of the tibia has lately been advocated by Mr. Syme. He thinks the stump thus formed is long enough to preserve the use of the knee-joint, and he prefers it because the medullary cavity is not opened, and the dense bone which is liable to exfoliation is not cut through. Like Mr. Liston, he thinks it better to retain the head of the fibula, both because its removal might give rise to inflammation in the joint, and also because it destroys the insertion of the biceps muscle. (See *Lancet*, Feb. 24, 1855.) The preservation of the flexor muscle is important, if the patient is to walk on the ordinary wooden pin with his knee bent, as the insertion of the extensors through the medium of the ligamentum patellæ remains intact. If the head of the fibula is left, the two most important flexors, viz. the biceps on the outside and the semi-membranosus on the inside will still remain entire.

This amputation should be performed only when the state of the limb really requires its removal at so high a level. In such a case it might be preferred to the alternative of amputation through the lower third of the thigh or through the knee-joint, but it should not be selected as a matter of choice, and in preference to the amputation lower down, as it appears to have been by some of the surgeons whose observations have been quoted.]

Amputation below the Place of Election.—By some surgeons of repute, the plan of amputating through the calf of the leg, when the foot or ankle is the part diseased or injured, has been condemned. It was strongly disapproved of by Solingen, towards the close of the sixteenth century. His precept was, that the leg, like the forearm, ought to be amputated as low as possible, and the patient furnished with a suitable mechanical contrivance, on which he would be able to walk exceedingly well. Dionis was nearly in the same way of thinking upon this subject as Solingen. The opinions of these surgeons, however, had fallen into such oblivion by the middle of the seventeenth century, that Ravaton, White, and Bromfield severally imagined, that they were the first inventors of amputations low down the leg.

Mr. White, of Manchester, in a paper dated 1769 (*Med. Obs. and Inq.* vol. iv.), informs us, that he took the hint to amputate a little above the ankle, from seeing a case in which this had been done by a simple incision, with such success that the patient could walk extremely well, though with a machine that was very badly constructed. After this, Mr. White began to operate above the ankle with the double incision; and he invented a machine much better calculated for the patient to walk upon.

In 1773, Mr. Bromfield published his *Chirurgical Cases and Obs.*, wherein he mentions his having begun, about the year 1740, to amputate above the ankle, in a case of a gangrene of the foot. The patient walked so well, with the aid of a simple machine, both along a level surface, and in going up and down stairs, that it was difficult to perceive he had lost his foot. Mr. Bromfield was persuaded, however, to give up this practice, until he learned that, in 1754, a Mr. Wright had thrice amputated in this way with success, when he again had recourse to it, without the least unpleasant consequences. (See vol. i. p. 189, &c.) Of late, the method has been revived by Vacca, Brünninghausen, and Soulera, and is sanctioned by Velpeau, where the patient is not obliged to walk a great deal, or is very desirous of not letting it be seen that he has lost any part of the limb. (See *Velpeau, Nouv. Elém.* t. i. p. 480.) Velpeau recommends cutting the skin in such a manner that the cicatrix may be situated behind and not in the centre of the stump. But, as Malgaigne observes, the delicate skin in this place would hardly be capable of bearing the pressure of the kind of short boot on which the patient would have to walk. (See *Malgaigne, Manuel de Méd. Opér.* p. 294.)

The advantage of amputating a little below the knee, is, that the pressure in walking with a wooden leg is entirely confined to the front of the limb, the cicatrix itself not being subjected to irritation. After amputating at the ankle, the pressure in walking operates directly on the cicatrix. According to Sabatier, this last plan has been extensively tried in France, but not found to answer; the stump being incapable of bearing pressure, and not continuing healed. (*Médecine Opératoire*, t. iii. p. 377, edit. 2.) The same author refers to some instances in which the patients were obliged, under these circumstances, to undergo amputation a second time; an observation made as long ago as the time of Paré. Baron Larrey spoke of the method as an objectionable operation, not merely because some patients, as, for instance, soldiers, have not the means of providing themselves with artificial legs, but because it is almost always followed by bad symptoms, owing to the small quantity of cellular substance and flesh, and the thickness of the bone at this part of the leg, whereby cicatrisation is impeded. He even made the extraordinary statement that he had seen many amputations done at this part, but nearly all the patients died of nervous fever or tetanus. (*Mém. de Chir. Mil.* t. iii. p. 394.) Mr. Liston also pronounced the operation near the ankle to be inadmissible, because a sufficiency of soft parts for the protection of the stump cannot be obtained below the calf. The place for incision, he observed, is consequently limited to two points,—either immediately below the tuberosity of the tibia, or in the bellies of the gastrocnemii. The former situation he preferred in hospital practice, and among the lower orders generally; the latter in the better classes of society, who could afford to purchase an expensive artificial support. (*Elements, &c.* part iii. p. 391.)

Mr. Alanson operated in the lower third of the leg with a posterior flap, in the following manner:—The disease was in the left leg; the patient, therefore lay upon his right side, upon a table of convenient height, so as to turn the part to be first cut fully into view. The intended line, where the knife was to pass in forming the flap, had been previously marked out with ink. A longitudinal incision was made with a common scalpel, about the middle of the side of the leg; first on the outside, then on the inside, and across the tendo Achillis: hence, the intended flap was formed, first by incisions through the skin and adipose membrane, and then completed by pushing a catlin through the muscular parts in the upper incised point, and afterwards carrying it out below, in the direction of the line already mentioned. The flap was thick, containing the whole substance of the tendo Achillis. The usual double incision was made; the retractor applied to defend the soft parts; and the bone divided, as high as possible, with the saw.

The flap was placed in contact with the naked stump, and retained there, at first, by three superficial stitches, between which adhesive plasters were used. The stump healed in a month, and the man was soon able to use an artificial leg, with which he walked remarkably well. He bore the pressure of the machine totally upon the end of the stump, and was not troubled with the least excoriation or soreness.

In the next instance, in which Mr. Alanson operated, he formed the flap by pushing a double-edged knife through the leg, and passing it downwards and then outwards, in a line first marked out for the direction of the knife. In this way the flap was more quickly made. The leg should be completely extended during the operation, and kept in that posture till the wound is perfectly healed.

I will next notice Mr. Hey's method. He believed that very near the ankle was not the proper place for this kind of amputation. Some cases occurring, in which, from a scrofulous habit, the stump would not heal completely, nor remain healed, Mr. Hey determined to try whether amputation in a more muscular part would not secure a complete healing, and give the patient an opportunity of resting his knee on the common wooden leg, or using a socket, as he might find it most convenient. Mr. Hey latterly preferred this method, and selected the middle of the leg as the place where the bones should be sawn through. His operation was by posterior flap, and he gave detailed instructions for regulating its exact dimensions.

Mr. Fergusson, like Mr. Hey, and for similar reasons, selects the middle of the leg whenever he has the choice of site. He thinks that a stump of sufficient length for fixing any apparatus will thus be left, while, if it should be found that the weight of the body cannot be sustained in this way, the projection, when the knee is bent, will appear so trifling that little objection can be taken to it. (*Op. Surg.* ed. 3, p. 494.)

[In selecting the most appropriate situation to amputate the leg (when the surgeon has the power of selection), it should be remembered always that the risk to the patient's life is a consideration of even greater moment than his subsequent convenience in progression, and that risk will certainly be much less in amputations near the ankle than in those through the calf of the leg, both on account of the smaller size of the wound and the smaller proportion of the limb which is taken away. M. Velpeau states the proportion of deaths after amputation at the usual place of election to be as one to four or five, while in amputation near the ankle it is only about one in ten. The diminution in risk, then, is a very weighty argument in favour of the amputation low down. But, in addition to this, the only valid objection to the lower operation, namely, that the end of the stump is incapable of bearing pressure, has been removed by the greater perfection which has been attained in the adaptation of artificial limbs; since in no case, if they are properly constructed, is the pressure made to fall on this part, but is distributed equally over the rest of the limb. Mr. F. Gray, who has had great experience in the construction of artificial limbs, and has introduced many valuable improvements in their mechanism, says that " in no instance, except in Syme's and Chopart's operations, can *any* pressure be taken on the end or point of the stump, which is exquisitely sensitive and tender," and he takes " especial care that nothing whatever shall come in contact with it."

Mr. Gray considers that the best place for amputation, so far as the mechanical adaptation is concerned, is at the upper part of the lower third of the leg. This leaves the patient a complete command over the artificial limb, without being so long as to interfere with its mechanical arrangements. (See *Automatic Mechanism*, by F. Gray, p. 85.)

If, then, we take into consideration the twofold recommendation of the diminution of risk and the subsequent advantages to the patient, there can be little doubt that the real place of election is in the lower third of the limb, and that the calf of the leg should only be selected in exceptional cases where the expense of an artificial limb would be a continual burden to the patient; and not even then unless it appear probable that his state of health and constitution will carry him safely through the more severe operation.

Mr. Quain observes, it may be that the shorter stump is more convenient to the poor man because it will fit better the supporting ledge of the common pin leg with which he is obliged to be content afterwards. He believes, however, the superior convenience in this respect to be outweighed by the greater risk attending the larger wound. But in the case of all those who can afford the expense of the better constructed artificial limb, he thinks the lower amputation is beyond all question the more advantageous one for the facility of progression. (See *Med. Times*, Dec. 1851, p. 659.) M. Bourgéry, in comparing the amputation at the old place of election with that near the malleoli, says that both statistics and authority are in favour of the lower operation. Many surgeons whom he quotes, and " others whom it would be too long to enumerate, both in France and in other countries, are so convinced of its superiority, that they would prefer it even if no convenient artificial support could be obtained." (See *Méd. Opér.* tom. i. p. 246.)

In the lower third of the leg, as in the upper, the circular method, or that with a posterior flap, may be adopted; but it will not be necessary again to describe either operation in detail. That by posterior flap is objectionable on account of the flap being composed almost entirely of the tendo Achillis. Perhaps the most convenient mode of operating is by two semicircular flaps composed of the integuments only. These flaps may be formed either from the antero-posterior, or from the lateral surfaces of the limb. They should of course be made, not by transfixion, but by incision from without inwards. After they have been dissected up and reflected, the muscles should be divided opposite to their base by a circular incision. In the ordinary circular operation there is sometimes a difficulty in turning up the skin, in consequence of the increasing size of the limb from below upwards at this part. This difficulty is avoided by dividing the integuments in the way suggested above. When the amputation is done very near the ankle there is no interosseous space through which the knife can be passed: the retractor therefore need only have one slit, instead of two as in operating higher up.]

[AMPUTATION AT THE KNEE-JOINT.]

[Amputation through this joint was performed nearly three centuries ago by Fabricius Hildanus (1581), after which period it appears to have fallen into disuse till about 1764, when it was practised with considerable success by Hoin of Dijon, and advocated by J. L. Petit, and afterwards by Brasdor. Subsequently to this, although it was performed occasionally, it may be said to have been proscribed by the general opinion of surgeons till reintroduced by M. Velpeau in 1830. M. Velpeau collected the records of fourteen cases, out of which he found that only one had terminated fatally, and judging from these very favourable results, he was induced to advocate amputation at the knee as preferable even to amputation through the upper part of the leg. Subsequent experience, however, has shown that such an average is by far too favourable, and M. Velpeau himself admits that he may have exaggerated the safety of the operation when he attempted to revive it in 1830. He does not now think it should ever be undertaken when it is possible to amputate lower down, though he still strongly recommends it as preferable to amputation in the lower third of the thigh. M. Malgaigne thinks it is an operation that has been too lightly condemned, and which, when the surgeon has the choice, merits a decided preference over amputation in the continuity of the thigh. (*Méd. Opér.* p. 316, ed. 5.)

The mode of operating originally adopted by Hoin, was with a posterior flap cut from the calf of the leg. He made a horizontal incision below the patella extending round the limb for three-fourths of its circumference. This incision divided the skin, ligaments, and other fibrous tissues. The leg being a little flexed, the crucial ligaments and any remaining portion of the lateral ligaments were divided with the point of the knife, after which, the leg being further flexed, and the head of the tibia drawn towards the operator, the blade of the knife was carried through the joint, and a flap was cut from the muscles of the calf long enough to cover the articular end of the femur. By this proceeding the patella was preserved. (See *Bourgéry, Méd. Opér.* t. ii. p. 269.)

M. Velpeau disapproves of the above method, and recommends a *circular* incision through the skin, three or four finger-breadths below the patella, without involving the muscles. The skin is to be dissected up and reflected, care being taken to preserve as much as possible of the cellular and adipose textures. He then divides the ligamentum patellæ and lateral ligaments; after which, bending the knee, he cuts the crucial ligaments, carries his knife through the joint, and finishes by dividing horizontally the vessels, nerves, and muscles at the posterior part on a level with the raised up integuments. (*Nouv. Elém. de Méd. Opér.* t. iii. p. 254.)

In 1836, M. Baudens operated successfully at the knee-joint in two cases of gunshot wound of the leg, and since that period he has always strongly advocated the operation. He recommends an *oval or elliptical* instead of a circular incision, with a view to retain more integument anteriorly, and throw the cicatrix more towards the posterior part. The incision should descend anteriorly five finger-breadths below the inferior border of the patella, but only three finger-breadths below this level posteriorly or towards the popliteal space. The integument is to be dissected from the front and sides of the joint, as high as the lower border of the patella, and reflected back, but posteriorly the cellular adhesions which unite the skin to the muscles should be preserved uninjured. The ligaments should next be divided in succession until the tibia is completely disarticulated. This will permit an assistant to pass his fingers into the wound and compress the popliteal artery, and the knife may be carried through the muscles at the back of the joint, so as to divide them at the level of the incision already made in the skin. In M. Baudens' first case, the skin was dissected back as high as the upper border of the patella, and that bone was removed. A portion of the condyles of the femur, in which the ball was found to be lodged, was also removed. In the second case, the patella was retained, and the articular cartilage on it and on the lower end of the femur was not interfered with. No exfoliation of this structure took place, and the wound was completely healed in ten days. (See *Baudens, Cliniques des Plaies d'Armes à Feu,* p. 532, Paris, 1836.)

In 1824, Dr. Nathan Smith, of Connecticut, amputated successfully at the knee-joint, with *anterior and posterior flaps* of equal size. This was the first instance in which the operation was performed in America. It was some years before the date of M. Velpeau's Memoirs, and was one of the fourteen cases to which he referred. Dr. Smith's instructions for the operation are as follows:—"Mark two points, one on the out, and the other on the inside of the limb; the latter half an inch below the head of the tibia, and the other opposite to it. Then draw a semicircular line from one point to the other over the anterior part of the leg, and in such a direction that its lower part shall touch the lower part of the tubercle on the tibia into which the ligament of the patella is inserted, and then mark another circle on the posterior part of the leg exactly corresponding to the former. The above lines limit the two flaps, the former of which will be formed of the patella and its ligaments, and the latter of the head of the gastrocnemius, the tendons of the flexor muscles, and the popliteal blood-vessels and nerves. The operator should first raise the anterior flap with the patella, which will expose the anterior part of the joint and render the division of the lateral ligaments easy. Two or three strokes of the knife will then complete the section of the crucial ligaments and of the lower flap." (See *Amer. Med. Rev.* vol. ii. p. 370; and *S. Smith on Amp. at the Knee-joint, N. Y. Journ. of Med.* vol. ix. p. 313, 1852.) The American surgeons who have since performed the operation have usually made the anterior flap longer and the posterior flap shorter than Dr. Smith recommended, in order to throw the cicatrix well back towards the popliteal space, and out of the way of pressure from the wooden leg.

Dr. Markoe, of New York, in a paper recently published, strongly recommends amputation at the knee-joint in preference to the lower third of the thigh. Dr. Markoe has himself operated twice successfully, and has watched with care the progress of all the cases (nine in number) which have occurred in the New York Hospital. He says he first became an advocate for it in 1841, "on examining, at the New York Hospital, a stump left after this operation. The integument covering the condyles was sound, and free from callosities, excoriations, or tenderness; and with this surface applied upon a cushion in an ordinary wooden leg, he could walk without inconvenience ten miles a day, and had been able to do so since the stump was healed, some years before." He says the impression made upon his mind, when comparing it with the useless tender pointed cones of flesh left by the ordinary amputation through the thigh, was a desire to ascertain whether such an inestimable advantage might not in certain cases with safety and propriety be secured. Dr. Markoe gives the statistics of eighteen cases operated on by American surgeons, and to these he adds twenty-eight others, occurring in Europe and collected by Dr. Stephen Smith, making forty-six cases in all. Of the American cases five, and of the European twelve, were fatal; making a total mortality of seventeen, or thirty-seven per cent. Of the different modes of operating, Dr. Markoe gives a "decided preference to that by the long anterior and short posterior flap. This has the advantage of throwing the wound on the most depending aspect of the stump, allowing easy exit to the discharges, and it moreover brings the cicatrix so far back between the condyles that it is not exposed to pressure." "There is, it is true, nothing but integument on the face of the stump, but that integument is applied over a large, smooth, natural surface, well adapted to receive and sustain pressure." (See *New York Journal of Med.* vol. xvi. 1856.)

In this country, disarticulation of the knee-joint has been very rarely practised. Mr. Syme, Mr. Fergusson, and others, have, it is true, of late years amputated occasionally through the condyles of the femur, in cases of disease of the knee-joint; but these are not, strictly speaking, disarticulations of the knee. These cases will be again referred to.

The writer is informed by Mr. Blenkins, of the Grenadier Guards, that seven amputations at the knee were performed by British surgeons in the Crimea, and that of these four died and three recovered. It is stated by Dr. G. B. Macleod, that in four of these the articular end of the femur was removed. These four, therefore, should rather be considered as examples of the operation suggested by Mr. Syme, than true disarticulations of the knee. (See *Ed. Month. Journ.* July, 1856, p. 38.)

The following are the particulars of one of the three successful cases. In this case Mr. Blenkins was the operator. At the assault on the Redan, September 8, 1855, a soldier, aged 22, received a severe compound fracture of both bones of the leg, with extensive laceration of the integuments. The state of the limb did not admit of amputation of the leg; it was therefore removed at the knee-joint, by the large anterior and small posterior flap operation, the anterior flap being made six inches in length. The patella was retained, and the cartilage on it and on the condyles of the femur was not interfered with. The posterior flap was cut from without inwards, so as to remove as much as possible of the mass of muscles of the calf, which is left in the usual mode of cutting from within outwards. The flaps came together perfectly, and the wound healed in an unusually favourable manner. In three weeks it had all but closed, and at the end of six weeks it was perfectly sound and cicatrized in every part. The end of the stump was beautifully rounded, and formed an excellent surface to receive the pressure of a wooden leg. Mr. Blenkins much prefers the operation with the long anterior flap, and he believes the mortality might not have been so great had this mode of proceeding been adopted in all the cases.

In the French army in the Crimea, M. Baudens made amputation at the knee-joint one of the subjects to which he paid special attention. He says that the opinion of all the principal surgeons engaged was that disarticulation of the knee should be preferred to amputation of the thigh in all cases where it is impossible to amputate through the upper part of the leg. This opinion is confirmed, he adds, "by all that he has seen in his hospital experience from Marseilles and Toulon to Constantinople and the Crimea. It is in fact incontestable that disarticulation of the knee has succeeded in a given number of cases more often than amputation of the thigh, even in its inferior third." According to M. Baudens, however, amputation at the knee should be preferred to that of the thigh, only on the express condition that it should be performed immediately; consecutively he thinks amputation of the thigh should have the choice. The operation practised was invariably that recommended by M. Baudens, and by which the principal covering is obtained from the anterior part. (See *Comptes Rendus,* tom. xii. 1855, p. 1077.)

The present Editor has recently (October 1857) performed this operation at St. Mary's Hospital, on a boy eight years of age, who laboured under necrosis of the shaft of the tibia and of its upper epiphysis. An anterior flap was formed from the integument covering the lateral and anterior part of the upper third of the leg. This flap, which was of sufficient width and length to cover the condyles of the femur, was reflected upwards; the ligamentum patellæ was cut through and the joint opened. It was found that the disease had extended into the joint, but lymph had been thrown out and plastic adhesions formed, so as completely to separate it into an upper and lower compartment. In the upper compartment were situated the patella and condyles of the femur free from disease. In the lower compartment was found the head of the tibia, denuded of cartilage, bathed in pus and partially necrosed. The adhesions and ligaments were now divided; the knife carried through the joint, and a short posterior flap formed. The flaps were adjusted by interrupted sutures and light dressings applied. The line of approximation of the flaps was completely behind the condyles of the femur. Union by the first intention took place except in the neighbourhood of the ligatures. These separated in the first fortnight. A few drops of synovia were on two or three occasions seen to ooze from the wound. In a month the stump was soundly healed, and the little patient was exhibited to the members of the Western Medical Society about five weeks from the performance of the operation. At the present date, three months after the operation, the patella and anterior flap remain moveable on the condyles of the femur, and the weight of the body is borne without inconvenience on the end of the stump. Mr. Hussey also has lately amputated the leg at the knee-joint, in the Radcliffe Infirmary, Oxford, for necrosis of the tibia with immense hypertrophy of the integument and soft parts, in a lad aged 17. The operation was done with a scalpel, but the mode of proceeding is not stated. The condyles of the femur were not touched; the articular and semilunar cartilages were healthy. The amputated limb weighed 11¼ pounds. The last ligatures came away on the thirteenth day, and the patient was rapidly regaining health. (See *Med. Times and Gaz.* Dec. 12, 1857, p. 604.)

Amputation at the knee-joint, although recommended by many surgeons of note in America and on the Continent, has been very rarely practised in this country. Mr. Fergusson stated in 1846, that it had never, to his knowledge, been performed; and, in fact, with the exception of the Crimean cases, the two cases by Mr. Lane and

Mr. Hussey above related, and another alluded to by Mr. Fenwick, as having occurred in the Glasgow Infirmary (see *Ed. Month. Journ.* Oct. 1847, p. 248), appear to be the only recorded instances. Many surgeons hesitate to perform it, knowing the dangerous consequences of wounds of the knee-joint, and fearful of similar results from its exposure in amputation. Indeed, although the two cases are not exactly similar, experience shows that there is ground for apprehension on this score; M. Velpeau lost three cases from purulent inflammation "in the large and deep synovial cul-de-sac which is prolonged upon the sides of the condyles and upon the anterior surface of the femur;" the suppuration from which extended upwards amongst the muscles of the thigh; and he refers to four other cases which proved fatal from the same cause. The American surgeons however, have been more fortunate in this respect. Dr. Stephen Smith says:—"Fearful as are the results of the inflammatory process instantly lighted up in ordinary wounds of the knee-joint, dangerous consequences from this source are rare exceptions in the severer wound of the bisection of this articulation in amputation." (*On Amp. of the Knee-joint, N.Y. Journ. of Med.* Nov. 1852, p. 325.)

Admitting this danger, however, there appears to be sufficient evidence to establish the expediency of the operation in suitable cases, whether of injury or disease. The mortality appears to be certainly *not greater* than after amputation of the thigh. According to the statistics given by Dr. Markoe, the mortality in the two cases is 37 per cent. as compared with 43½; the advantage being thus 6½ per cent. in favour of amputation at the knee.

But even if the mortality were *equal* in the two cases, amputation at the knee deserves preference on account of the very decided advantage which it affords the patient for progression. There is ample evidence that the stump is capable of supporting the weight of the body without pain or inconvenience; and the extent of surface and rounded form of the condyles admirably adapt it for this purpose. From the power of supporting pressure results the further advantage, alluded to by Velpeau, that the free play of the hip-joint is preserved; whereas after amputation of the thigh, the artificial limb has to take its bearings from the pelvis, and the patient walks as if he had an anchylosis of the hip-joint, all his motions being made by the pelvis, and not at the coxo-femoral articulation.

In comparing the results of different modes of operating it will be found, that the cases which have been attended with the most striking success have unquestionably been those in which the principal covering has been obtained from the anterior aspect of the joint. This object may be attained either by the elliptical incision of M. Baudens or by the large anterior and short posterior flap recommended by the American surgeons, and adopted in Mr. Lane's and Mr. Blenkins's cases. These methods are preferable to Mr. Velpeau's circular incision, because they remove the cicatrix to a position where it will not suffer irritation from pressure, and they possess several important advantages over the large posterior flap, which was recommended by Hoin. The integument in front of the knee is much better organized for bearing pressure than that of the calf; it is, in fact, the very same which is found to bear the weight of the body so well in the kneeling position and after amputation below the knee. The flap falls at once of its own accord over the end of the bone; the position of the wound is depending and allows the discharge to escape without difficulty; the main artery is cut through before its division, and fewer ligatures will be required. The flap from the calf, on the contrary, cannot be adapted without bending it at an angle which is unnatural to it, and it tends by its own weight to fall away from the end of the bone; the wound is not so advantageously placed and many more arteries will require to be ligatured.

The patella when sound should always be retained; it affords a fixed point for the action of the extensor muscles, and these muscles will retract it sufficiently to prevent its interfering with the rounded form of the stump, while its removal would increase materially the surface of the wound.

When the cartilage on the femur is healthy, it should not be interfered with. Its presence does not impede the immediate union of the wound, whereas, by sawing off a slice of the bone an injured surface is substituted for a healthy one, with an additional risk of suppurative phlebitis from exposure of the veins in the cancellated texture; besides which, the rounded form of the condyles, which is one of the leading advantages of the operation, is thereby destroyed. M. Velpeau believes that adhesion always takes place between the flap and the cartilaginous surface, even in those cases where the wound unites by the first intention, and where no undue inflammation is excited. This adhesion, however, is not the invariable rule, for in Mr. Lane's case the patella and the flap remained distinctly moveable on the condyles beneath. When the wound does not unite by the first intention, and suppuration ensues, the cartilage will either exfoliate in fragments from the surface of the bone beneath, or it will undergo gradual disintegration, and be removed with the discharge, and the granulations from the bone will then coalesce with the granulations on the flap. (See REMARKS ON AMPUTATION AT THE JOINTS, *ante*, p. 71.)

Amputation through the Condyles of the Femur.—In 1845 Mr. Syme published a paper advocating amputation at the knee, or more correctly speaking, through the condyles of the femur, by which method he had operated successfully in two cases of diseased knee-joint. His principal reason for so doing, in preference to amputating the thigh in its lower third, was his belief that division of the cancellated texture of a bone is not so likely to be followed by inflammation of the medullary membrane and exfoliation as when the dense substance of the shaft is sawn through. Mr. Syme does not consider the state of the soft parts, usually met with in diseased joints, a sufficient reason for operating higher up, since, "however much they may be altered by scrofulous degeneration or suppuration, they readily admit of restoration to their natural condition," as is clearly shown by the results of excision of joints. In his first case, Mr. Syme "made an incision across the knee in a line with the upper edge of the patella, then pushed the knife from one side to the other under the joint, cut a flap from the calf of the leg, and finally sawed through the condyles of the thigh bone, which were ulcerated and carious." Finding he had not quite sufficient covering in this way, he made, in his second case, "the anterior semilunar incision in a line with the *lower* edge of the patella, and had the integuments retracted before cutting into the joint above this bone." "The posterior flap must be made very long, indeed to the full extent of the gastrocnemius muscles; care being taken, however, to avoid preserving more than a moderate portion in regard to thickness." (See *Ed. M. Journ. of Med. Science*, May, 1845, p. 537.)

In the following year, however, Mr. Syme says: "As the soft parts required to form the stump in this situation are apt to be so deranged in their texture as to delay, though not prevent recovery, and thus in some measure counterbalance the advantage of exposing cancellated instead of dense bone, together with the contents of its medullary cavity, I do not persist in advocating amputation at the knee now, when satisfied that the operation by circular incision, if performed with due care and on proper principles, may be employed in the lower third of the thigh safely and advantageously. (See *Ed. M. Journ.* Nov. 1846, p. 225.)

In the same year, Mr. Fergusson performed a similar operation successfully in a case of diseased knee-joint. His mode of proceeding was, like Mr. Syme's, with a posterior flap; both are, in fact, equivalent to the original operation of Hoin, excepting as regards the removal of the patella and of part of the femoral condyles. Mr. Fergusson has seen this patient repeatedly since. He has frequently walked forty miles in a day with a very indifferently-made artificial leg; and once accomplished 120 miles in three days without the slightest damage to the tissues! (*Op. Surg.* ed. 3, p. 503.) Mr. Fergusson says he has since frequently performed this operation; but does not state how often. (*Med. Times and Gaz.* July 8, 1854, p. 26.) Mr. Jones, of Jersey, operated in 1853 in the same manner, and the result to the patient was a "most serviceable stump, upon which he could bear the weight of his trunk in progression." (*Med. Times and Gaz.* June, 1854, p. 570.) This was a secondary amputation after compound fracture of the leg. A similar practice has been followed successfully by Mr. Potter, of Newcastle. (See *Lancet*, May 27, 1854.) And also by Dr. Markoe. (See *N. Y. Journ. of Med.* Nov. 1856, p. 823.)

This operation may be substituted with advantage for amputation in the lower third of the thigh in some cases of diseased knee-joint, and also of compound fracture into the joint, from gunshot wounds, for example, when the condyles of the femur are only to a slight extent implicated. In either of these cases the removal of the lower end of the bone of course becomes a matter not of choice but of necessity. This kind of operation, however, is not likely to be very frequently required; diseased knee-joints, which are not eligible for excision of the ends of the bones, will most probably be in a condition to compel the amputation to be performed higher up; and the same may be said, as a general rule, of compound fractures in which the lower end of the femur is involved. When the end of the femur is sawn through, the operation with the posterior flap, as recommended by Hoin, may perhaps be found the best; the thick muscular cushion thus obtained will be less likely to suffer injury from the sharp edges of the sawn bone than an anterior flap, which must necessarily be composed of integument only. The large size of the flap, however, and, in diseased joints, its altered and deranged condition will probably, as Mr. Syme found, cause delay in the healing process; but when this disadvantage has been surmounted, the condition of the stump, in the cases recorded, appears to have been in every respect highly satisfactory.]

Amputation of the Thigh.

[Here, as in the arm, there is but one bone, and here, in like manner, the deep muscles are adherent to the bone, while the superficial ones pass from the pelvis to the leg without taking any attachment to this segment of the limb. There is no "*place of election*" for the performance of amputation of the thigh; but the rule of operating as far as possible from the trunk of the body should be invariably followed. By so doing, not only will the danger from the immediate shock of the operation be diminished, and the recovery be more rapid on account of the smaller extent of the wounded surface; but the subsequent utility of the stump, from the power which the greater leverage thus obtained will enable it to exercise over the movements of the artificial limb, will be greatly increased. The propriety of this rule is now universally admitted, both by the surgeon, whose more immediate concern is in the recovery of the patient from the operation, and also by the mechanician, who is engaged afterwards in the adaptation of the artificial limb.]

Many writers, however, have disapproved of amputating too close to the knee (*Graefe*, op. cit. p. 60); Mr. Liston recommended that the bone should not be sawn very much lower than its middle, his opinion being that "a long stump here is equally inconvenient to a person in any walk of life" (*Pract. Surg.* p. 382, ed. 4); and Langenbeck urged one objection to it, not specified by any other author, viz. that if the operation be done lower down than two hands' breadths above the knee, the femoral artery shrinks into the aponeurotic sheath which it here receives from the vastus internus and triceps, and cannot be drawn out with the forceps, so as to be separately tied, without first slitting up that sheath. Hence he recommended cutting through the muscles at the distance above the knee already mentioned. (*Bibl. für die Chir.* b. i. p. 571, 12mo. Gott. 1806.) But when I come to look at the breadth of two adult hands, and see how much of the limb would be sacrificed, at all events only to save a little trouble, I cannot bring my mind to concur with Langenbeck — the remedy being worse than the alleged evil. In general, the disease obliges the surgeon to begin the incisions two or three inches above the patella, and, as Velpeau remarks, Langenbeck's direction is superfluous. (*Nouv. Elém. de Méd. Opér.* t. i. 504.)

The patient is to be placed on a firm table, with his pelvis resting on its edge, and the limb projecting beyond it. His back should be properly supported by pillows and assistants, who are also to hold his hands, and keep him from moving too much during the operation. The ankle of the sound limb may be fastened, by means of a strong band or garter, to the nearest leg of the table.

The next thing is the application of the tourniquet. (See Tourniquet.) The pad should be placed exactly over the femoral artery, in as high a situation as can be conveniently done. When the thigh is to be amputated high up, it is better to let an assistant compress the femoral artery in the groin with his thumb, or any commodious instrument furnished with a round blunt end, calculated for making direct pressure on the vessel without injuring the integuments. Some authors, indeed, give a general preference to this method, whether the thigh be amputated high up or low down. (*Paroisse, Opuscules de Chir.* p. 188; *Brünninghausen, Erfahr. über die Amp.* p. 273; *Langenbeck, Bibl. Chir.* p. 564; *Liston, Obs. in Ed. Med. and Surg. Journ.* vol. xx. p. 43, and *Elements*, part iii. p. 362.) Were the patient, however in a debilitated state, and unable to bear loss of blood, as there might, in this way, be considerable bleeding, by reason of the anastomoses with the branches of the internal iliac artery, I should feel disposed to employ the tourniquet whenever circumstances would conveniently admit of its application. In amputations of the thigh the great objection to the use of this instrument is, that it impedes the free and immediate retraction of the loose muscles after they have been cut; the consequence of which is, that the surgeon cannot divide so high, as he otherwise could do, the deeper muscles, which are more fixed and attached to the bone. Yet, in order to have the bone well covered with flesh, and no danger of a sugar-loaf stump, the latter object is one of vast importance. Perhaps the best general rule is, to abandon the application of the tourniquet in amputations performed as high as the middle of the thigh, except where the patient is remarkably weak, so that he cannot bear the smallest loss of blood, and no steady, intelligent assistant is at hand, to whom the compression of the artery in the groin can be prudently confided.

Mr. Guthrie, in speaking of amputations on the two lower thirds of the thigh, observes, that "in these cases the tourniquet should be used;" but in operations high up the thigh, he joins all other surgeons in recommending the inguinal artery to be compressed against the os pubis. (*On Gunshot Wounds*, p. 202.) The utility of slackening the tourniquet completely, however, as soon as the principal vessels are secured, — a piece of advice delivered by this excellent surgeon, — I presume, cannot be right on the ground which he specifies, viz. the impediment made by the strap of the instrument to the retraction of the muscles, and the consequent difficulty, in high operations, of sawing the bone, *because in common practice the bone is always sawn before any of the vessels are secured;* and loosening the tourniquet entirely, while any arterial branches still require the ligature, must generally be objectionable, if loss of blood be a disadvantage. In flap amputations, high up the limb, indeed, where the arteries are sometimes tied, before the division of the bone, the employment of a tourniquet at all is quite out of the question.

Circular Amputation of the Thigh. — Whether the right or left thigh is to be removed, it is customary, in England, for the operator to stand on the patient's right side. In France, the surgeon places himself on the outer side for either limb, which plan, when the left limb is to be removed, leaves the duty of drawing up the skin and muscles entirely to the assistant. (*Velpeau, Nouv. Elém.* 8vo. t. i. p. 507.) The great advantage of the other method seems to be, that the surgeon's left hand can be thus more conveniently and quickly brought into use than if he were always to stand on the same side as the limb he is about to amputate. This seems to be the only assignable reason for this habit; for, when the left thigh is to be amputated, it is certainly some inconvenience to have the right limb between the operator and the one that is to be removed. But this is found less disadvantageous than not having the left hand next the wound.

An assistant, firmly grasping the thigh with both hands, is to draw up the skin and muscles, while the surgeon, beginning with that part of the edge of the knife which is towards the handle, makes a circular incision, as quickly as possible, through the integuments down to the fascia, or, as Mr. Guthrie and Dr. Hennen recommend, even completely through it. According to Mr. Guthrie, the skin cannot be sufficiently retracted, unless the fascia be divided, which he appears to think ought rather to be drawn up with the integuments than dissected from them. (*On Gunshot Wounds*, p. 204—208; also *Hennen's Military Surgery*, p. 263.) In this way, the necessity for all painful detachment of the skin from the fascia is superseded. However, in secondary amputations of the thigh, if the integuments are unsound, and cannot be retracted, Mr. Guthrie approves of their being dissected back. On the contrary, Langenbeck is very particular in enjoining surgeons to avoid cutting through the fascia by the first sweep of the knife, because he finds that the muscles are better held together, and can be more regularly divided, by cutting them and the fascia at the same time. (*Bibl. für die Chir.* b. i. p. 564.) Nor does M. Roux divide the fascia by the first incision. (*Mém. sur la Réunion immédiate de la Plaie après l'Amputation circulaire*, p. 9, 8vo. Paris, 1814.)

In a thigh of ordinary dimensions, the first incision should be made four inches below where it is intended to saw the bone. Graefe, does not dissect the skin from the muscles at all in amputating the thigh, but takes care, after making the cutaneous incision, to have the integuments and subjacent flesh very firmly drawn up before commencing the oblique division of the muscles. This retraction he also strongly advises to be done uniformly and smoothly all around the member, lest, in dividing the muscles, any irregular projection of the skin interfere with the requisite movements of the knife. (*Normen für die Abl. grösserer Gliedmassen*, p. 103.)

In common amputations of the thigh, Roux strongly disapproved of separating the skin far from the muscles, as a circumstance highly unfavourable to the healing of the wound by adhesion. He divided only a few of the cellular bands between the integuments and fascia; and occasionally he has imitated M. Louis in cutting through the skin and superficial muscles together. (*Mém. sur la Réunion de la Plaie après l'Amputation, &c.* p. 9.)

The practice of detaching the bone from the circumjacent flesh to the extent of about an inch, after the other principal incisions are completed, as advised by Celsus and Louis, I have sometimes seen followed at Saint Bartholomew's Hospital, and have adopted it myself on other occasions, with the decided advantage of letting the bones be sawn higher up than could otherwise have been effected. Mr. Guthrie, after the incisions down to the bone, even recommends dissecting back the muscles from it "*for the space of two or three inches*, as the size of the limb, or other circumstances, may require;" but I should be reluctant to imitate the practice to this extent, though inclined to think most favourably of it within more moderate limits. If we reckon that three inches of the member lie between the first circular cut in the skin and the place where the knife arrives at the bone, and then take away two or three inches more of the femur, it is clear that, in many examples, we should be getting very high up the limb; and if a detachment of the muscles from the bone, to the extent of two or three inches, were thus made, it would at all events be of no service, unless the bone would admit of being sawn at this great distance from the termination of the oblique division of the muscles. However, if this were truly practicable (a point which I leave for others to discuss), it would certainly be consonant to the excellent general maxim laid down by J. L. Petit, that, in amputation, as much of the bone and as little of the flesh should be taken away as possible. (See *Traité des Mal. Chir.* t. iii. p. 150.) When this final detachment of the deep muscles from the bone is adopted, particular care, as Roux observes, should be taken always to divide the thick aponeurosis connecting the triceps to the linea aspera. (*Mém. sur la Réunion de la Plaie après l'Amputation*, p. 10.)

With respect to Desault's method of amputating the thigh by a circular incision, already mentioned, he considered turning the knife obliquely upwards quite unnecessary. His plan was to cut through the muscles, layer after layer, with the precaution of retracting the first stratum before he divided the second; the latter was then cut through on a level with the flesh that had been previously divided and retracted, and so on down to the bone. This, says he, is the right way of forming a true hollow cone, of which the integuments, which were drawn up before the muscles were cut, form the base, from which are gradually continued the various layers of muscles, and the highest point of which is the bone itself. (*Œuvres Chir. de Desault, par Bichat*, t. ii. p. 547.)

Dupuytren objected to this last method as tedious and painful, on account of the repeated division of the same textures by it. Hence, he preferred cutting through the integuments and muscles down to the bone with a single stroke of the knife, sometimes perpendicularly, sometimes obliquely. The contraction of the muscles, and the retraction produced by the assistant, who grasped the limb above the incision, instantly caused the wound to assume a conical projecting form. At the base of this cone, close to the edge of the retracted skin and muscles, the knife was applied again, and the flesh here drawn up as soon as divided. By cutting the muscular strata in succession, as they presented themselves under those already divided, and retracted, Dupuytren was able to lay bare the bone six inches above the line of the first incision. The operation was rapidly completed, and the patient saved from all the agony resulting from the dissection of the skin from the muscles. (See *Leçons Orales de Clinique Chir. de M. le Baron Dupuytren*, t. iv. p. 297.) In this plan, however, the deep muscles attached to the bone must have been cut through more than once, if the operator really made his knife penetrate to the bone at the first stroke, as is represented. The avoidance of the tedious dissection of the skin, the saving of pain, and the abridgement of the operation, were not the only considerations in favour of this method, for one still greater influenced Dupuytren, namely, that of not destroying the natural connections of the skin to the subjacent parts, and preserving the sources of its nutrition. Hence, he followed this plan in all circular amputations of parts of limbs, where there was only one bone. (Op. cit. t. iv. p. 351.)

Care is to be taken to leave the nervus saphenus major out of the noose. Its diminutive size prevents it from being readily seen; but as it is always situated close to the sheath, and on the outer and front part of the artery in the middle third of the thigh, there ought to be no great difficulty in finding it. (*Velpeau*, op. cit. t. i. p. 506.)

[Mr. Syme, who had for a long period been an advocate for flap amputations, has lately expressed an opinion in favour of the circular method in the lower third of the thigh; though at or above the middle of the bone he still thinks there can be no doubt of the propriety of the flap method. His reason for changing his opinion with reference to amputation in the lower third is the tendency to protrusion of the bone from retraction of the flaps during the healing process. The retraction is of course greater in the lower than at the upper part of the limb, on account of the greater length of muscular fibre remaining. Mr. Syme observes: "This distressing result depends upon the vital contractility of the muscular tissue, which, continuing in operation so long as the cut surface is not prevented from yielding by the formation of new adhesions, not only lessens the mass of flesh provided for covering the bone, but gradually retracts it, together with the superjacent integuments." (*Ed. Month. Journ.* 1846.) This is in accordance with the observation made long since by Sir A. Cooper, that "if muscular fibres are preserved with the integuments, they will contract, and retraction of the skin covering the stump will be the result." (*Lancet*, vol. i. 1823, p. 148.) Mr. Syme makes two semicircular flaps of skin, which he causes to be retracted to the extent of two inches, and he then divides the muscles in the ordinary way by circular incisions.

In the upper half of the thigh, the increasing size of the limb from below upwards will often render difficult the retraction or reflection of the integuments after the circular incision. This is especially the case, as M. Baudens has remarked, when the limb is swollen from inflammatory effusion. To avoid this difficulty, M. Baudens has suggested a combination of the flap and circular methods. He forms *short* external and internal flaps in the ordinary way, by transfixion, but comprising only the skin and the superficial muscular substance. The flaps, being turned back, can be readily retracted towards the hip, so as to allow the *circular division* of the remaining soft parts to be made at a sufficiently high level. M. Baudens' operations were performed in cases of gunshot fracture of the femur, and he commenced the incisions for the flaps *below* and not *above* the line of passage of the projectile. He made the circular incision fall upon the lower end of the upper fragment of the bone, the uneven end of which he resected after the separation of the limb. He found that the perforation of the flaps, made by the passage of the ball, so far from being hurtful, were advantageous by serving as outlets for the suppuration. (See *Clin. des Plaies d'Armes à Feu*, p. 527.)

The inconvenience arising from the increasing size of the limb might be avoided also, either by making two semilunar flaps of the integument instead of dividing it circularly, or by making the usual circular division, and superadding to it a longitudinal incision upwards on each side.]

Flap Amputation of the Thigh. — Although surgeons differ on the question, whether flap amputation of the thigh ought to be preferred, as the general practice, Desault's, or rather Vermale's mode of operating, has certainly obtained the sanction of many respectable names. In Guy's Hospital, flap amputation of the thigh seems now to be mostly preferred. The operation has been for many years past adopted by my friend Mr. Vincent in St Bartholomew's Hospital; and it is the plan which is always followed by Mr. Liston in the North London Hospital. "According to the point of removal (says he), the direction of the flap varies. If, in operating high in the limb, the flaps be made laterally, there will be imminent risk of the bone protruding through the upper part of the wound; for the patient uniformly raises the stump towards his abdomen. No antagonist muscular power is left to oppose the action of the muscles inserted into the trochanter minor, and the elevation of the stump is involuntary: it always occurs to a remarkable extent in young persons. On this account, anterior and posterior flaps are here preferable to the lateral; for then the more the stump is raised the better is the end of the bone covered, the anterior flap folding over it. Transfixion is, therefore, made horizontally, and the posterior flap should be a little longer than the anterior. But, in the lower part of the limb, lateral flaps are not only not liable to the same objection, but preferable to the anterior and posterior. In the neighbourhood of the knee-joint, the soft parts consist almost entirely of ligamentous tissue on the fore and back part, and proper cushions can be obtained only from the sides. Transfixion is therefore made perpendicularly. Thus the bone will be well covered by parts likely soon to adhere," &c. (See *Liston's Elements*, part iii. p. 394.)

By Mr. Guthrie, the flap operation is considered preferable to the circular incision at the upper part of the thigh, "as it permits the head of the bone to be removed, if found necessary; allows it to be examined and cut shorter with greater ease, and makes a much better covering afterwards." (*On Gunshot Wounds*, p. 200.)

In the flap amputation of the thigh, as originally practised by Vermale, the operator takes hold of the soft parts with his left hand, and draws them more or less away from the bone. He then introduces a long sharp-pointed knife down to the anterior surface of the femur, a few lines below the place where it is intended to apply the saw. The point is then conveyed close round the outer side of the bone, and pushed through the skin at the point of the back of the thigh exactly opposite that of its entrance. By cutting from above downwards, and from within outwards, the surgeon now forms the external flap, which should be three or four inches in length. It is to be held upwards by an assistant. The point of the knife is next brought to the front angle of the wound, and, while the soft parts are drawn inwards, it is to be carried close round the inner side of the femur, and pushed out at the posterior angle of the wound, without injuring the skin there, a second time. In this way a second flap is formed, of the same shape and length as the first. No retractor is necessary in this mode of amputating. Velpeau prefers making the external flap first, for two reasons: first, because the soft parts being less bulky on this side, it is proper to begin with saving a sufficiency of them, so that the flap may be equal in size to the other; and, secondly, because the femoral artery is not cut till the moment when the flap is completed, and the vessel may then be instantly secured without any previous pressure being made upon it in the groin. (*Velpeau, Nouv. Elém. de Méd. Opér.* t. ii. p. 511.) Flap amputation of the thigh is varied by different operators, some making anterior and posterior flaps, and others, like Langenbeck, not transfixing the limb, but cutting down to the bone from without inwards. Transfixion seems to me to be recommended by the power which it gives the surgeon of making with rapidity a capital flap.

Flap amputation of the thigh, after the manner of Vermale, is preferred by Klein, Lisfranc, Liston, and many other modern surgeons. (See *Edinb. Med. and Surg. Journ.* vol. xiv. 36—46, &c.) Of seven cases in which Klein adopted this method, the greater number were healed in ten days, and the rest in three weeks; and this success determined him in future always to practise it. After this mode, he finds there is no danger of the muscles retracting themselves, and the end of the bone protruding, even though the patient be transported from one place to another. With respect to the occasional difficulty of taking up the obliquely-cut vessels, Klein admits this objection, but thinks that it equally applies to Alanson's method. He lays great stress on the utility of giving due support to the flaps with compresses and a roller. (See *Practische Ansichten der bedeutendsten Chirurgischen Operationen*, p. 35—38, 4to. Stuttgart, 1816.)

[Mr. Fergusson makes the posterior flap about two inches longer than the anterior, to compensate for the greater retractility of the muscles at the posterior part of the thigh. Mr. South believes the retraction of the posterior flap depends, not on the greater retraction of the muscles, but "on the position in which the limb is placed after the amputation; the hind muscles, being extended, are drawn back from the face of the stump, whilst those in front are relaxed, and have, therefore, no disposition to pull away from the stump." (Translation of *Chelius*, vol. ii. p. 909.)]

If the state of the integuments did not admit of two flaps being made, a single one might be formed on the inner or outer side, the front or the back part of the limb, according to circumstances. MM. Hello and Fouilloy commonly prefer making only one flap from the anterior soft parts, a method which seems to M. Velpeau to have the advantage of more certainty, than any other plan, of preventing the protrusion of the bone, because the flap is kept over the whole extent of the wound by its own weight. Yet he is disposed to believe the circular method, when well performed, preferable to all these modifications, which he would employ only as exceptions to it. (*Nouv. Elém. de Méd. Opér.* t. i. p. 512.)

In one instance, where a ball had broken the upper third of the femur, and mortification had spread so far towards the great trochanter and buttock, that it was impossible to operate, except by the flap operation, or by taking the head of the bone out of the joint, Klein made a broad flap six inches long at the inner and upper part of the thigh, and then he cut the soft parts straight across just below the great trochanter, so as to make this wound meet the termination of the incision, by which the inner flap was formed. This patient got perfectly well in three weeks (op. cit. p. 39); and so did another very similar case, operated upon by the same gentleman (p. 43). Where the bleeding is considerable, the femoral artery and profunda should be tied previously to sawing the bone; but, if the vessels are well commanded by the pressure, the sawing ought to be first completed.

In the middle of the thigh, Lisfranc preferred amputating with two lateral flaps; pressure was made on the femoral artery as it passed over the brim of the pelvis; and the vessel is tied immediately the inner flap is formed. Lisfranc made the flaps with a long, narrow, two-edged knife, which was introduced through the limb on each side, and then cut obliquely outward and downward with it; but I think Mr. Syme is right in recommending the knife used by Mr. Liston, and the back of which is thin and blunt, except for an inch from the point. (*Ed. Med. Surg. Journ.* vol. xiv. p. 37.) Mr. Hey likewise preferred a knife with a blunt back, lest the vessels should be cut with it in a way that would render the securing of them troublesome.

[Mr. Luke adopts the plan of cutting the first flap by transfixion, and the second from the skin towards the bone. In this way the two flaps may be made exactly equal in size, and the edge of the second may without difficulty be cut as evenly as that of the first. "The operator, whether intending to remove either the right or the left limb, stands on the right side of the patient. He places the left hand on the thigh, above the part to be operated on, then takes a profile view of the limb, and inserts the amputating knife midway between its anterior and posterior surface. It is passed quickly transversely to the opposite side of the limb, and, by being inclined neither backwards nor forwards, is made to emerge at a point corresponding to that at which the instrument was passed in. The knife is then carried downwards and forwards, so as to make the lower flap, which, in consequence of its having been formed during the tension of the integuments, is perfectly even. The upper flap is then proceeded with, and is formed in a reverse manner to the lower. The knife is swept round the integument, commencing a little anterior to the point of emergence of the knife in the first steps of the formation of the lower flap, and terminating a little in front of the point of entrance, the incision corresponding in form and length to the incision of the skin in the lower flap. Two sweeps of the knife obliquely backwards are sufficient to divide the subcutaneous muscles. The lower and upper flaps are thus made, and the operation is finished in the ordinary manner. The two flaps being thus equal in length, and having their bases equal and their borders even, can be applied easily to each other without any undue traction. On the cessation of hemorrhage, they are brought together by sutures, and supported by a compress above and below, maintained in position by a few strips of plaster, and a turn or two of a roller. The application of the compresses is a matter of considerable importance, the object in their use being to apply a sufficient amount of support to keep the whole of the opposed surfaces of the flaps in mutual contact. With this object in view, their size should be so regulated as to be applied over the entire surface of each flap, but not on the extremity of the bone in the angle between the flaps." Mr. Luke attributes the favourable result that has attended his amputations in a great measure to the careful application of the compresses. Primary adhesion of the two flaps has frequently taken place throughout their entire extent; and, in most instances, this has been the case to a greater or lesser degree. (See *Ward*, in *Med. Times and Gaz.* Jan. 1852.)]

AMPUTATION AT THE HIP-JOINT.

The very idea of this formidable operation, for a long while checked the hand even of the most ready advocate for the use of the amputating knife, and every mind shuddered at so extensive a mutilation. Still, it could not be denied, that the chance of saving life occasionally depended upon a submission to the greatest temporary suffering, and that, without the most cruel of sacrifices, the preservation of the patient was totally impossible. Dreadful as amputation at the hip appeared, both in respect to the magnitude of the part of the body to be removed, and the extent of the wound caused by such removal, the desperate nature of some cases at length began to incline surgeons to view more dispassionately a scheme, at which the mind at first naturally revolted. Morand is the earliest practitioner who made this severe operation the subject of attention. (*Opuscules de Chir.* t. i. p. 176, 8vo.) In 1739, two essays on the same topic were communicated to the Royal Academy of Surgery at Paris, by two of his pupils, Volner and Puthod. In 1743, Ravaton wished to have performed amputation at the hip-joint for a gunshot fracture of the trochanter major and neck of the thigh-bone, but was prevented by the opposition of other surgeons. (*Chir. d'Arm.* p. 323, &c.) In 1748, the propriety of attempting the operation was urged by L'Alouette. (*Disp. Chir. Halleri*, t. v. p. 265.) At length, the Royal Academy of Surgery at Paris thought the subject highly deserving of further investigation. In 1756, they therefore proposed the following question, as the grand prize subject: *In the case, in which amputation of the hip-joint should appear to be the only resource for saving the patient's life, to determine whether this operation ought to be practised, and what would be the best way of performing it?* No satisfactory memoirs having been presented, the same subject was proposed again in 1759. The approbation of the Academy was now conferred on a paper written by Barbet, in which the propriety of amputating at the hip-joint was defended, and some of the cases demanding the operation specified. If, for instance, a cannon-ball, or any other violently contusing cause, had carried off or crushed the thigh, so as to leave only a few parts to be cut to make the separation complete, he thought a surgeon ought not to hesitate about doing it. The same author conceived that a sphacelus extending to the circumference of the joint, and destroying the greatest part of the surrounding flesh, might also render the operation equally necessary and easy. (See *Sabatier, Méd. Opér.* t. iii. p. 271, &c.) Cases were also adduced, where the surgeon completed the separation of the dead parts with a knife. However, this cannot be considered as amputation at the hip-joint. Dividing a few dead fibres was a thing of no importance, in regard to the likelihood of its creating any bad symptoms. The proceeding, in fact, seems to me to have no analogy at all to the bloody operation of taking the thigh-bone out of the socket. It is quite a different thing, when the operator has to cut through parts which bleed profusely, and are endowed with life and sensibility. [Mr. Cooper is here probably alluding to a case mentioned in M. Barbet's essay, which was operated on in 1748, by La Croix, of Orleans. This case, however, has since been mentioned by Mr. Sands Cox, by Mr. South, and by Dr. Stephen Smith, as the first example of amputation at the hip-joint. The patient was a boy of fourteen, both of whose lower limbs had become gangrenous from eating diseased rye; the first operation was through the right thigh, and four days after the left thigh was amputated at the hip-joint; he seemed to be going on very well, but died on the eleventh day after the second operation. (*South's Chelius*, vol. ii. p. 933.) The *operation* seems to have consisted merely of the division of the round ligament and sciatic nerve with a pair of scissors.]

In addition to the memoir by Barbet, thirty-three other essays were offered to the Academy, the majority of which were filled with arguments in favour of the operation; and, besides these productions, two other memoirs were published at Paris, one by Goursaud in 1758, explaining a new method of operating, and another by Moublet (see *Journ. de Méd.* an. 1759).

Some of the best surgeons of the last and present century condemn the proceeding. The following are Mr. Pott's sentiments: — "M. Bilguer and M. Tissot are the only people whom I have met with, or heard of, in the profession, who speak of an amputation in the joint of the hip as an advisable thing, or as being preferable to the same operation in the thigh." After a quotation or two, he continues—"That amputation in the joint of the hip is not an impracticable operation (although it be a dreadful one), I very well know. I cannot say that I have ever done it, *but I have seen it done*, and am now very sure I shall never do it, unless it be on a dead body. The parallel, which is drawn between this operation and that in the shoulder, will not hold. In the latter, it sometimes happens, that the caries is confined to the head of the os humeri, and that the scapula is perfectly sound and unaffected. In the case of a carious hip-joint this never is the fact; the acetabulum ischii, and parts about, are always, more or less, in the same state, or at least in a distempered one, and so indeed most frequently are the parts within the pelvis," &c. (*Pott on Amputation.*) Here it may be remarked, that Pott was right, inasmuch as the operation is totally unjustifiable in disease of the hip-joint; but wrong in not perceiving that, though unfit for such a case, it might be proper for others. Callisen had difficulty in supposing any circumstances, in which the operation could be undertaken with hopes of success. (*Syst. Chir. Hod.* p. 418, t. ii. edit. 1800.) And Richerand thinks, that, unless the limb be nearly separated by the disease, or accident, a prudent surgeon should decline making the attempt. (*Nosogr. Chir.* t. iv. p. 519, edit. 4.)

It is a remarkable fact in the history of surgery, that an operation, which had been invented in France, and concerning which so much had been written in that country, should have been first put in practice in England. "I have been informed," (says Professor Thomson,) "that the operation was performed in London by the late Mr. H. Thomson, surgeon to the London Hospital, and imagine that it must have been his operation to which Mr. Pott alludes." (*Obs. in the Mil. Hospitals in Belgium*, p. 264.) At all events, whether this was the identical case which Mr. Pott saw, or not, the example referred to by this distinguished surgeon is the earliest instance of the operation being actually performed. [The correctness of this statement is somewhat doubtful, even if we exclude the case by La Croix in 1748 already referred to, and to which the priority has been given of late years. The date of Mr. Thomson's case is unknown, and as M. Perrault operated in France in 1773, about the period that Mr. Thomson's case is supposed to have occurred, it is impossible to decide whether the priority should be accorded to the French or the English surgeon. Mr. South, who has made inquiries on this point, says, "Whether Thomson or Perrault operated first, or whether Thomson operated before Kerr, I cannot ascertain." (*South's Chelius*, vol. ii. p. 933.)] In the first *successful* amputation of the hip, M. Perrault, of Sainte Maure, was the operator. It was done in the year 1773, in a case of traumatic gangrene. The particulars are recorded by Sabatier. The patient, named Goix, recovered, and afterwards lived a good while as cook at an inn at St. Maure, where M. Velpeau saw his son in 1815. (See *Velpeau, Nouv. Elém. &c.* t. i. p. 514.) In Dec. 1774, it was performed by Mr. Kerr, of Northampton, on a girl between eleven and twelve years of age, in a case of diseased hip; a case, however, in which I am completely satisfied that it ought never to be attempted, for the reason laid down by Mr. Pott. In fact, Mr. Kerr, after removing the limb, found the acetabulum, and all the adjacent parts of the ossa innominata, carious. But the experiment was here rendered still more hopeless, by the patient being consumptive. Yet, with all these disadvantages, the girl lived till the eighteenth day from the operation, and, after death, her lungs were found to be a complete mass of disease, one of them being totally reduced to matter. (See *Duncan's Med. Commentaries*, vol. vi. p. 337. 8vo. Lond. 1779.) Although amputation at the hip used commonly to be demonstrated on the dead subject, by lecturers on surgery in London, the observation of M. Velpeau is very correct, that in England and Germany little serious idea was entertained of reviving the practice of it on the living till the commencement of the present century, and that about this epoch several trials of it were made by surgeons of the French army. M. A. Blandin relates three cases. His first patient was operated upon in August, 1794, and recovered. The second also got well, and the third lived till the fifty-eighth day after the operation. About the same period, M. Perret, another military surgeon, had one successful case. In 1798, Mulder amputated at the hip with success, on a young woman aged 18. (See *Velpeau, Elém. de Méd. Opér.* t. i. p. 514.) Larrey performed this operation twice in Egypt; and once, while he was serving with the French army on the Rhine. He was encouraged to make these attempts to save his patients by the consideration, that he had already preserved some lives by amputating either both thighs, both legs, or both arms, or removing the humerus at the shoulder-joint. Larrey has also the merit of having first done the operation in the description of cases, in which (with the exception of bad examples of necrosis, or of incurable disease, of the higher part of the femur) it is more decidedly proper than any other; viz. gunshot injuries of the head, neck, and upper part of the femur, with or without injury of the femoral artery, or where the limb has been carried away by a shell, or cannon-ball, too high up to admit of amputation in the ordinary manner. However, he also regards as fit occasions for amputation at the hip-joint, circumstances in which, from gunshot violence, the limb is seized, or threatened, with gangrene, nearly up to the hip. (*Mém. de Chir. Mil.* t. ii. p. 185.)

Severe as the operation is, Larrey contends that, if it ever prove the means of saving lives which are in danger, it is an act of humanity, and he argues that it is justifiable by the old maxim of Hippocrates, "Ad extremos morbos extrema remedia." To the chief objections which have been made to it, he replies, 1st, That the wound is more alarming than dangerous. The Cæsarean operation (says he) has been successfully performed on the living female, and is still recommended by many practitioners. L'Aumonier, principal surgeon of the Rouen Hospital, successfully removed a scirrhous ovary of considerable size. Examples are recorded of the arm and scapula being torn away, and the patients soon recovering. Besides, the surgeon has it in his power to lessen the wound produced by the operation. 2ndly, The dangers of hemorrhage may be obviated by the assistants temporarily placing their fingers on the mouths of the cut vessels, until ligatures can be applied.

In confirmation of his sentiments, concerning the propriety of the operation, Larrey adverts to a fact reported by Morand, where a soldier had both his legs amputated very high up, and also both his arms so near the shoulders, that he could hold nothing in his armpits. Yet mutilated as he was, he enjoyed good health. (*Opuscules de Chir.* p. 183.) And Larrey, in his own work, has recorded several instances, in which the whole of a limb was removed, or more than the halves of both the upper or lower extremities of the same subject, without any fatal constitutional disturbance. (*Mém. de Chir. Mil.* t. ii. p. 182—184.) One of his patients above alluded to survived the operation a week, at the end of which he was carried off by the plague; and the others died, after being conveyed, in a very uneasy manner, during a precipitate march of the army. (See *Relation de l'Expédition de l'Armée d'Orient en Egypte, &c.* p. 319. 8vo. Paris, 1803.) At the battle of Wagram, Larrey operated at the hip-joint on two soldiers of the imperial guard, under very unfavourable circumstances; these patients died in a few hours. (*Mém. de Chir. Mil.* t. iii. p. 349.)

Whatever method of amputating at the hip be adopted, the surgeon should remember, that the acetabulum is not deep enough to receive the entire head of the femur, which constitutes more than the half of a sphere, and is so embraced by the fibrous capsule, that it remains as it were strangulated, if this latter part be not divided close to the margin of the acetabulum. As for the ligamentum teres, it is rendered tense by abduction of the limb, and presents itself to the edge of the knife. On the contrary, if the operator begin with dividing the external portion of the capsule, the limb should be placed in the position of adduction; the ligamentum teres is then relaxed, but it makes no resistance to the disarticulation, and may afterwards be easily divided. The hip-joint is more superficial in front than in any other direction. A line drawn perpendicularly downwards, from the union of the middle with the external third of Poupart's ligament, will be sure to pass over the fore part of it.

Internal and external Flaps.—Larrey operated as follows:—He began with making an incision in the track of the inguinal artery in the bend of the groin, and tied this vessel as closely as possible to Poupart's ligament, in order that the ligature, which was placed above the origin of the circumflex arteries and the profunda, might obviate all inconvenience from the bleeding, which might otherwise have happened from their numerous branches. This being done, a straight knife was perpendicularly plunged between the tendons of the muscles attached to the trochanter minor and the base of the neck of the femur, so as to bring out its point at the back part of the limb, or in a diametrically opposite situation to its first entrance; and now, by directing the knife obliquely inwards and downwards, a flap, which was not to be too large, was made of the soft parts at the inner and upper portion of the limb. This flap was now drawn towards the scrotum by an assistant, and the articulation was brought into view. The obturator artery, and some branches of the pudendal, wounded in making the flap, were immediately tied. The thigh was now put into the state of abduction; the inner part of the orbicular ligament, made tense by this position, was divided, and the joint opened. The ligamentum teres was then cut, and the bone dislocated. The knife was next brought to the outside of the great trochanter, and an external flap formed of the soft parts, calculated to meet that which had been made at the inner side of the limb. In proceeding through the operation, Larrey secured, as soon as they were divided, the obturator arteries, and several branches of the pudendal, gluteal, and ischiatic arteries. The two flaps were brought together, and kept in this position, with strips of adhesive plaster, and a woollen spica bandage. (See *Mém. de Chir. Mil.* t. ii. p. 186—188.)

In the Russian campaign, Larrey had two more opportunities of amputating at the hip-joint. In the first instance, he operated upon a Russian at Witepsk, whose thigh-bone was broken to pieces up to the trochanter, and the soft parts of two-thirds of the thickness of the limb destroyed. This man went on as favourably as possible until the 25th day from the operation, the parts being healed except at two points, where the ligatures had been brought out; but, unfortunately a scarcity of provisions now occurred, and the patient died on the 29th or 30th day. The second operation was done on a French dragoon, after the battle of Mozaïsk, who was afterwards seen perfectly cured by the surgeon-major, at Orcha, who received him there, and made a report of the fact to Larrey. (See *Mém. de Chir. Mil.* t. iv. p. 26, 50, 51, 8vo. Paris, 1817.)

In 1812, M. Baffos amputated at the hip nearly in the manner of Larrey, except that he only compressed the artery in the groin, and did not begin with tying it, a method to which Larrey himself afterwards gave the preference. (See *Mém de Chir. Mil.* t. iv. p. 434.) The patient was only seven years old, and the case a diseased hip. The wound healed, but the child died of scrofula three months afterwards. The cotyloid cavity was found full of fungous flesh, and the os innominatum carious. As the latter state always exists in the diseased hip-joint, the whole of the disease does not admit of removal by amputation, and consequently the attempt ought never to be made. (See JOINTS, DISEASES OF.)

The plan of operation, adopted by Baffos, is considered, I believe, by all surgeons of the present day, better than that formerly practised by Larrey, inasmuch as the unnecessary preliminary measure of taking up the artery in the groin, instead of simply compressing it against the os pubis, was rejected. Cutting down to the artery as a precaution against hemorrhage is doing a double operation, and putting the patient to needless suffering: it was the earliest method, having been proposed by Volther and Puthod. Who was the first proposer to compress the artery against the os pubis, instead of cutting down to the vessel, I am not at present aware, but the plan was publicly recommended by Mr. Abernethy, in his anatomical lectures, for the last thirty years of his life.

Lisfranc was said to complete amputation at the hip-joint upon the dead subject in ten seconds; the following was his method, as described by a modern writer:—The nates of the patient resting on the edge of the table, and the limb being supported by an assistant, the operator draws a line an inch in length, from the anterior and superior spinous process of the ilium, straight down the thigh. From this point, he marks another inwards towards the pubes, of half an inch, so as to form a right angle. On the inner extremity of the last, he places the point of a long-bladed catlin, and pushes it perpendicularly downwards, till it strikes against the head of the femur. Then passing it on the outer side of the bone, he thrusts it onwards till it protrudes at about an inch from the margin of the anus. He now cuts outwards, for near an inch, in order to clear the great trochanter, and forms the external flap, four or five inches in length, by cutting down the limb between the muscles and bone. The femoral artery, which may now be seen, is compressed between the fingers and thumb of an assistant, while the operator thrusts the knife in and out at the same points, as before; but carrying it on the inner side of the head of the bone, he forms a smaller flap on that side of the extremity. Then, with the point of the knife, he cuts through the capsular ligament, dislocates the bone, and removes the limb by dividing the round ligament, &c. (See *Averill's Operative Surgery*, Lond. 1823, p. 158, &c.; *Maingault, Méd. Opératoire*, fol. Paris, 1822.) It is obvious (says Mr. Syme) that so long as the surgeon merely cuts downwards, and keeps close by the bone, he will not injure the femoral artery, which cannot be divided till the knife is carried outwards. This is one great excellence referred by Lisfranc to his operation; for, before the surgeon cuts the artery, the assistant can introduce his fingers into the wound, and compress the vessel. The disarticulation is accomplished as follows: The surgeon, seizing the limb with his left hand while the assistant holds aside the flaps, makes a cut half round the margin of the acetabulum at its fore part. The limb is then put into the posture of abduction, the bone starts from its socket, the knife is carried round its head, and the triangular ligament, and remains of the capsular ligament, are divided. (See *Ed. Med. Surg. Jour.* No. 78, p. 41.) A similar method of operating was followed by Walther. (See *Graefe and Walther's Journ.* Also *Anderson's Quarterly Journ.* vol. i. p. 630.) It was likewise preferred by Mr. Syme, in an interesting case, where he amputated at the hip-joint for an extensive necrosis of the femur, involving the neck of the bone. Unfortunately, when the wound was nearly healed, the patient became dropsical, and died at the beginning of the eighth week from the period when his limb was taken off. (Op. cit. p. 25.) Dupuytren made a semilunar incision, with its convexity downwards; it began near the anterior superior spine of the ilium, and terminated near the tuberosity of the ischium. Only the skin was first divided, which was then retracted by an assistant, and the muscles cut in the same direction, so as to form the internal flap four or five inches long. This was reflected, the capsule opened in Larrey's manner, the knife passed through the joint, and the outer flap made. Dupuytren and Béclard preferred compressing the artery on the horizontal branch of the os pubis to applying a ligature to it. Here we find two very high authorities in support of what has always seemed to me the best practice.

Langenbeck begins the first incision on the outside of the femoral artery, and forms the external flap, by extending the wound towards the tuberosity of the ischium. The knee is then inclined inwards, and the head of the femur dislocated: after which the knife is carried to the inside of the thigh, and the inner flap made. (*Bibl. für die Chir.* b. iv. s. 512.) Béclard's method seems to differ from this, chiefly by transfixion being adopted in making the flaps. The same observation applies to Lisfranc's plan. It would be useless to describe every variety of operating where the only peculiarity consists either in making the outer or the inner flap first; or in transfixion, and then cutting from within towards the skin; or in not transfixing the limb, but cutting from the integuments inwards. Some operators also make one flap longer than the other; while others, with Delpech, consider the wound more likely to heal favourably when only an internal flap is made. (See *Velpeau, Nouv. Elém.* t. i. p. 522.)

When serving with the army in Holland in 1814, I assisted the late Dr. Cole in the performance of this operation. The plan adopted by him was that taught by Mr. Abernethy, in his lectures, for more than thirty years. The flow of blood through the femoral artery was stopped by compressing the vessel in the groin with the handle of a key covered with lint. The thigh was then amputated as high as possible, close below the trochanters. The femoral artery was immediately secured, and afterwards every other vessel requiring ligature. An incision was now made near the border of the acetabulum, the cotyloid ligament divided, and the head of the bone removed with the utmost facility and expedition. The patient lost even less blood than in an ordinary amputation, and the wound admitted of being brought together with adhesive plaster in the best manner possible, so as to represent a transverse line. I am sorry to add, that the patient lived only till the following day. In one dreadful case of fracture of the upper part of the femur by a grape-shot, where the operation had been delayed too long, the whole limb being inundated with matter, and the upper end of the lower portion of the bone projecting through the flesh backward, I ventured to perform the same operation at Oudenbosch in Holland, a few days after the assault on Bergen-op-Zoom; and here happened what must often occur: immediately the soft parts had been divided, as the bone was broken to pieces, the limb came off, leaving the head of the bone, the trochanters, and a small piece below them projecting. Had not the man appeared in a very bad way by the time the vessels had been secured, I should now have removed the head of the bone; but the shock of the operation was such that he survived it but a few minutes, though scarcely any blood was lost. The mode of operating by the circular incision is preferred by Graefe, who unknowingly considers it as a new method. (*Normen für die Abl. grösserer Gliedm.* p. 118.) It has also been proposed by Dr. Veitch, with the modification of leaving an inch or two of the bone projecting, which is done without giving any additional pain, by dissecting off the soft parts below the first incisions down to the bone. This projecting piece is intended to serve as a lever, with which the head of the bone is to be got out of the acetabulum. (*Edin Med. and Surg. Journ.* vol. iii. p. 129.) Ingenious as this suggestion may be, I do not regard it as an important practical improvement; 1st, because in almost all cases where the operation is necessary, the bone is so fractured that its division is already made by the injury: 2ndly, because the scheme is unnecessary; for, in Dr. Cole's case, where I assisted, the head of the femur was removed from the acetabulum with the utmost facility by merely making an incision over that cavity, cutting the ligaments, and availing ourselves of the small piece of bone accidentally projecting. In fact, in all gunshot injuries requiring this operation, excepting a few instances of spreading gangrene from wounds, the bone is usually broken too high for Dr. Veitch's method to be practicable. With the same view of facilitating the exit of the head of the bone from the acetabulum, Graefe (p. 123) recommends dividing the transverse ligament which completes the brim of the anterior and inferior sides of the socket. Disarticulation will always be free from difficulty, however, if the capsule be divided close to the borders of the acetabulum.

Sir Astley Cooper commenced his operation by making an incision just below Poupart's ligament, a little on the outside of the femoral artery. The wound was then carried obliquely downwards and outwards to the back of the thigh, about one-third of the way down it, from which point the knife was carried in the opposite direction, obliquely upwards and inwards to meet the first incision, so as to form an elliptical curve. The femoral artery, being now divided, was immediately tied. The muscles were next cut through, another artery secured, and the bone taken out of its socket. Only about twelve ounces of blood were lost.

Oval incision.—The following method, recommended by M. Scoutteten, is stated not yet to have been practised on the living subject (*Velpeau, Nouv. Élém.* t. i. p. 525), though Sir Astley Cooper's plan seems to have been very similar to it in regard to the track of the incisions. The patient is to lie on the opposite side of the body to that on which the operation is to be done. The inguinal artery is to be compressed. The surgeon, standing behind the limb, is to put the thumb or forefinger of his left hand on the great trochanter. With the right he introduces the point of the knife perpendicularly over this process, and then gradually depressing the handle, extends the incision forwards and inwards four finger-breadths below the groin. He then carries the knife round the limb, cutting as deeply as possible and bringing the knife at length up to the point from which the wound commenced. All the muscular fibres are rarely divided by this first incision, and hence the knife must generally be applied again, ere this first stage of the operation can be completed. For the purpose of getting at the capsule, the sides of the wound must be kept apart, and any muscular fibres, not yet cut, be divided. As soon as the capsule is perceived, it is to be cut through perpendicularly on the head of the femur. The limb is now to be somewhat depressed, and the foot turned outwards, whereby the head of the bone is forced nearly out of its socket, and quits it completely as soon as the round ligament is cut, which is the only part by which it is confined. The operator then raises the thigh bone, so as to make its head project; after which he cuts the rest of the capsule and muscular fibres, and completes the separation of the limb. When the operation is on the left side, the surgeon stands in front of the limb. (See *Scoutteten, Méthode Ovalaire, ou Nouvelle Méthode pour amputer dans les Articulations,* Paris, 1827, 4to.) [This method has lately been adopted in five cases by Professor Heyfelder, of Erlangen, and three of the patients recovered. He considers this mode of operation affords great advantages for the apposition and cicatrization of the wound, and attributes the success he has met with, in a great measure, to its employment. (*Deutsche Klinik,* March, 1853.)]

Anterior and Posterior Flaps.—Mr. Liston preferred anterior and posterior flaps. The patient is placed on a firm table, with the nates projecting a little beyond its edge. The sound limb may be secured to the foot of the table with a towel; all occasion for an assistant to hold it being thus done away with, and more freedom afforded to the operator in his movements. The other limb is supported by one assistant, while another presses with one or both thumbs on the femoral artery, where it passes over the pubes. Transfixion is then performed horizontally, the knife passing in a somewhat semicircular direction, so as to include as much of the soft parts as possible, and an anterior flap is made by cutting downwards. During the passage of the knife across the joint, the assistant, holding the limb, rotates the limb, if it be the right one, a little outwards, or, if it be the left, in the contrary direction, so as to facilitate the bringing of the point of the knife through the skin well inwards. After the formation of the flap, the assistant abducts the limb forcibly, and depresses it; the joint is opened; the round ligament cut; the rest of the capsule divided; the blade of the knife placed behind the great trochanter; and the posterior flap quickly formed. After transfixion for the anterior flap, and when the sawing motion of the knife has made a little advance, the compressing assistant shifts his hands into the incision immediately behind the back of the knife, and thus obtains a firm grasp of the femoral artery, previously to its division. He retains this hold during the rest of the operation, at the same time retracting the flap. As soon as the limb is off, the bleeding vessels in the posterior flap are compressed, and tied as quickly as possible. Lastly, the femoral artery is secured, which, while the assistant retains his hold of it, will not bleed. (See *Liston's Elements*, part iii. p. 395.) The methods of M. Plantade, M. Manec, and Mr. Ashmead (see *Velpeau, Nouv. Elém. &c.* t. i. p. 520) are all only modifications of the foregoing plan. M. Plantade makes the principal flap in front, and seems to have been one of the greatest advocates of this method, which he began to recommend in 1806.

Amputation at the hip-joint has now been performed in many instances, and the patients saved. The earliest example of success is that done, as I have stated, by M. Perrault in 1773. Other successful operations, done by Blandin and Mulder, I have already noticed. Another successful amputation of the hip, (the first by any British surgeon,) was performed by Mr. Brownrigg, staff surgeon, on the 12th of December, 1812. The upper part of the thigh-bone had been broken by a gunshot near Merida, in Spain, on the 29th of December, 1811. Some time ago, the man was living at Spalding in Lincolnshire in perfect health. Other successful amputations of the hip are those performed by Larrey at Witepsk; by Mr. Guthrie in the Netherlands on a French prisoner of war; and by Sir Astley Cooper, who performed the operation on account of a disease of the higher part of the femur. As the patient had formerly suffered amputation of the thigh, it was certainly not the sudden removal of nearly a quarter of him; but, I cannot presume to say, what difference in the chances of success, and whether any, would be connected with the circumstance. The same remark applies to a case lately under Mr. Mayo, where the patient, a young woman, recovered. The proceeding was adopted on account of the agony experienced by the patient from a neuralgic affection of her stump.

In June, 1824, amputation at the hip was done by Delpech, on account of a necrosis of the femur, and the patient was completely well in the following September. (See *Revue Médicale.*) The operation was also performed by Dr. Mott, of New York, on the 7th of October, 1824, and the whole of the wound had healed by the 20th of November. This case was a bad fracture of the upper part of the femur, followed by abscesses and disease of the bone. (See *Philadelphia Journal*, No. 9, vol. v. New Series.) The patient's age was favourable, as he was a boy of only ten years of age. At this period of life, the chances of success will always be greater than in adults, not only in consequence of the remedial power of nature being then particularly great, but on account of the smaller dimensions of the wound necessary for the purposes of the operation. Another successful amputation at the hip was performed by Mr. Orton in 1826; the disease commenced in the knee; but terminated in extensive disease of the thigh-bone, large abscesses, and dislocation of the knee, the leg being fixed in the bent position, and drawn under the thigh. (See *Méd. Chir. Trans.* vol. xiii. p. 605.) The operation has also been performed with a successful result by Wedemeyer and Bryce.

On the other hand, the failures of this operation are numerous, though undertaken by surgeons of reputation and ability. Mr. Guthrie, Dr. Emery, Mr. Brownrigg, Baron Larrey, Baron Graefe, Sir B. Brodie, Mr. Carmichael (*Trans. of the Assoc. Physicians*, vol. iii.); Drs. Blick, Emery, and Cole; Baron Dupuytren; MM. Gensoul, Clot, Roux, Delpech, Pelletan, Dieffenbach, Syme, Velpeau, and Walther, have each had the mortification of losing at least one of their patients, after this very severe operation.

A calculation has been made, that the proportion of recoveries has been six in twenty operations, which is equivalent to a mortality of 70 per cent. At all events, it appears that, in the course of ten years, nearly twenty well-authenticated instances of recovery, after this severe operation, have occurred. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 515; *Chelius, Handb. der Chir.* b. ii. p. 763.)

[In 1844, Mr. Sands Cox, of Birmingham, had a successful case, in a young woman who had previously undergone amputation of the thigh for a diseased knee-joint. The amputation at the hip was on account of a diseased growth in the stump, with obstinate fungous ulceration of the integuments. This, it should be observed, is the third instance of *successful* amputation at the hip where amputation of the thigh had been previously undergone; the other two, by Sir A. Cooper and Mr. Mayo, have been already mentioned. Two more have since occurred, and each with a similar result; one by Mr. Syme, in 1849, the other by Dr. Bradbury of Boston, U.S., in 1852. The reason of the great success of these cases is, no doubt, to be found in the smaller amount of shock and of disturbance to the circulation which they occasion; for although the actual operation is the same, the immediate impression on the system must be very different where some six inches only of the limb are removed, and where the whole member, equal in weight perhaps to one-fourth of the entire body, is at once taken away. In these five cases, the amputation of the thigh had been done some time previously, and the patients had either completely recovered, or, at any rate, were no longer suffering from its immediate effects. But there are two other instances of amputation of the hip following amputation of the thigh under less favourable circumstances; where, in fact, the second operation was rendered necessary by the evil consequences resulting from the first. One of these, which recovered, was by M. Textor, in 1841, for gangrene of the stump after amputation of the knee. The other, which was fatal, was by Mr. Guthrie, in 1814, for sloughing and hemorrhage after amputation of the thigh for gunshot wound. We have thus seven examples of amputation at the hip where the thigh had been previously amputated, with the remarkable result that six out of the seven were successful.

In 1845, Mr. Cox published a Memoir on Amputation at the Hip-joint, at which period he was enabled to collect the records of eighty-four cases, which he gives in a tabular form. Of the eighty-four, twenty-six recovered, and fifty-eight died, giving a mortality of, as nearly as possible, 69 per cent. This, however, is in all probability too favourable a result, for, as Mr. Cox observes, there is "great difficulty in obtaining an account of the failures of the operation, especially of the cases which were operated on on the field of battle, where the operators had no time or opportunity to commit the details to paper;" while, on the other hand, the successful cases have always excited so much interest, that there is little likelihood that any of them have been left unrecorded.

In 1852, Dr. Stephen Smith, of New York, published a similar statement, comprising ninety-eight cases. Several successful cases had occurred in the interval since the appearance of Mr. Sands Cox's memoir, in 1845. The ratio of mortality is, therefore, very considerably reduced, and, according to Dr. Smith, the proportion of deaths to recoveries in the whole ninety-eight, is as fifty-six to forty-two, or 57·14 per cent. Some fatal cases, however, have been overlooked by Dr. Smith; one, for instance, by Mr. Liston, and another by Mr. Syme (both of which are included in Mr. Sands Cox's table), and a third in 1849, by Mr. Jones, of Jersey. But even allowing for these, the result is too favourable to be accounted for in any other way than by the non-publication of some of the unsuccessful cases. In sixty-two instances where the cause of the operation is stated with sufficient accuracy, Dr. Smith gives the following comparison between cases for severe injury and cases for chronic disease. In thirty of the former class, three out of five died, or 60 per cent. In thirty-two of the latter, the result, as might have been expected, was more favourable, the deaths and recoveries being equal, or a mortality of 50 per cent. The following further analysis of these cases, showing the mortality at different periods since the introduction of the operation, is also interesting. Previously to 1800, according to Dr. Smith, it had been performed fifteen times, the recoveries to the deaths being as two to three, or the mortality $66\frac{2}{3}$ per cent. These results had the effect of directing attention strongly to the operation, and during the twenty years subsequently to 1800, it became of much more frequent occurrence, although the ratio of mortality was very considerably increased. During this period there were performed twenty-four operations, of which eighteen proved fatal, giving a mortality of 75 per cent. During the next twenty years, ending with 1839, there are reported forty-two cases, of which twenty-nine were fatal, eleven successful, and two doubtful,—admitting the doubtful among the fatal,—and they give a mortality of nearly 74 per cent. During the last twelve years the number of operations reported is twenty-one, of which eighteen were successful and two fatal, being a mortality of a little over 14 per cent. In reviewing the history of this operation, thus briefly sketched, it will be seen that the per centage of mortality has not gradually diminished from the earliest introduction of the operation, but quite abruptly. It is difficult to account for this feature in the operation (says Dr. S.), except in a general way, for the ratio of accidents and injuries to chronic disease of the thigh remains nearly the same in both periods. We may suspect, however, that the cases were better selected, that the operation was more skilfully executed, and, above all, that much is due to the employment of anæsthetics. (*New York Journ. of Med.* vol. ix. 1852, p. 184.)

Since the publication of the last edition of this dictionary in 1838, there are records of nineteen cases performed by British surgeons, of which the following is a brief outline.

In June, 1843, by Dr. Handyside, of Edinburgh, for malignant disease of the femur in a boy aged 13. The method employed was by anterior and posterior flaps. This case recovered favourably from the operation, but died 4½ months afterwards of a malignant tumor in another part of the body. (*Lond. and Ed. Med. Journ.* April, 1845, p. 254.)

In Nov. 1844, by Mr. Sands Cox, of Birmingham. Successful. This case has been already referred to.

In Feb. 1846, by Mr. Whipple, of Plymouth, for diseased knee-joint, abscesses, and irregular growth from the femur, extending up to the trochanters. Anterior and posterior flaps. Successful. (*Lancet*, vol. ii. 1846, p. 883.)

In Sept. 1848, by Mr. Syme, for abscesses and necrosis following amputation of the thigh, which had been performed three months previously for a compound fracture. Anterior and posterior flaps. Twenty-one ligatures were applied. This was the first successful case in Scotland. (*Lond. and Ed. Month. Jour.* 1848, and *Med. Times*, Jan. 1849, p. 252.)

In Feb. 1849, by Mr. Jones, of Jersey, for sloughing and secondary hemorrhage after a lacerated wound of the thigh, sixteen days after the accident. Anterior and posterior flaps, the anterior being the longer. Fatal in twenty-seven hours. (*Med. Times*, March, 1849, p. 434.)

In Nov. 1849, by Mr. Wigstrom, 14th Light Dragoons, at Lahore, for diseased femur and profuse suppuration, extending nearly to the hips. Anterior and posterior flaps. Successful. (*Lancet*, vol. i. 1850, p. 411.)

The above, with the exception of Mr. Jones's case, are included in Dr. Smith's statistical tables.

In April, 1852, by Mr. Hancock, in the Westminster Hospital, for erysipelas and gangrene after compound fracture of the thigh. Operation seventeenth day after the injury; died almost immediately. (*Lancet*, vol. i. 1857, p. 31.)

In Jan. 1853, by Dr. R. J. Mackenzie, of Edinburgh, for extensive necrosis of the femur. Long anterior, short posterior flaps. Secondary hemorrhage and death on seventh day; went on well till that time. (*Ed. Med. and Surg. Journ.* 1854, p. 117.)

In Feb. 1853, by Dr. Fayrer, at Rangoon, for gunshot fracture. Died a month afterwards from tetanus, wound all but healed. (*Ed. Med. and Surg. Jour.* 1854, p. 418.)

In March, 1853, by Dr. Beatson, at Rangoon, for gunshot fracture. Secondary amputation. Anterior and posterior flaps. Died shortly afterwards. (*Ranking's Abstract*, vol. xxi. p. 182, and *Ind. Annals of Med. Science.*)

In April, 1853, by Mr. Charles Guthrie, in the Westminster Hospital, for malignant disease of femur. Anterior and posterior flaps. Fatal next day from hemorrhage. (*Lancet*, vol. i. 1853, p. 405.)

In May, 1853, by Mr. Wheatcroft, of Cannoch, Staffordshire, for disease of hip-joint. Three flaps. Fatal in four hours. (*Lancet*, vol. i. 1853, p. 470.)

In March, 1854, by Mr. Adams, at the London Hospital, for malignant disease of the femur. Anterior and posterior flaps. Fatal in eleven days. (*Med. Times*, April, 1854, p. 349.)

In March, 1855, by Mr. Erichsen, at University Coll. Hospital, for compound fracture from railway injury. Anterior and posterior flaps. Died same evening. (*Lancet*, vol. i. 1855, p. 363.)

In July, 1855, by Mr. Tatum, in St. George's Hospital, for malignant disease of the femur. Large anterior and smaller posterior flap. Successful. (*Lancet*, vol. ii. 1855, p. 77.)

In March, 1856, by Mr. Curling, in the London Hospital, for malignant disease of the femur. Anterior and posterior flaps. Successful. Died ten months afterwards from chest disease, not malignant. (*Lancet*, vol. i. 1857, p. 6.)

In October, 1856, by Mr. Hancock, at the Charing Cross Hospital, for extensive necrosis of femur. Anterior and posterior flaps. Successful. (*Med. Times and Gaz.* Jan. 1857, p. 114.)

In March, 1857, by Mr. Stanley, in St. Bartholomew's Hospital, for malignant disease. Short anterior, long posterior flaps. Death in two hours. (*Lancet*, vol. i. 1857, p. 343.)

In Sept. 1857, by Mr. Lane, in St. Mary's Hospital, for compound fracture from railway injury. Short anterior, long posterior flap. Death same evening.

Thus we have had, since 1838, nineteen cases, with eight recoveries and eleven deaths. Thirteen of these were for various chronic diseases, and eight out of the thirteen recovered. The results of the operation, therefore, when undertaken for disease, have latterly been of a decidedly encouraging character. Unfortunately, however, the reverse has been as decidedly the case when it has been undertaken for injury. The remaining six cases were for this cause, and the whole of them were fatal. Three of these were primary, and three were secondary amputations. Equally unfortunate have been the results of the operation during the late war. Fourteen amputations at the hip-joint were performed by British surgeons in the Crimea, and the whole fourteen died. The French, however, according to Dr. Macleod, had one case of recovery at the hospital at Pera, in the winter of 1854. (*Ed. Med. Jour.* June, 1856, p. 1083.) Three more cases, all unsuccessful, occurred in the Punjab campaigns in 1848-9. (See *McRae*, *Ind. Annals of Med. Science,* April, 1857, p. 663.)

The mode of operation now generally practised is that with anterior and posterior flaps. It may sometimes be modified by making the anterior flap larger than the posterior, which, when practicable, is probably an improvement, because the flap falls by its own weight over the wound, and the discharge will escape with greater facility. The long anterior flap is recommended by M. Baudens. (*Bourgéry*, *Méd. Opér.* vol. i. p. 273.) M. A. Guérin suggests that the posterior flap may be made more even and regular by cutting from without inwards. For this purpose, after the disarticulation is completed, the knife should be carried under the limb to divide the integuments and remaining muscles from the surface upwards towards the wound. (*Méd. Opér.* t. i. p. 191.) Mr. Skey recommends two flaps to be formed from the integuments only, with a circular division of the muscles after the flaps have been reflected back. (*Op. Surg.* p. 357.) This latter plan has not yet, we believe, been carried out in practice. It is customary to employ about half a dozen interrupted sutures to maintain the edges of the flaps in apposition.]

No one can expect, however, this operation not to fail in a large proportion of the cases in which it is attempted: this must always happen, let it be done in the most skilful manner possible. Yet, as there are unquestionably some descriptions of injury, where life must inevitably be lost if this proceeding be rejected, and experience proves that it sometimes answers, an important consideration is, what cases are most proper for it? Here I am decidedly of opinion, with Professor Thomson, that the examples in which it is particularly called for, and where no delay should be suffered, are those in which the head or neck of the thigh-bone has been fractured by a musket-ball, grape-shot, or small piece of shell. Eight or ten such cases, where amputation ought to have been done in the first instance, were brought in waggons several days after the assault on Bergen-op-Zoom into the hospital superintended by myself at Oudenbosch, and not one of these patients lived ten days after their removal. In the whole course of my professional life, I have never elsewhere witnessed so much suffering, or suppuration in such profusion. From each limb, at least three or four pints of matter were discharged daily. Had amputation at the hip been performed at first, some of these patients might possibly have been saved; at all events, I am certain that it was their only chance.

Larrey deems the operation proper, where the thigh has been shot off high up, or where the femur and soft parts near the hip have been broken, and extensively lacerated by a cannon-ball or pieces of shell. Here the operation (though perhaps the only chance) must almost always fail, because, as Professor Thomson observes, these injuries occasion a shock to the constitution, of which the patient mostly sinks either immediately, or in a few hours. (*Obs. made in the Mil. Hosp. in Belgium*, p. 274.) The truth of this observation I saw exemplified at Merxhem, near Antwerp, at the bombardment of the French fleet in that port; a shell burst between the thighs of one of the guards; tore and lacerated two-thirds of the thickness of the upper part of the right thigh; broke the ascending ramus of the ischium; lacerated the perineum and scrotum; and fractured the higher part of the femur. There was no hemorrhage of consequence; but the exposed lacerated surface of the soft parts was immense, and the unfortunate soldier, who lay with his hairs standing erect, and bereft of his intellectual faculties, sunk in the course of a quarter of an hour into a state of insensibility, and was quite dead in twenty minutes. However, there are numerous cases, in which the patients, after dreadful injuries of the upper part of the thigh, are less depressed and overcome, and live several weeks; facts clearly proving, that the operation ought to be attempted. Many instances of this kind are related by Mr. Guthrie. (*On Gunshot Wounds*, p. 134, &c.) [Mr. Guthrie thinks "It may be laid down as a principle, in all cases of accident, whether from shot, shell, or railway carriages, that no man should suffer amputation at the hip-joint when the thigh-bone is entire. It should never be done in cases of injury where the bone can be sawn immediately below the trochanter major, and sufficient flaps can be preserved to close the wound thus made. An injury warranting this operation should extend to the neck or head of the bone, and it may be possible even then to avoid it by removing the broken parts." (*Lancet*, vol. i. 1852, p. 555.)] Bad and incurable disease of the upper part of the femur (not the scrofulous hip, nor any other example in which the pelvis is affected) may also require the performance of amputation at the hip-joint, as was recently illustrated in the practice of Mr. Syme, and in that of Sir Astley Cooper. The case in which Mr. Carmichael amputated at the hip was what is termed an osteo-sarcoma: the patient, a girl, nineteen years of age, died on the fifth day. (See *Trans. of the King's and Queen's College of Physicians, Ireland*, vol. ii. p. 357, &c.; and vol. iii. p. 158.) Dr. Mott's case was one of fracture of the upper part of the femur, ending in disease of the bone and extensive abscesses. The disease for which Delpech operated was necrosis of the thigh bone. The propriety of the operation in desperate cases is now perfectly established.

Thus, as M. Velpeau observes, a comminuted fracture, an osteo-sarcoma, a spina ventosa, any incurable disease of the femur extending above its shaft, gangrene, in short, any disease reaching to the vicinity of the hip, and so serious as to require the removal of the limb, are cases for amputation at this joint, provided the acetabulum and bones of the pelvis be unaffected. It is indispensable for gunshot wounds of the upper third of the thigh combined with fracture. (See *Nouv. Elém. de Méd. Opér.* t. i. p. 516.) It was performed by Mr. Mayo for a neuralgic affection of a thigh stump.

[Several of the more recent operations have been for malignant disease of the femur, and the question has arisen whether in all such cases it would not be better to amputate at the hip than in the continuity of the bone already diseased. That the disease does return rapidly in the stump when the amputation is performed in the continuity of the bone is unfortunately too well ascertained. Three cases of this kind occurring to Messrs. C. Guthrie, Lloyd, and Prescott Hewett, are recorded in the *Lancet* for 1850 and 1851, and in all these cases the surgeons are stated to have expressed their regret at not having amputated at the next joint above the disease. But, as it is observed in that journal, it is doubtful whether there is a sufficient guarantee against recurrence in taking off the limb at the hip-joint, to justify the immediate risk of life incurred by this hazardous operation. (See *Lancet*, vol. i. 1853, p. 406.)]

[STATISTICS OF AMPUTATIONS.]

[It is to be regretted that all our large public institutions do not furnish regular returns of the results of their principal operations. Such returns, showing not only the mortality, but the causes of death, and the period after the operation at which it takes place, would be of the greatest possible value in determining many questions relating to the subject of amputation.

In the absence of such sources of information, the following tables have been compiled from the principal statistical returns which have been published of late years. They produce, it will be seen, an aggregate of 5242 cases. Being derived from various sources, military and civil, from hospitals, both provincial and metropolitan, in this country, France, and America, and the cases having been subjected, therefore, to every variety of external influences, they may be supposed to afford a tolerably correct idea of the mortality after these operations.

The following are the authorities whose researches have been made available for this purpose.

B. Phillips.—640 cases of amputations of all kinds occurring in the previous four years in Great Britain, France, Germany, and America. (*London Med. Gaz.* 1838, vol. xxii. p. 457.)

Dr. J. A. Lawrie.—On the results of amputation. 276 cases in the Glasgow Infirmary from 1794 to 1838. (*London Med. Gaz.* Dec. 1840, vol. xxvii. p. 394.)

Steele.—Amputations in the Glasgow Infirmary from 1839 to 1848—284 cases. (*Ed. Med. and Surg. Journal*, 1849, vol. lxxii. p. 282.)

Statistical Reports of Operations in the London Hospitals, by the Medical Society of Observation, from 1837 to 1842—186 cases. (*MS. in Library of Med. Chir. Soc.*)

J. Erichsen.—140 amputations occurring in University College Hospital. (*Science and Art of Surgery*, p. 60.)

J. F. South.—54 amputations performed by him in St. Thomas's Hospital between 1835 and 1840. (*Translation of Chelius*, vol. ii. p. 905.)

Edw. Parker.—Statistical Account of Amputations in the Liverpool Northern Hospital, from March, 1834 to March, 1841—73 cases. (*Lond. Med. Gaz.* vol. 28, 1841, p. 269.)

J. H. James.—On the Causes of Mortality after Amputation. 300 cases in the Devon and Exeter Hospital from 1816 to 1849. (*Transactions of the Provincial Med. and Surg. Association*, vol. xvii. 1850.)

Samuel Fenwick.—Operations in the Newcastle Infirmary from 1823 to 1843—225 cases. (*Ed. Monthly Journal of Med. Science*, 1848.)

E. L. Hussey.—Analysis of cases of Amputation of the Limbs in the Radcliffe Infirmary, Oxford—180 cases. (*Med. Chir. Trans.* vol. 31, p. 221, 1856.)

Dr. G. W. Norris.—Statistical Account of Amputations in the Pennsylvania Hospital, from 1830 to 1850—200 cases. (*American Journ. of Med. Science for* Aug. 1838, May, 1840, and July, 1854.)

Dr. Geo. Hayward.—Statistics of the Amputations at the Massachusett's General Hospital, from 1822 to 1850—146 cases. (*American Journ. of Med. Science for* May, 1840 and Jan. 1851.)

Henry Buel.—Amputations in the New York Hospital during nine years, from 1839 to 1848—91 cases. (*Amer. Journ. of Med. Science*, vol. xvi. 1848. p. 33.)

Dr. Stephen Smith.—Statistics of Amputation at the shoulder-joint—39 cases. (*New York Journ. of Med.* Jan. 1853); and of Amputation at the hip-joint—98 cases. (Same Journal, Sept. 1852.)

Dr. Markoe.—On Amputation at the knee-joint—46 cases. *New York Journ. of Med.* Jan. 1856, p. 45.)

Malgaigne.—Amputations in the Parisian Hospitals during ten years, from 1836 to 1846—519 cases. (*Erichsen's Surgery*, p. 60, and *London Med. Gaz.* Sept. 15, 1848.)

Guthrie.—(*Commentaries on the Surgery of the War from* 1808 *to* 1815. Ed. 5, 1853, pp. 150–154.)

R. Alcock.—(*Medical History of the Spanish Legion.* London, 1838.) 123 cases.

Crimea.—500 cases, occurring in the latter half of the late war, furnished to the writer by the kindness of Mr. G. E. Blenkins, Grenadier Guards.

Statistical Table, showing the Mortality after Amputations of all kinds (exclusive of fingers and toes.)

	Number of Cases.	Fatal.	Mortality per Cent.
Phillips . .	640	150	23·43
Lawrie . .	276	100	36·3
Steele . . .	284	122	42·95
London Hospls.	186	69	37·09
Erichsen . .	140	32	23
South . . .	54	13	24·07
Parker . .	73	20	27·39
James . . .	300	43	14·33
Fenwick . .	225	54	24
Hussey . .	180	23	12·77
Norris . .	200	49	24·50
Hayward .	146	32	21·91
Buel . . .	91	26	28·57
Malgaigne .	519	281	54
Guthrie . .	1305	470	36·01
Alcock . .	123	58	47·15
Crimea . .	500	202	40·4
Total .	5242	1744	33·25

In the following table the amputations performed for injury are distinguished from those performed for disease, in order that a comparison may be made between the two classes of cases.

	INJURY.			DISEASE.		
	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie . .	123	65	52·84	153	35	22·87
Steele . .	225	99	44	59	23	38·98
Lond. Hospls.	77	33	42·85	109	36	33·02
Erichsen . .	45	14	31·11	95	18	18·94
South . . .	24	9	37·5	30	4	13·33
Parker . .	49	14	28·57	24	6	25
James . .	94	25	26·59	206	18	8·73
Fenwick . .	81	26	32·09	144	28	19·44
Hussey . .	56	10	17·85	124	13	10·48
Norris . .	156	44	28·2	44	5	11·34
Hayward .	59	22	37·28	87	10	11·49
Buel . . .	62	19	30·64	29	6	20·67
Malgaigne .	164	107	65·24	335	174	49·01
Guthrie . .	1305	470	36·01			
Alcock . .	123	58	47·15			
Crimea . .	500	202	40·4			
Total .	3143	1217	38·72	1439	376	26·12

In the next table a further subdivision is made of the amputations for injury into primary and secondary, in order that the results at the two periods may be compared.

Amputations for Injury.

	PRIMARY.			SECONDARY.		
	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie . .	77	39	50·65	46	26	56·52
Steele . .	169	62	36·68	56	37	66·07
Erichsen . .	23	6	26·08	22	8	36·36
South . . .	21	8	38·09	3	1	33·33
Parker . .	40	8	20	9	6	66·66
James . .	68	18	26·47	26	7	26·92
Fenwick . .	71	23	32·39	10	3	30
Hussey . .	50	9	18	6	1	16·66
Norris . .	115	28	24·34	41	16	39·02
Hayward .	34	13	38·23	25	9	36
Buel . . .	36	10	27·77	26	8	30·76
Guthrie . .	456	77	16·88	849	393	46·27
Alcock . .	82	43	52·43	41	15	36·58
Crimea . .	441	166	37·64	59	36	61·01
Total .	1683	510	30·3	1219	566	46·43

By separating the cases occurring in military from those occurring in civil practice, the following results are obtained.

	Number of Cases.	Fatal.	Mortality per Cent.
Military .	1928	730	37·86
Civil . .	1215	487	40·08

Subdividing these into primary and secondary, we have—

Primary:			
Military .	979	286	29·21
Civil . .	775	247	31·87
Secondary:			
Military .	949	444	46·78
Civil . .	270	122	45·18

Particular Amputations.

Amputations of the Forearm.

	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie . . .	22	0	0
Steele . . .	43	6	13·95
Lond. Hospls.	21	5	23·8
Erichsen . . .	15	0	0
South	5	0	0
Parker . . .	9	3	33·33
James . . .	33	1	3·03
Fenwick . . .	15	4	26·66
Hussey . . .	28	1	3·57
Norris . . .	40	2	5
Hayward . .	11	2	18·18
Buel	13	3	23·07
Malgaigne . .	10	2	20
Guthrie . . .	39	6	15·38
Alcock . . .	7	2	28·57
Crimea . . .	59	3	5·08
Total .	370	40	10·81

Distinguishing those for injury from those for disease:—

Injury . . .	292	30	10·27
Disease . . .	78	10	12·82

Subdividing those for injury into primary and secondary :—

Primary	232	16	6·89
Secondary	47	10	21·27

Separating the military from the civil cases :—

Primary :—

Military	79	4	5·06
Civil	153	12	7·84

Secondary :—

Military	26	7	26·92
Civil	21	3	14·28

Amputations of the Arm.

	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie	53	21	39·62
Steele	74	29	39·18
Lond. Hospls.	27	7	25·92
Erichsen	19	5	26·31
South	6	0	0
Parker	7	2	28·57
James	38	5	13·15
Fenwick	35	5	14·28
Hussey	23	3	13·04
Norris	31	5	16·12
Hayward	11	1	9·09
Buel	11	0	0
Malgaigne	90	41	45·55
Guthrie, 1815	72	17	23·61
Alcock	29	12	41·37
Crimea	102	25	24·5
Total	628	178	28·34

Distinguishing those for injury from those for disease :—

Injury	463	134	28·94
Disease	165	44	26·66

Subdividing those for injury into primary and secondary :—

Primary	336	94	27·97
Secondary	114	37	32·45

Separating the military from the civil cases :—

Primary :—

Military	137	36	26·27
Civil	199	58	29·14

Secondary :—

Military	66	18	27·27
Civil	48	19	39·58

Amputations at the Shoulder-Joint.

	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie	6	3	50
Lond. Hospls.	3	3	100
James	3	0	0
Fenwick	5	2	40
Hussey	1	1	100
Smith	39	14	35·89
Malgaigne	7	7	100
Guthrie, 1815	18	7	38·88
Alcock	10	1	10
Crimea	39	13	33·33
Total	131	51	38·93

Distinguishing those for injury from those for disease :—

Injury	113	46	40·7
Disease	18	5	27·77

Subdividing those for injury into primary and secondary :—

Primary	73	25	34·24
Secondary	26	15	57·69

Separating the military from the civil cases :—

Primary :—

Military	48	10	20·83
Civil	25	15	60

Secondary :—

Military	19	11	57·89
Civil	7	4	37·14

Amputations of the Leg.

	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie	62	30	48·38
Steele	95	44	46·31
Lond. Hospls.	65	28	43·07
Erichsen	53	9	16·98
South	14	3	21·42
Parker	37	11	29·72
James	80	13	16·25
Fenwick	112	29	25·89
Hussey	50	1	2
Norris	71	29	40·84
Hayward	54	10	18·51
Buel	24	7	29·16
Malgaigne	191	105	54·97
Guthrie	93	23	24·73
Alcock	18	6	33·33
Crimea	101	36	35·64
Total	1120	384	34·28

Distinguishing those for injury from those for disease :—

Injury	649	257	39·59
Disease	471	127	26·96

Subdividing those for injury into primary and secondary :—

Primary	447	172	38·47
Secondary	175	73	41·71

Separating the military from the civil cases :—

Primary :—

Military	141	41	29·14
Civil	306	131	42·81

Secondary :—

Military	71	24	33·80
Civil	104	49	47·11

Amputations at the Knee-Joint.

The cases collected by Drs. Stephen Smith and Markoe are forty-six in number. To these may now be added seven cases occurring in the Crimea, and seven others by Messrs. Syme (2), Potter, Jones, Markoe, Lane, and Hussey. Only two of these latter, and three out of the seven Crimean cases were true disarticulations of the knee; in the remainder the articular end of the femur was removed.

	Number of Cases.	Fatal.	Mortality per Cent.
Markoe . . .	46	17	37
Crimea . . .	7	4	57·14
Other cases .	7	0	0
Total . .	60	21	35

Mr. Fergusson's cases are not included, their number not having been stated.

Amputations of the Thigh.

	Number of Cases.	Fatal.	Mortality per Cent.
Lawrie . . .	128	46	35·98
Steele . . .	72	43	59·72
Lond. Hospls. .	70	26	37·14
Erichsen . . .	53	18	33·96
South . . .	28	10	35·71
Parker . . .	20	4	20
James . . .	146	24	16·43
Fenwick . . .	58	14	24·13
Hussey . . .	78	17	21·79
Norris . . .	33	8	24·24
Hayward . .	70	19	27·14
Buel	34	10	29·41
Malgaigne . .	199	126	63·31
Guthrie . . .	148	62	41·89
Alcock . . .	45	28	62·22
Crimea . . .	164	105	64·01
Total .	1346	560	41·60

Distinguishing those for injury from those for disease, we have: —

Injury . . .	641	368	57·41
Disease . . .	705	192	27·23

Subdividing those for injury into primary and secondary: —

Primary . . .	383	233	60·83
Secondary . .	235	124	52·76

Separating the military from the civil cases: —

Primary: —

Military . . .	219	122	55·7
Civil	164	111	67·68

Secondary: —

Military . . .	138	73	52·9
Civil	97	51	52·57

Amputations at the Hip-Joint.

If, to the cases given in Dr. Stephen Smith's tables in the *New York Journal of Medicine*, 1852, (see *ante*, p. 118) be added those which have been since recorded, and which have been alluded to in this article, the total number will be found to amount to 139, with the following result: —

Number of Cases.	Fatal.	Mortality per Cent.
139	91	65·46

The cause of operation is not ascertainable in all these cases, but in 102, where it has been recorded, we find 62 were for injury and 40 for disease: —

	Number of Cases.	Fatal.	Mortality per Cent.
Injury	62	47	75·8
Disease . . .	40	21	52·5

SUMMARY.

	TOTAL NUMBER.			INJURY.			DISEASE.			PRIMARY.			SECONDARY.		
	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.	Number of Cases.	Fatal.	Mortality per Cent.
Forearm	370	40	10·81	292	30	10·27	78	10	12·82	232	16	6·89	47	10	21·27
Arm .	628	178	28·34	463	134	28·94	165	44	26·66	336	94	27·97	114	37	32·45
Shoulder	131	51	38·93	113	46	40·7	18	5	27·77	73	25	34·24	26	15	57·69
Leg . .	1120	384	34·28	649	257	39·59	471	127	26·96	447	172	38·47	175	73	41·71
Knee.	60	21	35	—	—	—	—	—	—	—	—	—	—	—	—
Thigh .	1346	560	41·60	641	368	57·41	705	192	27·23	383	233	60·83	235	124	52·76
Hip . .	139	91	65·46	62	47	75·8	40	21	52·5	—	—	—	—	—	—

Summary of the Operations for Injury.

		TOTAL NUMBER.			PRIMARY.			SECONDARY.		
Forearm .	Military .	105	11	10·47	79	4	5·06	26	7	26·92
	Civil . .	174	15	8·62	153	12	7·84	21	3	14·28
Arm . .	Military .	203	51	26·65	137	36	26·27	66	18	27·27
	Civil . .	247	77	31·17	199	58	29·14	48	19	39·58
Shoulder .	Military .	67	21	31·83	48	10	20·83	19	11	57·89
	Civil . .	32	19	59·37	25	15	60	7	4	57·14
Leg . .	Military .	211	65	30·80	141	41	29·14	71	24	33·80
	Civil . .	410	180	43·90	306	131	42·81	104	49	47·11
Thigh . .	Military .	357	195	54·62	219	122	55·7	138	73	52·9
	Civil . .	261	162	62·06	164	111	67·68	97	51	52·57

On examining these statistics, the first striking fact is, that although the per centage varies greatly in different hospitals and in different localities, the mortality after all amputations, calculated from a total of more than 5000 cases, is as high as 33·25 per cent., or one in every three of the patients submitted to the operation. So fatal a result was scarcely suspected, till Mr. Benjamin Phillips drew the attention of the profession to the subject in 1838.

The next fact clearly established, is the greater mortality after amputations performed for injury than after those performed for disease. This, also, would not at first sight appear probable; the operations for injury being for the most part done on robust, healthy individuals, and those for disease on persons debilitated by long continued pain and suppuration. The difference appears to depend in a great measure on the shock which the injury has inflicted on the system, since the deaths which take place during the first three days after the operation are much more numerous in the amputations for injury than in those for disease. But in addition to this cause, it has been found that the mortality from secondary morbid processes, such as inflammation of internal organs, erysipelas, phlebitis, pyæmia, &c., is also greater in the one class than in the other. The occurrence of phlebitis was found, by Mr. James, in the Devon and Exeter Hospital, to be confined almost entirely to the primary amputations for injury. The occurrence of erysipelatous inflammations and of pyæmia will, no doubt, always vary greatly in different institutions; it will be less frequent in hospitals situated in the agricultural districts than in the more crowded institutions and vitiated atmosphere of a manufacturing town. Mr. James thinks that the nature of the injury will have a material influence on the result, and that those cases will be most fatal which involve the greatest degree of crush or laceration, and this more especially in the lower extremities, partly from the larger mass disorganised, partly from the greater inability of the system to repair the injury, the impression produced by which does not pass away even when the injured part is completely removed. (See *Trans. of Prov. Med. Ass.* vol. xvii. 1850, p. 81.) The same author has pointed out that the mortality varies also in the operations for disease, being least in the chronic diseases of bones and joints, greatest in cases of old ulcers, in acute gangrene, and acute suppurative inflammations. (Op. cit. vol. xviii. 1851, p. 332.) Exhaustion and hectic, and the supervention of tubercular disease at a later period are, perhaps, the most frequent causes of death after amputations for disease; but these have but little share in the mortality after amputations for injury.

The next point is the comparison between the primary and secondary operations for injury. In the table which has been given, the advantage will be seen to be in favour of the former, to the amount of 16 per cent.—the mortality being 30 per cent. in primary and 46 per cent. in secondary operations. This disproportion is, doubtless, partly owing to the circumstance that the intermediary or compulsory operations are in most instances recorded with the secondary, and the apparent mortality of these latter is thereby very considerably increased. If this source of fallacy were removed, there is reason to believe that in civil practice operations performed when the *true* secondary period has arrived (that is, when the inflammatory symtoms have subsided, and the suppurative stage is fully established,) are but little, if at all, more fatal than primary. Secondary amputations are seldom fatal from shock, and they are therefore found to be most successful, as compared with primary, in the larger portions of the limbs, where the effects of the shock are found to operate most prejudicially in primary operations. In amputations of the thigh, it will be seen that the proportion of mortality is reversed, and is considerably in favour of secondary instead of primary operation. This remark applies to the military as well as to the civil cases.

The success of secondary amputation, however, should not be considered as an argument in favour of delayed operation; since, as has been before explained, many will die before the favourable period arrives, and many others will undergo amputation as a matter of necessity in the intermediary period, and under the most unfavourable circumstances. The table, therefore, although it may exaggerate the mortality after secondary amputations properly so called, most probably does not at all exaggerate the *advantage* to be gained from immediate operation in all cases where there is no hope for the ultimate preservation of the limb.

Primary amputations, it will be observed, have been more successful in military than in civil practice: while on the other hand, civil surgeons have succeeded somewhat better than military with their secondary operations. Some reasons for the greater success of primary amputation in military surgery have already been given (*antè* p. 49); but another has been suggested by Mr. James, in the fact that a large number of the military operations are performed for "compound fractures from musketry, in which the injury is by no means equal in extent, and consequently in degree of shock to that which occurs in those accidents which in civil practice are more generally submitted to amputation." On the other hand, the resources at the command of the military surgeon are often insufficient for the satisfactory treatment of compound fractures, and therefore when the secondary period arrives, the patients are in a less favourable condition for operation than those which have been treated in a civil hospital.

The mortality increases in a nearly direct ratio with the bulk of the part removed—rising from 10 per cent. in the fore-arm to 41 per cent. in the thigh, and 65 per cent. at the hip-joint. It is to be regretted that sufficient data do not exist for estimating the mortality in the upper as compared with the lower third of the thigh, and of the upper with the lower third of the leg. Another circumstance deserving of attention is, that the disproportion in the mortality of amputations for injury and those for disease is greater according to the size of the part removed. The advantage on the side of disease is as much as 30 per cent. in the thigh; but is not more than 2 per cent. in the arm; while in the fore-arm the proportion is reversed, and the advantage is slightly on the side of amputations for injury. By making a similar comparison of primary with secondary operations at different levels, it will be seen that the advantage is greatly on the side of primary amputation, in the case of the fore-arm and arm, that this difference becomes less striking in the leg, and that the proportion is reversed in the thigh, in which situation secondary amputation has the advantage. In this respect secondary amputation has some analogy with amputation for disease, *i. e.* it is more successful, as compared with primary, in proportion to the size of the part removed.

Space will not permit of a more lengthened comment on the figures which have been given ; it is hoped, however, that they may prove not altogether useless to those who may be prosecuting further inquiries into the subject.] *James R. Lane.*

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ANASTOMOSIS (from *ἀνὰ* through, and *στὸμα*, a mouth). Anatomists and surgeons imply by this term the communications of the blood-vessels with each other, or their running and opening into each other, by which the continuation of a free circulation of the blood is greatly ensured, and the danger of mortification lessened. In cases of aneurism, when the main artery of a limb is tied, the anastomoses of the branches given off above the ligature, with other branches below it, form at once a channel through which the lower part of the limb is supplied with blood. Were there no such arrangement in the human body as anastomoses, aneurisms could never be cured by a surgical operation. So infinitely numerous, indeed, are these anastomoses, that they do the office of the subclavian, carotid, and external and internal iliac arteries, when these vessels are tied, and upon this fact is founded the success of some of the most brilliant operations in modern surgery. Nay, such has been the providence of nature in this respect, that even when the thoracic aorta has been completely obstructed, the channels for the conveyance of the blood to the lower extremities have yet been found adequate to that purpose. This was proved in an example where the obstruction had been gradually produced by disease, and the anastomosing vessels of course had had time for enlargement ; for this is a very different case from that in which a ligature is suddenly applied to the aorta ; though, as far as can be deduced from the particulars of some experiments made on dogs by Sir Astley Cooper, and in one operation in which he tied the human abdominal aorta (*Surgical Essays*, part i. p. 101), blood will still pass to the lower extremities in sufficient quantity for their nutrition. At least this inference is safely deducible from the very memorable operation to which I have referred, subject to one important condition, viz. that there be no additional cause of impediment to the passage of blood to the lower extremities, beside the ligature above the bifurcation of the aorta. When Sir A. Cooper tied the human aorta in the abdomen, the experiment was made as the only possible means of hindering a man from bleeding to death, who had a large aneurism of the external iliac artery actually beginning to bleed, and extending too high to admit of anything else being done. Now, although the unfortunate patient was not saved, and it must be acknowledged that the chances of any other result were very small, the case furnished the important proof, that if the abdominal aorta be suddenly and completely obstructed, the blood may yet pass in adequate quantity to the lower extremities, provided there exist no other cause of impediment to the passage of the blood into those members ; for on the side occupied by the aneurism the circulation in the limb was stopped, while in the opposite limb the circulation and natural warmth were preserved. To this subject I shall hereafter return. (See AORTA.)

The changes which take place in the arterial system of the limb, when the main artery is rendered impervious by the application of a ligature, are well described by Mr. Hodgson : "The blood meeting with an obstacle to its progress through the accustomed channel, is thrown in greater quantity and with greater force into those branches which arise above the seat of the obstruction. The ramifications of these branches, in consequence of the unusual influx of blood, undergo a remarkable dilatation; the more minute vessels also, by which they anastomose with corresponding ramifications, arising from branches given off below the obstruction, are from the same cause sufficiently enlarged to allow a free passage of the blood into the inferior trunks of the limb. At first the circulation is in this manner carried on through a congeries of minute anastomosing arteries : in a short time a few of these channels become more enlarged than the rest: as these increase in size, the smaller vessels gradually collapse, and ultimately a few large communications constitute permanent channels through which the blood is transmitted to the parts that it is destined to supply. This is one mode by which a collateral circulation is established."

"But in some situations more direct and ostensible inosculations are provided ; so that when one channel is obstructed, the blood passes through the other in a sufficient stream for the nourishment of the part which it is destined to supply. Under these circumstances no dilatation of the collateral branches is necessary : the circulation in such instances may be said to be constantly carried on through inosculating trunks. These great communications principally exist in the extremities of the body where the dilating impulse which the blood receives from the heart is of course diminished. Thus the radial artery inosculates freely with the ulnar; the anterior with the posterior tibial; and the internal carotid with the vertebral arteries. Two modes, therefore, exist, by which arteries communicate with each other—the anostomoses of minute ramifications and the direct inosculations of trunks." (See *Hodgson, On Dis. of Arteries and Veins,* p. 234.)

[It may be as well to remark that when the circulation is carried on by anastomosing branches after the obliteration of the main artery of a part, the current of the blood will be reversed in the branches which are connected to the main artery on the distal side of the obliteration, and which are to convey blood into it. After the lapse of some months the anastomosing vessels which have taken upon themselves the office of the principal artery, not only become enlarged, but assume a tortuous disposition, and a pulsation may be detected in them long before any can be felt in the principal arteries on their distal side. Indeed, the pulsation of the main arteries may remain scarcely perceptible for years after the application of a ligature.

Although it appears to be fully established that the circulation of the blood may be effectually carried on by the anastomosing branches after a ligature has been applied to a main artery in any part of its course, yet it may be well for the scientific surgeon to bear in mind that great differences exist as to the number and size of these anastomosing vessels in different parts of the body. To such an extent is this the case, that a ligature applied to a main artery in some positions will be ineffectual in arresting hemorrhage, or perhaps even in curing an aneurism, while in other positions the anatomosing branches may be so few and small as to be scarcely adequate under particular local or constitutional circumstances to maintain the vitality of the limb. My attention was forcibly drawn to this subject many years ago, when house surgeon at the Lock Hospital. Having been fortunate enough to procure for dissection the body of a person who had died in that institution without friends, I was desirous of obtaining a minute injection of the blood-vessels of the left side of the head and neck, and of the left upper extremity. With this object in view, an injecting pipe was placed in the aorta, close to the heart; firm ligatures were applied to the descending thoracic aorta and to the arteria innominata. It was expected by these arrangements that the injection would be prevented passing into the right arm and right side of the head and neck. The next day, however, on removing the right arm from the body, it was found that its blood vessels, as well as those of the right side of the head and neck, were minutely injected. It was concluded that the ligature on the arteria innominata must have given way. On examining the vessel and the ligature, however, all was perfectly secure. It was now at once seen that the injection contained in the right arm and right side of the head and neck must have passed through the circle of Willis, and thus have been conveyed, contrary to the usual course of the circulation, by the right carotid into the innominate artery, and by the right vertebral into the subclavian. I have ever since had my doubts whether a ligature applied to the arteria innominata alone would be found to interrupt the circulation sufficiently either to cure an aneurism, or to arrest hemorrhage in the subclavian or carotid arteries of the right side. At any rate, I should expect the circulation to be too free to admit of a coagulum forming on the distal side of the ligature, an occurrence so necessary to prevent secondary hemorrhage on the separation of the ligature. On this account, should I ever be called upon to tie the innominate artery for aneurism of the subclavian artery, I have long made up my mind that it would be sound practice to ligature conjointly with the innominate artery the common carotid close to its origin. With respect to the aorta itself, if this vessel should be again ligatured in the human subject, it is evident that the supply of blood to the lower extremities would be greatly influenced by the level at which the ligature was applied to that vessel. If below the inferior mesenteric artery, the position selected by Sir Astley Cooper, the small anastomosing branches of the lumbar arteries, with the ilio-lumbar, lateral and middle sacral arteries, aided by the communications of the epigastric with the mammaria interna, would be the principal channels depended upon, which it is to be feared will never be found sufficient to carry on the circulation in the lower extremities, whereas, if the ligature be applied above the inferior mesenteric artery the free anastomosis this vessel has with the superior mesenteric artery would ensure an ample current of blood into the aorta itself for the support of the lower limbs. The instances here given may be sufficient to draw the attention of surgeons to the important fact that it is by no means a matter of indifference at what level on a main artery a ligature should be applied, when it is considered that the double object of curing an aneurism and of carrying on the circulation of the blood is to be provided for.]

The best general account of the anastomoses in relation to aneurism is contained in *Scarpa's Treatise on Aneurism,* more especially the Italian edition, which is embellished with beautiful engravings.

ANÆMIA (from ἀ priv. and αἷμα blood. Deficiency of blood). This term implies such a diminution of the quantity of blood in the sanguiferous system, or in any part of it, as is inconsistent with health. By medical writers it is sometimes restricted to a state of bloodlessness from defective hæmatosis, but the condition of the system is strictly analagous, whether produced directly by accident, by the abstraction of blood as a remedy, or by disease. In all cases the constitution of the blood remaining in the system is altered; the proportions of its constituents being changed by the absorption or imbibition of albuminous and saline fluids from the alimentary canal or the tissues through which the vessels permeate. The most important change is a diminution in density, produced by a smaller proportion of solids and especially of red corpuscles, the proportions of fibrine, albumen, fatty matters, and salts remaining little or not at all affected. After repeated hemorrhage, furnishing the least complicated form of anæmia, the red corpuscles have been known to sink to 27 in 1000 parts, and they are said to become relatively richer in hæmatin and poorer in globuline; their specific gravity being greater, and their tendency to sink in the liquor sanguinis increased (Lehmann). Thus true anæmia implies a degree of hydræmia, but the latter must not be mistaken for its essential character.

Although the effects of a diminution of the quantity of blood in the blood-vessels are in many respects similar, from whatever cause it may be produced, yet they differ somewhat according as the diminution may have arisen from antihygienic influences or direct loss; and in the latter case according to the rapidity of the flow, the quantity extravasated, and the previous state of the individual. Anæmia often arises from, and is accordingly complicated with, disease of one or more of the organs of hæmatosis, as of the lungs or liver; but the study of the morbid effects of direct loss of blood is essential to a just appreciation of its symptoms and results. The immediate effects of a *sudden* loss of a *considerable quantity* of blood, the quantity varying according to the previous state of the sanguiferous system and the general constitution of the individual, are at first a feeble and slow, and then a quick and fluttering pulse, sense of sinking, slowness of respiration interrupted with deep sighs and eructations, pallor of the countenance and especially of the lips, pallor and coldness of the general surface, vertigo, loss of consciousness, and syncope. When the bleeding has been arrested, not having proved sufficient to cause death, consciousness gradually returns and is usually attended with nausea, vomiting, irregular sighing and yawning, the return of the pulse, of the colour, of the warmth of the body, and recovery. When the flow continues a fatal result may be rapidly produced, the syncope may return again and again, the respiration becoming diaphragmatic and nearly imperceptible, and the patient may expire in one of the fainting fits, particularly if in an erect posture. Or there may be gradual sinking, with the faculties entire to the last; or delirium may occur with or without convulsions, followed, especially in children, by coma; or there may be stertorous breathing and involuntary discharge of the contents of the bladder and lower bowels. With these symptoms there is first an intermittent, then an imperceptible pulse, restlessness and jactitation, tremors and shudderings, struggles for breath, tetanic spasms or convulsions, loss of animal heat, and death.

When a large and rapid loss of blood does not result in death, reaction usually supervenes. The pulse becomes quick and more or less sharp and bounding although easily compressed; there are palpitations and throbbings in different parts of the body, particularly in the arteries of the head, and often in the aorta; the trunk is often hot while the extremities are cold; there is hurried respiration, often attended with anxiety and sighing, and an excessive desire for fresh air; pain or sense of pressure in the head with intolerance of light and noise; agitated sleep with dreams, and, on awaking, delirium, or a sense of impending dissolution. There is also intense thirst. During this state convulsions and coma are very liable to occur, particularly in children, and fatal exhaustion may suddenly supervene, especially on assuming an erect posture, or on any considerable exertion. When the reaction terminates in recovery it is succeeded by a state of debility with more or less of the general symptoms of anæmia presently to be described.

When bloodlessness is produced by losses in *small quantities, frequently repeated*, the effects are somewhat different. They are slow and insidious in proportion to the frequency of the repetition and the smallness of the quantity. They are extremely various; partaking, on the one hand, of those which have been described as resulting from excessive loss and the consequent reaction; and, on the other, of the symptoms of permanent anæmia however produced; and thus depend upon, or are very materially modified by, the age, temperament, and constitution of the individual.

This leads to the consideration of anæmia as a *chronic disease* produced by less direct causes, operating more slowly, and gradually diminishing the mass of blood in the body. The more important of these causes are, prolonged abstinence ; an habitual deficiency of the staminal principles of nutrition ; the absence of some element of the blood essential to cell-growth and hæmatosis ; continued debility of the functions of primary digestion ; diseases of any of the organs or tissues by which the supply of materials, or the combination of the elements, or the production of the proximate principles and vital cells of the blood are effected ; or of the channels of conveyance ; and particularly diseases of the lungs, the liver, the pancreas and mesenteric glands ; continued subjection to various antihygienic influences, as a vitiated or insufficiently renewed atmosphere, want of exercise, deprivation of the solar rays, the depressing passions, or any cause of depression of the nervous energies of sufficient duration to interfere with the processes of hæmatosis ; diseases attended with profuse discharges, acting as a drain to the constitution, as large abscesses or diabetes; sexual excesses, and the like. Anæmia is often employed as a relative term, and we have no precise standard of the quantity of blood in the body, individuals of different constitutions have more or less in health, and some are habitually anæmic ; so that, whether produced by voluntary or accidental direct loss, or by antihygienic causes, it is only by its effects that it becomes a disease. Well marked instances of chronic anæmia are however observable after large depletions employed in the treatment of acute diseases, the loss of blood from accidents, and the draining of blood from repeated hæmorrhages ; it is often found to prevail in large proportions of a population, in individuals subject to starvation and famine, and in masses of people residing in close dark localities, as in coal and other mines, and well marked instances are observable among various classes of operatives in our manufacturing towns. Chronic anæmia is occasionally produced mechanically by obstruction of the œsophagus or of the thoracic duct.

The symptoms of chronic anæmia, whether the insidious effect of small but frequently repeated losses of blood, visceral disease, or antihygienic influences, are in most respects the reverse of those which result from plethora. The blood, owing to the deficiency of red corpuscles, is deficient in its usual bright red colour, and the animal tissues generally reflect a much paler colour than natural. The capillaries are small or scarcely perceptible, and the cutaneous veins pale and collapsed. When a ligature is applied to the trunks in the limbs the veins become slowly distended ; they are also readily emptied by friction and slowly refilled. The countenance and integuments generally are blanched and waxy, the conjunctiva is pale and its capillary vessels disappear altogether, the mucous membranes are pale, particularly in the prolabia, the gums, the mouth and fauces, and the tongue. The action of the heart is feeble, the pulse weak, small, in extreme cases scarcely to be felt, readily quickened by mental or physical excitants, and often fluttering or palpitating with a sharp impulse, quite distinct from the steady strong impulse of hypertrophy. There is a sense of sinking, and even syncope may occur followed by palpitation, on quickly assuming the erect posture. Hæmatic murmurs are produced in various parts of the vascular system ; they may be heard with the stethoscope, or even with the naked ear, especially over the base of the heart and the large vessels at the root of the neck, but their diagnostic value must not be too highly estimated, as they are observable in impoverished states of the blood where no degree of emptiness exists, and in many cases are produced solely by external pressure on the parietes of the weak and easily compressible vessels, diminishing the calibre of the tubes. The respiration is short, feeble, and easily hurried. The animal heat is ill sustained, and the surface and extremities are below the natural temperature. There is great nervous sensibility with intolerance of light and sound, scintillations, and other amaurotic symptoms, tinnitus aurium, muscular debility, slight efforts producing fatigue, with languor, tremors, and want of capacity for sustained exertion. There is great debility of the functions of the stomach with deficiency of gastric juice, loss of appetite, occasional nausea, cardialgia, costiveness or irregularity of bowels, flatulent distension, and other symptoms of dyspepsia. The urine and secretions generally are pale and watery, and in females the menstrual fluid is pale and scanty. To these symptoms are often added others which depend on reaction, such as palpitations and throbbings, and extremely severe headaches : and in extreme cases most of the effects of direct loss of blood supervene, extremely hurried and oppressed breathing, gasping, tremors, spasms, convulsions, and coma. When of long continuance, general atrophy is the usual concomitant of anæmia, the blood also becomes in a remarkable degree hydræmic, giving rise to another train of effects, such as œdema, dropsical effusions, and softening of the tissues and internal organs, as of the brain, or to diarrhœa and profuse perspirations ; the diminished tone of the vital solids and of the exhalant orifices, and the poverty of the blood explaining many of these effects. Anæmia predisposes to hysteria, epilepsy, chorea, and other nervous affections, and may arrive in various ways at a fatal termination. The patient is often carried off in a fit of syncope, or convulsions, or coma, or may sink more gradually, exhausted, with effusions in the lungs, pericardium, brain, or abdomen. When death occurs, the heart itself the arteries and veins are almost empty, containing only a sanguineous serum ; the tissues and organs are all pallid ; little or no blood flows from the parts divided, and the viscera generally are comparatively bloodless.

Thus anæmia not only occurs after accidents and operations attended with loss of blood, but may precede them. It is found during convalescence after acute affections, particularly where active depletion has been resorted to; it may complicate any surgical disease, and the statements in this article show the importance of attending to the condition of the system as respects the quantity of blood contained in the vessels, especially in relation to blood-letting and depleting measures generally. Both inflammation and hemorrhage occurring in a state of general anæmia have an unfavourable tendency, owing not only to the deficiency of blood but also to the defective reactionary process and the low degree of vitality in the plastic materials derived from the blood. The blood of anæmic subjects cannot be spared. Moreover, anæmia is generally complicated with other morbid states of the blood, the continued emptiness of the vessels being favourable to the absorption of unassimilable materials and the defective nutrition of the organs unfavourable to secretion and depuration; hence blood, in its constitution essentially anæmic, becomes diluted with water, and the blood-vessels may be as full or even fuller than natural, producing a distinct train of symptoms. (*Vide Hydrhœmia; Spurious Anœmia.*) Anæmic blood is also extremely liable to be poisoned by foreign matters introduced from without, or by retained secretions and excretions.

Local Anœmia. — Deficiency of the supply of blood to a part may be produced by various causes diminishing the calibre or obliterating the artery by which the supply should be maintained. Tumors of various kinds, the spontaneous coagulation of the blood in an artery, disease of the coats of an artery leading to the deposition of fibrine, the obstruction of an artery by fibrinous flakes transported from a distance, as from the valves of the heart, are so many mechanical causes. It may also be produced by an excessive determination of the current of blood to other parts. This local anæmia may be totally independent of the quantity of blood in the system, or its quality. The quality of the blood in the anæmic part is not so much changed and especially the proportion of corpuscles is but little diminished. The effects on the part are, however, very similar to those produced by general anæmia, except that they are often carried much further. This partial anæmia, however produced, may disturb or completely arrest the function of the part, producing loss of motion and sensation, coldness, and ultimately atrophy and disorganisation. Obstruction of the coronary arteries produces debility and atrophy of the heart itself. Disease of the cerebral arteries, or ligature of their trunks, or obstruction by fibrinous clots (*Dr. Kirkes, Med.-Chir. Transac.* vol. xxxv. p. 281), occasioning an interruption to the flow of blood, produce disturbance of the cerebral functions, softening of the brain, and even gangrene, with convulsions, spasms, paralysis, and all the usual symptoms and sequelæ of such disturbance. Arrest of the flow of blood to a secreting organ produces analogous results, with a diminution of the proper secretion and the ultimate poisoning of the blood with the effete matter that ought to have been eliminated. The complete obliteration of the main artery of a limb, if the blood is not supplied in time by the collateral circulation, results in gangrene. The effects of local anæmia differ greatly according to its degree, and as the arrest may have been sudden or slow and insidious. Analogous, although not quite identical effects, result from the spurious anæmia of a part, the blood being defective in some of the principles essential to nutrition, although the absolute quantity supplied may not have been diminished.

Treatment.—When blood is suddenly extravasated in large quantity, so as to compromise life rapidly, the first duty of the surgeon is to place the patient in the best position for the maintenance of the arterial circulation and the respiration, taking care that the bleeding vessel or organ is so directed that the flow of blood may be opposed by gravity. If the bleeding continues, we then proceed to arrest it by such surgical measures as the nature of the case may dictate. If the flow has been so great as to produce enduring syncope or apparent death, transfusion is the remedy. When blood is lost slowly or in repeated small quantities, various surgical appliances and internal remedies are resorted to. (*Vide Arteries, ligature of — compression of — cauterisation of—hemorrhage — transfusion.*)

When true anæmia, less urgently compromising life, complicates surgical diseases, the treatment must depend on the particular disease, but the anæmic condition must never be lost sight of. The remedies are hygienic and medicinal. The first, consisting in the strictest attention to a good system of diet, and the free respiration of a pure air, with a judicious employment of exercise where not forbidden by local disease, and due regard to sleeping and watching, cheerfulness of mind, and the avoidance of excesses of all kinds. As in all instances of direct debility the greatest care should be taken that the vital power is not taxed excessively and thereby exhausted, either in demands made on particular functions of life, or upon the general nervous and muscular systems. Hence the quantity and the quality of the food must be adjusted to the digestive powers of the individual and the special demands of the system. For the recovery of the nutrition of the adipose tissues the food must contain a due quantity of the oily element, and in like manner a sufficient proportion of the albuminous or protein principles is necessary to form a perfect pabulum for the nutrition of the muscular and vascular systems. The medical treatment consists in tonics, chalybeates, restoratives, and stimulants. The selection of medicines of these classes must depend on the particular case, and be left to the judgment of the practitioner. In some instances the anæmia appears to depend on the deficiency of a particular element in the blood, as of iron, the administration of which constitutes the first and most essential part of the treatment. Care is necessary in the use of this medicine. If given in too large a quantity, absolutely or relatively, as respects the other constituents of the blood or the elements of the food, or if given unnecessarily, it may act as a foreign material received into the blood, and if unassimilated by the vital fluid may produce congestion or irritation in the brain, lungs, and other organs, with their ordinary symptoms, as headache, pleuritic pains, or hurried respiration. Where anæmic blood appears from the state of the adipose tissues to have failed in their nutrition especially, cod liver oil is useful and may frequently be given advantageously at the same time as iron. Where the primary digestion is at fault, bitters, and chalybeates, and in depression of the nervous powers, valerian, assafœtida, musk, and repeated judiciously regulated doses of opium, and other remedies of that class, may be useful. Where anæmia has been produced suddenly by loss of blood, diffusible stimulants, of which wine, ether, and opium, are among the best, are often absolutely necessary, and in the more chronic cases these are useful, and may even be essential adjuvants. (For the *Bibliog.* vide *Blood, Pathology of.*)

H. Ancell.

ANÆSTHESIA IN SURGICAL OPERATIONS.

[The term anæsthesia, from α, privative, and αἰσθάνομαι, "I feel," has long been used by medical authors to denote the loss of common sensation in any part of the body, as a pathological condition, and it has of late been very generally applied to express the effects of medicines which are inhaled to prevent the pain of surgical operations. These medicines belong to the class of narcotics, or more properly narcotico-irritants; they suspend the action of the other senses as well as that of touch or feeling, and also induce a temporary loss of consciousness. The term narcotism, therefore, is more in accordance with the usual language of physiology as a definition of their effects; still anæsthesia expresses the purpose for which the medicines are inhaled, and it seems likely to remain in use, and the agents themselves will probably retain the name of anæsthetics.

Attempts to prevent the pain of surgical operations are not peculiar to our own age, and, according to Pliny and Dioscorides, who say that wine of the root of mandragora was used for this purpose, the attempts were not unsuccessful. A Chinese surgeon, named Hoa-tho, who flourished between 220 and 230 of our era, is also represented to have made patients insensible to operations by a preparation of hemp. The present practice of inhalation for the prevention of pain was, however, not suggested by the usage of the ancients, but originated from an observation of Sir Humphry Davy respecting nitrous oxide gas. He found that this gas relieved the pain he was suffering whilst cutting a wisdom tooth, and he actually suggested that it might be used to prevent the pain of surgical operations. This suggestion was published by Sir Humphry Davy at the end of the last century, but was not acted on till 1844, when Mr. Horace Wells, a dentist of Connecticut, used it with more or less success in a few cases of tooth-drawing, and even larger operations. He, however, gave up the practice in disappointment, on account of the gas sometimes failing to take the desired effect. In less than two years after this, a dentist of Boston, Massachusetts, named Dr. W. T. G. Morton, who had seen some of the attempts of Mr. Wells, tried an agent which had often been used in the lecture-room as a substitute for nitrous oxide, to produce the ordinary exhilirating effects of that gas. This agent was sulphuric ether, and with this Dr. Morton was completely successful. It is to him, in fact, that the world is indebted for the actual introduction of the present practice of preventing the pain of surgical operations. Sulphuric ether was first exhibited as an anæsthetic in September, 1846; it soon came into geneeral use in all parts of the civilised world, and was effectual in preventing the pain of surgical operations, in all cases in which it was properly administered. In November, 1847, the use of sulphuric ether was suddenly, and almost entirely, superseded by that of chloroform, which was introduced by Dr. Simpson, of Edinburgh, who was induced to try it from the knowledge that it formed the active ingredient of a liquid called chloric ether, which had occasionally been exhibited in the form of vapour, with more or less success, by Mr. Jacob Bell and others in London.

Chloroform or terchloride of formyle, consists of two atoms of carbon, one atom hydrogen, and three atoms chlorine. It is prepared by distilling rectified spirits of wine with chlorinated lime and water. It is a clear, colourless liquid, having a hot and intensely sweet taste. Its odour is neither strong nor unpleasant. It is a heavy liquid, having a specific gravity of 1·503 at 60° Fah. Notwithstanding its weight, it is a very mobile liquid, and when dropped from the lip of a small phial, the drops are extremely small, nine drops, being equal to only two minims. It is soluble in alcohol and ether in all proportions, but it requires nearly 300 parts of water for its solution. When dropped into water, it falls to the bottom of the vessel, and acquires an oily appearance. Chloroform is very volatile, boiling at 140° Fah. The specific gravity of its vapour is 4·2. Under ordinary circumstances, the vapour of chloroform has no separate existence, but is always mixed with air. It can exist in a pure state only when the temperature is raised to 140° or upwards; or when the pressure of the atmosphere is in a great measure removed by the air-pump.

The following table shows the amount of vapour of chloroform in 100 cubic inches of the mixture of air and vapour, when the air is saturated at the different temperatures indicated.

Temp. Fah.°	Air.	Vapour.
40	94	6
45	93	7
50	92	8
55	90	10
60	88	12
65	85	15
70	81	19
75	78	22
80	74	26
85	70	30
90	65	35

As the effects of chloroform, when inhaled, depend entirely on the quantity of vapour present in the air which the patient breathes, the effect of temperature on its volatility is of great practical importance. The air does not indeed become fully saturated with vapour during the process of inhalation, but the effects of temperature are relatively as great as if it did.

In order to facilitate the description of the effects of chloroform, the writer of this article has been in the habit of dividing them into degrees. The term degree is used in preference to stage, as during the action of chloroform, the slighter degrees of narcotism occur in the later stages of its influence, during the recovery of the patient, as well as in the beginning. The division into degrees is made according to symptoms which seem to depend entirely on the state of the nervous centres, and not according to the amount of anæsthesia, which, there is good reason to conclude, depends, in a great measure, on the local action of the chloroform on the nerves. The different degrees of narcotism glide insensibly into each other.

In the first degree are included all the effects of chloroform that exist while the patient retains a perfect consciousness of where he is and what is occurring around him. This degree constitutes all that a person recollects of the effects of the vapour, except when he happens to dream and remembers it afterwards. In the second degree of narcotism, there is no longer correct consciousness. The mental functions are impaired, but not necessarily suspended. The patient usually appears as if asleep in this degree; but if his eyelid be raised he will move his eyes in a voluntary manner. There are occasionally voluntary movements of the limbs ; and although the patient is generally silent, he may nevertheless laugh, talk, or sing. In the third degree there is no longer any voluntary motion. The eyes are not directed towards any object ; and although the limbs may move, they are not directed to any purpose. The pupil of the eye is generally inclined upwards, and is usually somewhat contracted. The blood-vessels of the conjunctiva are generally somewhat injected in persons who are well nourished and not deficient in blood. It is in this degree of narcotism that rigidity and spasms of the muscles are met with in certain cases. In the fourth degree of narcotism the breathing is stertorous, the pupils dilated, and the muscles completely relaxed. It is seldom necessary to carry the effects of chloroform so far as this degree. As the effects of the vapour subside the patient passes through the different degrees of its influence, in the inverse order to that in which they were induced.

There is often a considerable diminution of the common sensibility whilst the patient still retains his consciousness, especially when the chloroform is inhaled slowly, but it very rarely happens that even a trifling surgical operation can be performed without pain, unless unconsciousness is induced. Accordingly it is almost the universal practice, when this agent is used, to induce a state of unconsciousness before attempting to operate ; and to do otherwise would generally lead to failure. During the recovery of the patient who has been unconscious, there is, however, frequently a greater amount of anæsthesia than at the commencement of inhalation, and the tying of vessels and introduction of sutures may sometimes take place at the concluding part of an operation, whilst the patient is awake, without his feeling what is being done.

There is generally a considerable amount of anæsthesia in the second degree of narcotism. The loss of sensation is indeed sometimes so complete in this degree, especially in children, that the surgeon's knife may be used without pain, and I have seen a child unconsciously handle its toys all the time it was undergoing the operation of lithotomy. Commonly, however, the use of the knife, when the narcotism has not proceeded further than this degree, occasions expressions indicative of pain, which are either not remembered, or are recollected as having occurred in a dream. The patient is usually in the second degree of the effects of chloroform during the greater part of the time occupied in a protracted operation ; for although it is necessary, in most cases, to induce a further amount of narcotism before the operation is commenced, it is not usually necessary to maintain it at a point beyond this.

In the third degree of narcotism there is never any perception or consciousness of pain, but anæsthesia, in the proper sense of the term, is not a necessary part of this degree of narcotism when it is first induced, and in some cases a patient may flinch, and put on an expression of countenance which seems indicative of pain. By continuing the inhalation gently for a minute or two, a state of complete anæsthesia can be induced in almost every case, without carrying the narcotism beyond this degree.

The patient is always perfectly insensible in the fourth degree of narcotism. It is sometimes necessary to carry the effects of chloroform as far as this degree, when the surgeon is dissecting in the neighbourhood of important vessels and nerves, in certain robust persons, and others who have acquired an excess of sensibility by hard drinking, and who can scarcely be kept quiet under the knife, except when the breathing is stertorous.

The pulse is nearly always increased, both in force and frequency, during the early part of the inhalation of chloroform, but after the patient has become quite insensible, it generally settles down nearly to the natural standard; and in the middle of the greatest operations it is often beating with ordinary volume and strength not more than sixty times in a minute. The pulse rarely becomes weaker or slower than natural, except from considerable loss of blood, or when the patient is about to be sick.

The age of the patient has some influence in modifying the effects of chloroform. This agent acts very favourably on children, and does not cause the rigidity and struggling, after the loss of consciousness, which are sometimes met with in the adult; and absence of feeling is generally induced with less narcotism of the nervous centres than in grown-up persons. The effects of the vapour are more quickly produced and also subside more quickly in children than in adults, owing to their quicker breathing and circulation. Frequently, however, when the insensibility has been kept up for twenty minutes or half an hour, in a child, it is followed by a natural sleep of some hours duration, if there is no painful wound or other cause to prevent the sleep. The writer of this has given chloroform in a few cases as early as the ages of eight or ten days, and to 200 infants under a year old. In persons advanced in years the effects of the chloroform generally subside rather slowly, owing, no doubt, to the slower breathing and circulation.

The comparative strength or debility of the patient has considerable influence on the way in which chloroform acts. The more feeble the patient is, whether from illness or any other cause, the more quietly does he usually become insensible; whilst in the strong and robust there is frequently mental excitement in the second degree, and rigidity of the muscles and struggling in the third degree of narcotism. Patients in a state of debility resemble children in coming quietly and easily under the influence of chloroform, and also in the circumstance that the common sensibility is suspended with less oppression of the nervous centres than in robust persons. Children and persons in a state of debility have usually an acute sensibility, which causes them to suffer pain from very slight causes; but this sensibility is more easily suspended by chloroform and similar agents than the less acute sensibility of robust persons.

Patients who are subject to hysteria sometimes have symptoms of the complaint, such as laughing, crying, or sobbing, as soon as consciousness is suspended, or even impaired, by the chloroform ; but these symptoms can always be subdued by continuing the inhalation.

Chloroform occasionally brings on a fit of epilepsy in persons who are subject to this disease. In the few cases in which epileptic convulsions are caused by this agent, they do not appear till the third degree of narcotism is induced, differing in this respect from hysteria, which comes on in the second degree, or even earlier. The course to pursue when epileptic convulsions appear, is to continue the chloroform gently and steadily till they subside. The writer has never known the chloroform fail to subdue the convulsions in a very few minutes, and he has never seen them recur after the operation, as the effects of the vapour were subsiding.

Chloroform has often been administered to prevent the pain of surgical operations at all the periods of pregnancy, and no ill effects have been known to arise from its use in this way. The writer has exhibited it in several cases for the removal of large tumors, and other important operations during pregnancy, as well as in tooth drawing and other minor operations. One case of abortion has been related, which occurred in America, after its use; but in that instance it was inhaled very largely, for toothache, without medical advice. It is customary to avoid the menstrual period in fixing the time for any surgical operation which admits of delay, but when it cannot be so arranged, there is no objection to the inhalation of chloroform during menstruation. There is, however, a little more tendency to slight hysterical symptoms during its inhalation at this period than when the same patients inhale it at other times.

Phthisis and bronchitis sometimes cause a little difficulty and delay in the administration of chloroform, as the vapour is liable to excite coughing when the mucous membrane of the air passages is irritable. The inconvenience is, however, confined to the time of inhalation, and the cough is generally relieved afterwards ; indeed, chloroform has often been inhaled with advantage to relieve the cough in consumption, so that there is no possible objection to its use in cases where it is found requisite that the consumptive patient should undergo a surgical operation.

With regard to the employment of chloroform in cases where there is disease of the heart, the surgeon should bear in mind that the question is not strictly between using chloroform and not using it, but between this agent and the pain of the operation. The pulse often increases to more than twice its natural frequency during the performance of even trifling operations in the waking state, and the patient often strains and holds his breath till the action of the heart is extremely irregular and intermittent, from the impeded passage of blood through the lungs. These effects of pain appear much more likely to arrest the action of the heart, when embarrassed by valvular disease or weakened by fatty degeneration, than does the action of chloroform, when carefully administered and not continued too long. Fatty degeneration of the heart has, indeed, been present in a few of the deaths from chloroform, but this affection is so common, that it has probably been present in quite as great proportion of the patients who have inhaled chloroform with impunity, as in those who died from its effects. The only patient whom the writer has lost whilst inhaling this agent, was, indeed, a gentleman of seventy-three, with extreme fatty degeneration of the heart, the symptoms of which were very evident during life ; but it is probable, from the manner in which this patient died, that the disease of the heart was the sole cause of the sudden death ; and the writer has not been deterred from administering chloroform during surgical operations in numerous other cases in which the symptoms of fatty degeneration of the heart were present in a very marked degree.

Diseases of the brain do not prevent the administration of chloroform. The writer has given it to several patients who had suffered from a previous attack of apoplexy. In some of these cases the paralysis resulting from the attack still remained, but the chloroform was not attended or followed by any ill effects. Chloroform is often of signal service in the cases of insane patients who require a surgical operation, as it enables the surgeon to perform operations that he could not accomplish without its aid. The vapour, however, can sometimes be administered to insane patients only by force, as they cannot always be persuaded to breathe it voluntarily.

It was at one time asserted that persons addicted to hard drinking were with difficulty rendered insensible by chloroform or sulphuric ether, but the writer has always found that these persons were rendered unconscious, and even comatose, by the same amount of these agents as other patients ; sometimes, however, hard drinkers of spirituous and fermented liquors have a morbid excess of sensibility in the nerves of common sensation, and do not lie still under the use of the knife, except when the brain is deeply narcotised and the breathing almost stertorous.

The only direction which it is usually requisite to give beforehand to the patient who is about to inhale chloroform is, to avoid taking a meal previous to the inhalation. It is not desirable, however, that he should fast beyond his usual hour of taking food. The best time for an operation under chloroform is before the patient's usual breakfast time, when this can be arranged. It answers very well, however, to perform the operation about the time when the patient would be ready for another meal, or if the time of the operation fall two or three hours after the usual time of eating, to request him to take only a slender repast at that time, so as merely to prevent the feeling of hunger. These precautions are intended to prevent, as far as possible, the vomiting which not unfrequently follows the use of chloroform, and constitutes an unpleasantness and inconvenience which it is desirable to avoid.

The patient who is about to inhale chloroform is sometimes in a state of alarm, either about that agent itself, or the operation which calls for its employment. It is desirable to allay the fears of the patient, if possible, before he begins to inhale, as he will then be able to breathe in a more tranquil and regular manner. In some cases, however, the apprehensions of the patient cannot be removed, and they subside only as he becomes unconscious from the inhalation. It has been said that chloroform ought not to be administered if the patient is very much afraid, as the fear would make the chloroform dangerous ; but this is a mistake, the danger, if any, lies in the fear itself. Patients have been known to die of fear alone, before the discovery of inhalation for the prevention of pain ; and two patients died in a sudden manner, apparently from fear, just as they were commencing to inhale chloroform, and before they got under its influence; but it is probable that if they had lived till the chloroform had taken effect, they would have been as safe as other patients who have inhaled it. Fear and chloroform are each of them capable of causing death, but it seems impossible that they should combine to cause danger when the chloroform is administered with the usual precautions, so as gradually to remove consciousness. Fear is an affection of the mind, and can no longer exist when the patient is unconscious; and the action of that amount of chloroform which is consistent with even disordered consciousness is stimulating, and increases the force and frequency of the pulse, in the same way as alcohol, and is therefore calculated to counteract the effects of fear whilst it lasts; and when the chloroform has been absorbed in sufficient quantity to cause unconsciousness, fear subsides, and with the fear, its effects on the circulation. It is a subject of constant observation by the writer, that the pulse, which is extremely frequent in many patients from apprehension, when they begin to inhale, settles down to its natural pace as soon as they become unconscious. If anæsthetics were refused the patients who are much afraid, the timid and feeble, who most require them, would often be deprived of their benefits. Moreover, they would either be prevented from having the advantage of surgery, or they would be subjected to the still greater fear of pain, as well as the pain itself; for whatever fears a patient may have when the moment comes for inhaling a narcotic vapour, he has only chosen to breathe it on account of a still greater fear of pain.

The most convenient position in which the patient can be placed whilst taking chloroform is lying on his back or side, as he is then properly supported in the state of insensibility, and can be more easily restrained if he should struggle whilst becoming insensible. The half recumbent posture on a sofa answers very well, and the patient may be seated, when that is most convenient to the operator; he must, however, be placed in a large easy chair with a high back, so that the head as well as the body may be well supported, otherwise he would be apt to slide or fall when insensible. If faintness should come on, the patient must of course be moved into the horizontal position, as under any other circumstances.

Judging from experiments on the lower animals, the quantity of chloroform which requires to be absorbed to cause insensibility is such that, in the adult human subject of average size and strength, there is about eighteen minims of this liquid in the system during an operation, without pain; but as a good deal is dissipated in all the usual methods of inhalation without being absorbed, a much larger quantity than this is used in making a patient insensible. The chloroform also keeps exhaling from the lungs of the patient all the time he is under its influence, as can be proved by chemical tests, and must be replaced by the inhalation of a little at a time, during the course of an operation. About four cubic inches of vapour of chloroform in one hundred cubic inches of air, are the most suitable proportions for causing insensibility during surgical operations. A cubic inch and a half of vapour in each hundred cubic inches of air is, indeed, capable of causing insensibility, but an inconvenient length of time is occupied when the vapour is so much diuted, whilst, on the other hand, if the air breathed by the patient contains eight per cent. of vapour, or upwards, it is liable to act with dangerous, and ven fatal, rapidity.

The great point to be attended to in the administration of any narcotic vapour, is to present o the patient such a mixture of vapour and air s will produce its effects gradually, and enable the medical man to stop at the right point. Although four per cent. of vapour is the most suitable proportion in the case of chloroform, the quantity may vary from a little more than two per cent. up to about six per cent., without inconvenience or danger, so that the process of inhalation need not be one of mathematical exactitude. A great number of apparatus have been used in the administration of chloroform. That which the writer has employed for ten years is made of metal, and consists of a double cylinder, the outer space of which contains cold water, to regulate the evaporation of the chloroform. The inner part of the cylinder is furnished with two coils of stout bibulous paper, to afford a surface, wetted with chloroform, over which the air passes before being inhaled. The quantity of vapour which the air takes up can be ascertained by weighing the apparatus with some chloroform in it, before and after passing a measured quantity of air through it; and the extent of surface of bibulous paper can be altered at different times of the year, according to the temperature of the season. This apparatus is attached by a wide elastic tube to a face-piece, which admits of unimpeded respiration by either the mouth or the nostrils, and is furnished with a valve, by which any amount of additional air can be admitted to dilute still further that which has passed through the inhaler and become charged with vapour.

A pocket handkerchief folded and made into the form of a cone, as recommended by Dr. Simpson, is an apparatus which is very convenient, and has the merit of being always ready; and a good sized hollow sponge is also equally convenient. This method of giving chloroform is, however, open to the objection, that the proportions of vapour and air which the patient breathes cannot be properly regulated; and the objection is still greater from the circumstance that those who advocate this mode of administering chloroform proceed on the supposition that there is no occasion to regulate the proportions of vapour and air; that, in fact, it is only requisite to let the patient have sufficient air for the purposes of respiration, and enough chloroform to cause insensibility, and all will be right. The truth is, however, that if there be too much vapour of chloroform in the air the patient breathes, it may cause sudden death, even without previous insensibility, and whilst the blood in the lungs is of a florid colour. The table in the earlier part of this article shows that the air is capable of taking up a much greater quantity of vapour of chloroform at ordinary temperatures than it would be safe to inhale; and although the air does not get quite saturated with vapour of chloroform in passing over a handkerchief, yet, on many occasions, so much vapour has become mixed with the air, as to cause sudden death, without any previous warning from the symptoms.

Whenever chloroform is administered from a handkerchief or sponge, it should be diluted with one or two parts by measure of spirits of wine, or eau de Cologne. In this way the convenience of the handkerchief or sponge can be taken advantage of without the danger. Very little of the spirit is inhaled, as the greater part remains behind after the chloroform has evaporated; but it acts by lowering the elastic force of the vapour of chloroform, and diminishing the amount of vapour which is given off from the handkerchief or sponge, just as diluting a strong solution of ammonia with additional water diminishes the amount of the volatile alkali, which escapes as gas. One hundred cubic inches of air are capable of taking up fourteen cubic inches of vapour, at 60°, from pure chloroform, and becoming expanded to 114 cubic inches; but when the chloroform is diluted with an equal volume of alcohol, it will only yield eight cubic inches of vapour to 100 of air. In passing over a sponge or handkerchief the air would take up less than this, usually four or five per cent., which is a quantity sufficient to cause insensibility in four or five minutes, without the risk of sudden accident. It is not desirable to dilute the chloroform with spirit when it is administered with any kind of apparatus which is intended to regulate, with any approach to accuracy, the amount of vapour in the air which the patient breathes, for the chloroform evaporates from the spirit in greatest quantity at first, and less afterwards, as the remaining spirit contains less and less chloroform. This circumstance forms no objection, however, to diluting chloroform with spirit when it is to be inhaled from a handkerchief or sponge, as no great accuracy is aimed at by this method, and patients may be made insensible by these means with as much regularity when the chloroform is diluted as when it is not. Two drachms of the mixture of chloroform and spirit may be poured in the handkerchief or sponge at one time.

Whatever means are used in the exhibition of chloroform, or any other narcotic vapour, the patient should have the liberty of breathing either by the nostrils or mouth. There should be no tube in the mouth, nor any nose-clasp employed. When he begins to inhale, it is advisable to request him to breathe gently and quietly, in other words, to do nothing but conduct himself as if he were about to fall asleep naturally; for if he breathes deeply, the vapour feels much more pungent than it otherwise would do, and is apt to excite coughing, or a feeling of suffocation. It is desirable also to give the vapour in a very diluted state for a minute or so at first, in order that the air passages may get gradually accustomed to its presence. This is more particularly desirable in children and timid persons. It can be effected by means of the moveable valve in the face-piece of the inhaler which is used by the writer; or when a handkerchief or sponge is employed, by holding it at first some little distance from the face, and then gradually approaching it nearer, so that more and more of the air which the patient is to breathe passes over the surface moistened with the anæsthetic agent.

Some patients become excited as soon as they are unconscious, and attempt to get up, or to push away the chloroform; under these circumstances, if they cannot be calmed by what is said to them, they should be held, and the vapour should be gently and steadily continued for a minute or two, till a state of quietude is produced. The patient generally remains quiet as he becomes unconscious, but there is no difficulty in ascertaining whether he is conscious or not: if the eyelids remain open, the countenance shows whether the patient is conscious or not: and if they are closed it is only necessary to touch them gently in order to ascertain this circumstance. If he is still conscious, he will look at his medical man, and probably speak, or, at all events, show by his countenance that he is awake.

The absence of consciousness and a state of quietude are both requisite before the commencement of a surgical operation, and they go a good way towards the preparation of a patient for it, but these symptoms may be present and the patient not be ready for the operation. It is necessary to know whether he will lie still under the use of the knife, or whether he will make a resistance and an outcry, which he would probably not make if he were awake. The best plan to ascertain when the patient is ready for an operation, is to raise his eyelid gently, by placing one finger just below the eyebrow, and then to touch its ciliary border very gently with another finger. This should not be done roughly, nor too frequently, for fear of exhausting the sensibility when it is weak. Just after unconsciousness is induced, the eyelids are often closed very strongly when their margins are touched, and there seems to be a real hyperæsthesia; but this is probably only apparent, and arises from the control of the will being removed, whilst sensibility remains. By continuing the chloroform, the sensibility of the margins of the eyelids is diminished, until they may be touched without causing winking. Under these circumstances the most severe operations may, with scarcely an exception, be commenced without sign of pain. This test even indicates the amount of sensibility where a little remains; when, for instance, touching the edges of the eyelids causes very languid and slight winking, the patient will usually flinch a little on the use of the knife, but only in a manner that can be easily restrained, and does not interfere with the greater number of operations. The only cases in which the indication afforded by the sensibility of the eyelids is not always to be depended on, are those of certain hysterical patients, in whom there is occasionally no winking on the eyelids being touched, even when unconsciousness is scarcely induced. In these cases, one must be guided by the other symptoms, and also by the length of time the inhalation has continued, the strength of the vapour, and the depth and frequency of the breathing. Indeed these circumstances should be observed in every case, and all the symptoms should be watched, such as the expression of the face, the state of the breathing, and the condition of the limbs with respect to their tension or relaxation.

The condition of the breathing affords one of the best indications that the inhalation is proceeding further than is desirable, and this is fortunately a sign that cannot be overlooked by the person who is giving chloroform. Whenever the breathing becomes stertorous the inhalation should be immediately suspended. Under these circumstances the patient is always insensible, and indeed it is seldom requisite to carry the effects of the vapour so far that stertor is produced. It sometimes happens, when a little more chloroform has been inhaled than is necessary, that the patient breathes for half a minute or so by the diaphragm only. The abdomen rises and falls freely, but, as the muscles of the chest do not fix the ribs, hardly any air enters the lungs, and the face becomes rather livid; the pulse meanwhile goes on very well; and at last the patient takes a deep, sonorous inspiration, when the face resumes its proper colour, and the breathing goes on as usual. When this state of breathing occurs, it usually takes place a few seconds after the inhalation has been discontinued, and arises from the accumulation of the effects of the chloroform, owing to the absorption of the vapour which was contained in the lungs at the time when the inhalation was left off. This increase, or accumulation, of the effects of chloroform lasts for about twenty seconds; it is not dangerous unless the vapour is inhaled of too great strength, but it should always be borne in mind. It may be prevented by reducing the strength of the vapour just as the patient is getting insensible.

When rigidity and struggling occur in the third degree of narcotism, that is just after the suspension of consciousness, the inhalation should be continued gently till these symptoms are subdued. The patient is sometimes insensible before the rigidity is overcome, but it is necessary to have him in a state of quietude, in order to enable the surgeon to operate with convenience and safety. It is advisable to proceed cautiously and slowly when rigidity and struggling are present, because, when these symptoms occur, the patient has already absorbed nearly the usual quantity of chloroform, and he sometimes holds his breath, and then suddenly takes a deep inspiration, when he might inhale an overdose of the vapour, unless it were exhibited to him in a well diluted state. In very robust men, accustomed to great muscular exertion, it sometimes takes five or six minutes before the rigidity can be fairly subdued. If the operator should be afraid to proceed with the exhibition of chloroform on account of the violence of the muscular spasm and rigidity, the inhalation may be resumed after it has been discontinued for a few minutes, and the above symptoms will be less violent than at first. After the muscular spasm and rigidity are subdued by the chloroform, they rarely recur during the operation.

The pupils are usually somewhat contracted in the third degree of narcotism, when the eyes are inclined upwards, and they seem to be less sensitive to light when the patient is under the influence of chloroform than at other times. They do not become totally insensible to light, or widely dilated, except by such a deep effect of the chloroform as it is desirable to avoid.

There is often an increased flow of saliva during the inhalation of chloroform, and although this seldom causes any impediment, the patient occasionally makes efforts of deglutition, which retard the inhalation; and, at other times, he holds his breath, with his mouth full of saliva after he is unconscious, as if he had some obscure idea of disposing of it in a suitable manner. If a towel is placed against the lips under these circumstances, he generally empties his mouth, and goes on breathing properly.

The length of time which it is most desirable to occupy in the exhibition of chloroform, before an operation is commenced, is about two minutes in infants, three minutes in children, and four or five minutes in adults. Circumstances occasionally occur to lengthen these periods, but it hardly ever takes more than seven or eight minutes to render the patient sufficiently insensible. When a longer time has been occupied there has always been a physical cause for it. The writer has never had any reason to attribute the delay to any idiosyncrasy, or peculiarity in the patient, but merely to the circumstance that the vapour did not enter the lungs in sufficient quantity within a given time. He has had under his care several patients, who, it was supposed, were not susceptible of the effects of chloroform, or were, at least, very difficult to bring under its influence, as previous attempts had failed; but he met with no difficulty in causing insensibility in any of these cases.

If the operation be of short duration, the first application of chloroform will often suffice without repeating the inhalation. The patient now and then remains insensible to the knife for three minutes after the inhalation is left off, but this is an exception; and one cannot make sure of this prolonged effect of chloroform without producing a deeper state of narcotism than is desirable. When the operation lasts more than a minute or two, it is usually necessary to repeat the inhalation; and indeed it is generally advisable to let the patient have a few inspirations of air mixed with vapour of chloroform about every half minute whilst the operation lasts, in order to keep up the insensibility. When the surgeon is operating in the neighbourhood of important parts, it is desirable to prevent any sign of sensibility, and to keep repeating the chloroform so as to keep up the coma, without, however, causing dilatation of the pupil, or embarrassment of the breathing; but in the greater number of operations, it is better to wait till there is some sign of sensibility, such as a slight cry or tendency to flinch, before resuming the inhalation; and then a few inspirations of well diluted vapour make the patient quiet again.

Consciousness usually returns within five minutes after the inhalation has been discontinued. After a brief inhalation, for a very short operation, the patient sometimes becomes conscious almost immediately; whilst, after a protracted operation, ten minutes sometimes elapse before the recovery of consciousness. When left to himself the patient usually recovers from the effects of the chloroform in a very tranquil manner, and it is desirable not to talk to him until he has completely recovered. If he has not been moved whilst insensible, but wakes in the position in which he fell asleep, he very frequently supposes that he has not been asleep at all, and in a number of instances will contend, even after a prolonged operation, that the chloroform has not taken effect. Of course he soon finds out his error. After the greater number of operations the patients have to remain in bed; and even after minor operations under chloroform it is advisable that the patient should lie, or at least sit still for half an hour, or longer, before making any bodily or mental exertion.

There are occasional sequelæ of the inhalation of chloroform. Sickness is the most important of these. It is most frequent when the inhalation takes place soon after a meal, but the best directions with regard to diet will not always prevent it, as the food is sometimes not digested when the patient is expecting a surgical operation, and the breakfast may be vomited in an unaltered state after the lapse of several hours. Moreover, there may be sickness and retching when there is nothing in the stomach. Moving the patient, as the effects of the chloroform are subsiding, is very liable to excite vomiting when it might not otherwise occur; it is therefore advisable to allow the patient to lie for about half an hour, when convenient, without moving his head from the pillow. Even when a feeling of sickness is present it often subsides, by this means, without the occurrence of vomiting. It is desirable also not to give anything to eat or drink till about an hour after the chloroform, and generally not even then, unless there is an inclination for it. Even medicine, such as an opiate, is better delayed for an hour or so, except when there is an urgent necessity for giving it sooner. When a patient is faint from loss of blood of course this rule must be disregarded, and wine or brandy may be given, and repeated if it be vomited. When vomiting occurs, it most usually takes place after the chloroform is discontinued, and whilst its effects are passing off. It often occurs before the patient is quite conscious, and he does not know it unless he is told. In a few cases, in which there is a good deal of food in the stomach, vomiting comes on before the operation is concluded, and now and then even before it is commenced. When vomiting comes on during an operation, it is sometimes difficult to prevent the patient from awaking; but this can generally be accomplished by wiping the mouth, and resuming the inhalation as soon as the effort of vomiting is over. In many cases the sickness does not come on till the patient awakes, but the sickness really due to chloroform probably always begins within an hour or two, or, at the furthest, just after the first food which is taken. When sickness did not occur till the following day the writer has always found that an opiate had been taken, or, at least, that there was some other cause to which it was probably due. Several cases have occurred in which the sickness has lasted for two or three days in spite of the usual remedies; but these cases form a small portion of the whole number in which chloroform is administered, and they have chiefly happened in persons who were subject to attacks of vomiting from slight causes.

The sickness caused by chloroform usually subsides as soon as the stomach is emptied by vomiting. It is therefore advisable not to do anything for it for an hour or so; but when it continues beyond this period a little cold brandy and water removes it in most cases. When this remedy has failed, a dose of opium has been found to relieve the sickness. Effervescing draughts have not appeared to be of much service, and draughts of warm water seem to make the sickness worse. It is not advisable for the patient to make any effort, but only to vomit if obliged to do so.

Chloroform is occasionally followed by faintness and depression, especially if the patient remains in the sitting posture, and is liable to faintness at other times. The horizontal position is the treatment for this, with ammonia to the nostrils and wine or brandy if the faintness does not presently subside.

Hysterical symptoms sometimes come on in female patients as the effects of chloroform are subsiding, and the writer has on two occasions met with them in the male. These symptoms nearly always pass off spontaneously within half an hour. If they do not, they must be treated on the ordinary principles. Hysteria was probably quite as frequent and severe an attendant on operations when they had to be submitted to without the aid of anæsthetics as at present.

If chloroform, when administered in the usual way, were continued in the disregard of the symptoms death would undoubtedly be the result; and some persons who have lost their lives by incautiously inhaling it, when no one was near to watch its effects, have probably expired from its being continued too long; but on examining the details of the recorded deaths from chloroform, during its administration for surgical operations, it will be found that, in every case, the dangerous symptoms, if not the actual death of the patient, came on suddenly, and without previous warning. There is in fact no reason to conclude that any of these accidents occurred from mistaking, or overlooking, the symptoms which indicate that it should be left off, when it is administered throughout in a safe and gradual manner.

Experiments on dogs, cats, and other domestic animals, show that chloroform may cause death in two very distinct modes; and as these animals are acted on by chloroform precisely in the same way as the human being, in all those stages and degrees of its influence which can be induced without danger, it may safely be concluded that, when they are killed in such a manner that the mode of dying exactly resembles that which occurs in the accidents to the human subject, the precise cause of death is the same. When animals are made to breathe air containing four or five per cent. of its volume of vapour of chloroform until they are killed, death takes place slowly and gradually. They first become gradually insensible, and then deeply so; afterwards the breathing becomes embarrassed, and it ceases fifteen or twenty minutes after the beginning of the experiment. The heart continues to beat very distinctly for one or two, and sometimes three minutes after the breathing has ceased; and its action becomes suspended, as in asphyxia, by privation of air, on account of the absence of the respiration, and not from the direct action of the chloroform. During this interval, whilst the heart is still beating, the animal can be easily restored by artificial respiration, and, moreover, there are often two or three gasping inspirations at the moment when the heart is ceasing to beat, which generally have the effect of restoring its action, and bringing about the recovery of the animal, if the chloroform have been withdrawn.

When, on the contrary, the animals mentioned above are made to breathe air containing eight or ten per cent., or upwards, of chloroform, death takes place, in nearly all cases, very suddenly, and the action of the heart does not survive the breathing. The chloroform is absorbed into the blood as it passes through the lungs, in such quantity that it acts directly on the heart, which ceases to beat at the same moment as the breathing ceases, or, in a few cases, even before the breathing.

It is by this last of the two modes of death that the accidents from chloroform have occurred. In no recorded instance has the pulse survived the respiration, whilst in several cases it has ceased before the breathing; and as regards the strength of the vapour which was being inhaled just before the accidents happened, it may in every case have been as much as eight or ten per cent. in proportion to the air. Attention has rarely, if ever, been directed to this point in cases in which accidents have occurred, although great care and attention have been generally employed. Many of the deaths from chloroform took place before the operation was begun, several during its performance, and a few just when it was completed. In some of the accidents which occurred within the first two or three years after chloroform was introduced the patients died suddenly, within half a minute after commencing to inhale, having taken only a few inspirations.

There was disease of vital organs in a few of the patients who died from chloroform, but, on the whole, they were probably in as sound and healthy a condition as the multitude who have inhaled this agent without ill effects. Not a few of them certainly were robust young men suffering only from a local ailment or injury. This shows that the accidents cannot be attributed to the condition of the patient. Some hidden peculiarity of constitution has indeed been occasionally alluded to as a probable cause of the accidents, but there is an answer to this in the circumstance that many of the same patients had inhaled chloroform previously without ill effects, some of them within two or three days of the time of the accident. In no case can death be attributed to any impurity in the chloroform employed.

The appearances found in the body after death from chloroform are not very striking. The head has generally presented nothing peculiar. The lungs have usually been somewhat congested, and in some cases very much so. The quantity of blood in the cavities of the heart has varied very much, probably from its being disturbed by the artificial respiration nearly always employed; for in animals killed by chloroform, the right cavities of the heart are always full of blood, and the left cavities generally contain a small quantity. The blood has in nearly all cases remained fluid after death, as it usually does in cases of sudden death from any cause in the human subject. A good deal of stress has in some cases been laid on this fluidity of the blood after death from chloroform, but there is one circumstance which shows that it is not connected with the mode of dying as a cause, but only as a consequence. If the heart or great vessels of an animal are cut just after it is dead from chloroform, the blood which escapes always coagulates immediately and firmly, but if the body is not opened till the following day, the blood is found almost altogether fluid, and remains so.

The first rule to be observed, in order to avoid the danger of accident in administering chloroform, is to have the vapour always sufficiently diluted with air, to so regulate the process, in fact, that the vapour never constitutes more than six per cent. of the inspired air. The means of effecting this have been already detailed. The next rule is to attend closely to the symptoms which have been above described, and stop whenever insensibility is induced, or when the breathing has any tendency to become stertorous. When the first rule is followed the second is easy enough; but if the air the patient breathes should become too highly charged with vapour, it may happen that no amount of attention to the symptoms will avert an accident. In several fatal cases, which occurred whilst the patient was carefully watched, the last beat of the pulse was equal in volume and force to those which preceded it.

The great necessity of avoiding accidents with chloroform is rendered the more urgent by the circumstance that so little can be done to remedy an accident when it occurs. If the patient is in real jeopardy from chloroform he nearly always recovers spontaneously and immediately, or not at all. Only one or two instances are known of patients being restored from the effects of an overdose of chloroform, who would not probably have recovered of themselves. Artificial respiration promptly and vigorously applied, affords the best chance of restoring the patient; and it should be resorted to as soon as the pulse and natural breathing have ceased. Probably the postural method, introduced by the late Dr. Marshall Hall, is the most ready and effectual. The writer has been able to restore animals by artificial respiration, in some cases where they evidently would not have recovered without it, but only when a tube had been fixed in the trachea previously to giving the last dose of chloroform, so that the artificial respiration might be effectually performed within a quarter of a minute after apparent death. In these trials the action of the heart recommenced in a few seconds, or not at all. The jugular vein might with propriety be opened if it were distended; for in opening animals just after they were suddenly killed by chloroform, the action of the heart has, in some instances, recommenced on the distension of its right cavities being relieved by cutting the veins at the root of the neck. The writer has not found electro-magnetism of any use in the restoration of animals which were killed by chloroform. As to the dashing cold water on the patient, applying ammonia to the nostrils, and such like measures, it is enough to say that they would have no effect whatever, even in a case where the patient has inhaled chloroform within perfectly safe bounds, and is in a state to undergo even a minor surgical operation without flinching.

The proportion which the number of accidents from chloroform bears to the whole number who inhale it cannot be ascertained; for although cases of accident are generally published, the number who inhale it without injury is unknown. It is certain, however, that the proportion of the accidents from its use is extremely small. The remark is sometimes made, that patients used occasionally to die suddenly, just at the beginning of a surgical operation, apparently without any adequate cause. Whether these cases were as numerous as the deaths from chloroform might be the subject of ingenious speculation, for there is no means of determining; there is, however, no reason to suppose that the deaths which occur under the use of chloroform are of the same nature, and happen to the same persons, as the deaths alluded to. These latter probably arose from the effects of mental emotion or of pain, both of which are prevented by chloroform; and the endeavour of the medical man should be, to prevent, as far as possible, both the dangers of pain and mental emotion, and also those which are peculiar to chloroform.

Sulphuric ether continues to be still used in some parts of America and the continent of Europe. The chief objection to it is its strong and persistent odour, which remains in the breath of the patient frequently for two days. The surgeon also carries the odour of it about with him. The effects of sulphuric ether are as nearly as possible the same as those of chloroform, but a much larger quantity requires to be inhaled. Whilst less than a fluid drachm of chloroform usually suffices to make the adult patient insensible, about a fluid ounce of ether is required; and unless means are taken to counteract the cold produced by the evaporation of the ether, the evaporation itself often becomes so diminished, that a long time is occupied in causing insensibility; and in some cases, no effect is produced beyond a state of excitement, as the patient goes on breathing air cooled much below the freezing point, but containing very little vapour. By using a copious bath of cold water to supply the caloric carried off by the evaporation of the ether, the writer was able to make every patient insensible with this agent, and generally in the space of four minutes. The recovery from the effects of ether is generally slower than from those of chloroform, and the patient often remains in a state of inebriation for about half an hour after it. Sulphuric ether has, perhaps, but one advantage over chloroform, which is, however, an important one—it is its great safety. There is reason to conclude from experiments on animals, that this agent is altogether incapable of causing sudden accidents, such as those which have happened in the employment of chloroform. Only two deaths are known to have occurred during the inhalation of ether. They both took place in France. In one case the patient appeared to die slowly from want of air, owing to the faulty construction of the inhaler. The other death occurred suddenly, during the removal of a tumor of the upper jaw, in a very unfavourable subject, and was probably caused by loss of blood.

The writer of this article has employed amylene in between two and three hundred operations, but has discontinued it on account of two accidents which he met with. Amylene was discovered by M. Balard in 1844. It is made by distilling amylic alcohol, *i. e.* purified fusel oil, with chloride of zinc. It is a colourless and very mobile liquid, only two thirds as heavy as water, and less than half the weight of chloroform. It is composed of ten atoms carbon, and ten atoms hydrogen. It boils at 102° Fahr., and the specific gravity of its vapour is 2·45. Its solubility in water is curiously slight, as it requires about 10,000 parts of water for its solution. It has an odour somewhat resembling that of naphtha, not so strong or permanent as that of sulphuric ether, but stronger and more permanent than that of chloroform. It is almost without taste or pungency. The amount of amylene used in making an adult patient insensible is about half a fluid ounce, and is, consequently, intermediate between those of chloroform and ether. In a long operation, indeed, the amylene has to be repeated so frequently that a larger quantity is used than in the case of sulphuric ether. With the exception of the accidents alluded to above, the action of amylene was extremely favourable, and it appeared to possess certain advantages over chloroform in the following circumstances:—first, its vapour being almost altogether without pungency, it was easier to breathe; second, the operation could be performed with a less amount of narcotism of the brain than in the case of chloroform or ether. In the operations under amylene the patient was usually in an apparently waking state, though really unconscious of what was occurring around, and occupied with his dreams. In a few cases he was conscious, and even talked to his surgeon during the operation. Third, the recovery was more prompt even than after chloroform; and fourth, sickness was extremely rare after amylene.

Amylene does not cause insensibility unless the air which the patient breathes contains as much as fifteen per cent. of the vapour, and judging from experiments on animals, the vapour may be increased to thirty per cent. without danger. When administered on a handkerchief or sponge, it is probably attended with as little or even less danger than undiluted chloroform. It has been largely used in Paris, Strasbourg, Berlin, and Lyons, without any accidents from its use being recorded. In the two cases in which death occurred during its use, the heart suddenly ceased to beat when the patients were not very insensible. The breathing continued in one case for ten minutes afterwards, and in the other case for even a much longer period. The means which the writer employed for the exhibition of amylene were the same which he has found so successful in the employment of chloroform. If he should use amylene again, he would be inclined to give it from a large bladder or bag, so that the quantity of vapour in the air might be under complete control.

Several agents have been inhaled with success, in a few cases, for preventing the pain of operations, besides those treated of above, but as they have not come into general use, it is unnecessary to enumerate them in a work on surgery.

The process of administering an anæsthetic vapour is so much the same in every case where severe pain is to be prevented, that very little requires to be said respecting particular operations. It is desirable, as a general rule, that the patient should be placed, before inhaling, in the position in which the operation will be performed, so that the surgeon will be able to commence without delay, as soon as insensibility is induced. In operations on the back, however, the patient should inhale first, and be turned over afterwards; and in cases where moving him causes great pain, he may inhale in bed, and be moved when insensible. In lithotomy the patient should be placed on the table, with a pillow under his head, and inhale till he is insensible. The sound may then be introduced, and afterwards the bandages should be applied, and the patient be drawn down to the foot of the operating table, a little more vapour being administered whilst this is done, to keep up the insensibility. In lithotomy in children, the feet and hands are sometimes not bandaged, but in this case the person administering the anæsthetic should hold the head or shoulders of the child with one hand, whilst the surgeon makes his first incision, otherwise the child may push its body away at this moment, unless the insensibility is deeper than is necessary; for the assistants who hold the legs, and think they are doing great service, make a fulcrum which enables the child to do this. In amputations, the tourniquet may with advantage be adjusted whilst the patient is inhaling, and tightened as soon as he is insensible. Operations on the anus and rectum obviously cannot be performed under chloroform or ether, whilst the patient is on his feet, and leaning over a bed or table; he must be placed either on his side with the knees drawn up, or else in the lithotomy position. Some patients have a great tendency to straighten out the legs during operations on the anus, unless they are made very deeply insensible, and in the cases of strong muscular men, it is desirable for the surgeon to have two assistants, as the great muscles of the lower extremities are with difficulty restrained, even if they retain but a third of their ordinary power.

In great operations on the face, such as the removal of tumors of the maxillary bones, there is often considerable difficulty in keeping up the insensibility during the operation; but by having a hollow sponge in readiness, moistened with a mixture of chloroform and spirit, and holding it near the face whenever the hands of the operator and his assistants afford room, the patient can be rendered so far insensible that he does not remember the operation. The patient should not be made very deeply insensible in operations involving the mouth or nose, and accompanied with great bleeding. He may, however, be with safety made so insensible as not to have pain, provided all the facilities are given for getting rid of the blood that would be allowed in the waking state. The glottis retains its sensibility under the influence of anæsthetic agents if their effects are not carried to an extreme degree; but a patient when awake cannot breathe with more than a certain amount of blood in the fauces, therefore, as he cannot, when insensible, push away his surgeon and hold his head down, it must be held down occasionally, when the quantity of blood is such as to require it. A little blood is liable to get into the trachea in great operations about the mouth, whether the patient is insensible or not, and in either case it is coughed up again. There is no evidence of any harm having resulted from blood flowing into the windpipe in operations about the mouth. One patient died about an hour after the removal of the greater part of a tumor of the upper jaw and neighbouring bones, so much of it as could be reached; but his symptoms were those of exhaustion from loss of blood; and after death only a few small spots of blood were found in the lungs, and this small quantity apparently entered whilst he was moribund, for some hemorrhage continued to the time of death. Some of the blood is nearly always swallowed in operations about the mouth; this is generally the case in tooth drawing under the influence of chloroform, as is proved in the cases in which the patient afterwards vomits.

Chloroform and sulphuric ether are of great service in the reduction of dislocations, more particularly those of long standing; not only by the prevention of the pain, but by removing, or greatly diminishing, the resistance of the muscles. Some dislocations of the shoulder have been completely reduced, as long as five months after the accident, with the aid of these agents. There are other operations not unfrequently performed of late, under the influence of anæsthetics, which the surgeon could hardly have proposed without their aid; namely, the forcible breaking down of adhesions produced by disease of the joints. In a few cases also the operation for hernia has been prevented by the use of anæsthetics; the taxis having been successful under their use, after it had previously failed. Anæsthetic agents may be administered safely, and with great advantage, to patients who have to undergo operations in a state of great debility, either from disease or severe injury.

The local application of ice and salt, so much advocated by Dr. James Arnott, is capable of preventing the pain of those operations which do not go deeper than the skin. The ice should be well pounded and intimately mixed with the salt, then put into a piece of muslin, and applied to the part to be operated on. The effect is generally produced in from three to five minutes, and is known by the skin becoming very white and as firm as stearine. There is some pain during the application of the frigorific, and still more as the skin is recovering its sensibility, but this last can be moderated by the application of iced water. When the operation extends to the tissues beneath the skin, pain is experienced.

It was not to be expected that the use of anæsthetic agents should make any great difference in the ultimate result of important operations. The fact of a multitude of patients inhaling these agents for minor operations, without ill effects, shows that they are not injurious to the health; and this being the case, the prevention of the pain of great operations cannot be otherwise than beneficial. The satisfactory condition in which a patient is generally found just after an operation without pain, confirms this view; at the same time it must be remembered that death was seldom due to the immediate effects of an operation before anæsthetics were employed, but to causes which came into action after the operation, and which are still in force. There are no very extensive or trustworthy statistics of the results, even of amputations, before the employment of anæsthetics, to compare with the present results of these operations, and if there were, it would be necessary to bear in mind that the very introduction of these agents has, in many cases, altered the conditions under which operations are performed. On the one hand, the patient often gives his consent to an operation at an earlier and more favourable period than he would do if he had to submit to the pain, and on the other, the surgeon sometimes recommends an operation when the prospect of success is so small that it would hardly counterbalance the evil of the pain, if that could not be prevented. The progress of surgery has also altered the circumstances under which operations are performed; resection of the larger joints being often performed now in cases where amputation would formerly have taken place. This change of practice is itself very much due to the introduction of anæsthetics. The most unexceptionable way of endeavouring to ascertain whether any, and if so, what influence has been exerted on the result of large operations by the use of anæsthetics, is to examine the result of these operations for a series of years in the same institution, before the use of these agents and afterwards. Dr. Fenwick made an extensive inquiry of this kind into the results of all the important operations in the Newcastle Infirmary, for a number of years before the use of ether and chloroform, and for the period during which these agents have been in use, and the comparison is, on the whole, decidedly in favour of the latter period.

The writer of this article has not kept an account of all the cases in which he has administered chloroform, but he finds, nevertheless, that he has memoranda of rather more than three thousand eight hundred surgical operations in which he has exhibited it. These have not been selected cases; on the other hand, whilst he has not declined to administer chloroform in any instance in which a surgical operation was required, he has been consulted in a great number of cases, and has undertaken to give this agent where other medical men had hesitated to do so, on account of disease of the heart, of great debility, or some other cause; for the writer has, after giving the subject his careful consideration, acted on the principle that chloroform, when carefully administered is, under all circumstances, less likely to be injurious than severe pain. With this amount and kind of practice the writer has lost but one patient whilst inhaling chloroform, whom, he believes, as was previously stated, to have died of the disease of the heart under which he was labouring, and not from the anæsthetic; for the heart suddenly ceased to beat whilst he was making a straining effort, as if he were beginning to feel the operation — that of lithotrity. Every medical man who takes the same pains will of course be likely to have the same success as the writer; and, with the experience which has already been gained, it may reasonably be expected that accidents from the use of chloroform will be less likely than heretofore. There is every reason to conclude, therefore, that this agent may be administered with an amount of risk so small as to be hardly appreciable — less indeed than attends many of the most ordinary proceedings in medicine and surgery; and as severe pain is not without danger, it may not unreasonably be expected that chloroform may, in some cases, be an additional source of safety to the patient. The great and direct benefit of the prevention of pain by anæsthetics is so universally admitted, that it is unnecessary to do more than allude to it in this place; some instances have been mentioned above, in which these agents enable the surgeon to effect what otherwise could not be accomplished; and another advantage which they undoubtedly confer, is that of frequently causing patients to consent at once to receive the benefits of operative surgery, instead of withholding their consent, either altogether, or till the most favourable period for relief would be passed.]

John Snow, M.D.

ANEURISM, or ANEURYSM (from ἀνευρύσμα, a dilatation). The tumors which are formed by a preternatural dilatation of a part of an artery, as well as those swellings which are occasioned by a collection of arterial blood, effused in the cellular tissue, in consequence of a rupture, or wound of the coats of the artery, but having no outlet in the integuments (see *Guthrie, On Dis. of Arteries*, p. 40), receive the name of aneurisms. According to these opinions, aneurisms are of two kinds; the first being termed *true*, the second *spurious*, or *false*. Some modern writers reckon another form of aneurism, which is said to happen when the external coats of an artery being weakened by mechanical injury, or disease, the internal coat protrudes through the breach in the outer coat, so as to form a tumor distended with blood. This case has been denominated the *internal mixed aneurism*, or *aneurisma herniam arteriæ sistens*. The reality of this form of disease was believed in by Dr. W. Hunter; and some delicate experiments, instituted by Haller on the mesenteric arteries of frogs, appear to have been the first ground of the opinion.

However this may be with respect to the experiments made on certain animals, I am disposed to consider it fully proved by Mr. J. Hunter, Sir E. Home, and Professor Scarpa, that, in the human subject, an aneurism will not arise from the kind of weakness which is caused by cutting or even stripping off the external coat of a sound artery, whether the wound be closed or not.

[In the museum of the College of Surgeons there is a preparation, No. 1642, which is intended to illustrate this pathological condition. It is an aneurism of the upper part of the arch of the aorta, apparently formed by a hernial protrusion of the internal and middle through an opening in the external, the tumor being about the size of a walnut and having very thin and transparent coats. On close examination, this preparation appears to me to be of a very doubtful character; the external coat ceases abruptly by a ragged edge at the base of the tumor, and has all the appearance of having been dissected off.]

By the term *mixed* aneurism, Dr. A. Monro, senior, implied the state of a true aneurism, when its cyst had burst, and the blood was diffused in the adjacent cellular substance; an event which is frequent. Besides these varieties of aneurism, the *aneurismal varix*, or *venous aneurism*, and the *aneurism by anastomosis*, constitute diseases which are usually regarded as cases pertaining to the present subject, though incapable of being comprised under the ordinary definition of an aneurism.

An aneurism may then be defined to be a tumor filled with blood, either in a fluid or solid state, usually attended with pulsation, and the sac of which has an opening in it, by which it communicates with the artery, from which the blood is transmitted into it. Lisfranc defines it, "a tumor formed by arterial blood, and communicating with an artery," and divides all aneurisms into *traumatic* and *spontaneous*, according as they happen to be produced by a wound, or disease of the coats of the artery. (*De l'Oblitération des Artères dans les Aneurismes*, p. 6.)

Nothing can be more manifest than the fact, that, previously to the discovery of the circulation of the blood, no correct nor valuable opinions could have prevailed respecting the diseases which now go under the name of aneurisms. Indeed, it was not until after the days of Aristotle, that any distinction was made between the swellings of veins and those of arteries; such vessels not having been at that early period distinguished from each other. Their differences were first pointed out by Rufus of Ephesus. Down to Galen, however, nothing like consistency was established in the notions respecting aneurism. His opinion was, that all tumors of this nature were produced either by anastomosis, or by rupture: and though he has described their symptoms, he has not informed us of the characters by which each of these cases was distinguishable, one from the other. Paulus Ægineta divides aneurism into two sorts, both of which, he says, are attended with extravasation, and of course with rupture. Vesalius, who first applied anatomy to the investigation of disease, described aneurism arising from the *rupture of a dilated* aorta; the first specimen, I believe, on record of this form of disease. (*Bonetus Sepulch. Anat.* lib. iv. sect. 2.)

The combination of rupture with dilatation of the artery, was afterwards more particularly noticed by Nuck (*Oper. Chir. &c.* Lugd. 1692); but it was Fernelius who first promulgated the doctrine, that aneurisms were always dilated arteries. (*Universa Medicina De Extern. Corp. Affect.* lib. vii. cap. 3. Venet. 1564.)

This opinion was espoused by Forrestus, Diemerbroek, and others; but at length, the inaccuracy of attempting to refer every aneurism solely to dilatation of the coats of the vessel, was established by the observations of Lancisi, Freind, Guattani and Morgagni. In short, as Mr. Hodgson has stated, these authors proved, that aneurism may be produced either by the rupture, or the dilatation of the coats of an artery, or by a combination of both circumstances, the dilatation having preceded the rupture. (*On the Dis. of Arteries, &c.* 8vo. Lond. 1815.)

In truth, this admission of aneurism by dilatation, and of aneurism by rupture of the coats of an artery, together with the frequent combination of both circumstances, became the prevailing undisturbed doctrine of every surgical school, until Professor Scarpa, inclining to the tenets of Sylvaticus (*De Aneurysmate Tract.* Venetiis, 1600, 4to.), ventured to question the correctness of the common opinion about the dilatation of all the arterial coats. However, after the very clear and satisfactory elucidation of this disputed point by my friend Mr. Hodgson and others, as well as by several preparations in the Hunterian collection (see *Guthrie, On Dis. of Arteries*), the accurate views of the subject, first taken by Morgagni and the other eminent writers specified above, may be regarded as established beyond the possibility of dispute. At the same time, it is not to be supposed that Scarpa means to say, that the arteries are not subject to a morbid dilatation; on the contrary, he gives a particular description of this affection, which he carefully discriminates from aneurism.

Previously to offering a more particular account of the doctrine taught by Scarpa, respecting the formation of aneurism, as well as of the chief facts which may be adduced against a part of such doctrine, it seems proper to make the reader acquainted with the various forms of the disease, their ordinary symptoms, and a few pathological facts.

When an artery becomes dilated spontaneously (attended with particular circumstances marking its difference from another form of dilatation, which, as I shall explain, perhaps ought not to be set down as aneurismal), the swelling is commonly named a *true* or *genuine aneurism*. In such cases, the artery is either enlarged at only a small part of its track, and the tumor has a determinate border, or the vessel is dilated for a considerable length; in which circumstance the swelling is oblong, and loses itself so gradually in the surrounding parts, that its margin cannot be exactly ascertained. The first case, which is the most common, is termed the *circumscribed true aneurism*; the last, the *diffused true aneurism*; a case, however, which would be looked upon by Scarpa only as a specimen of dilatation, different in several particulars from aneurism, as will be hereafter noticed. When blood escapes from the wound or rupture of an artery into the adjoining cellular substance, the opening in the skin having closed, the swelling is denominated a *spurious* or *false aneurism*. In this instance, the blood either collects in one mass, distends the cellular substance, and condenses it into a cyst, so as to form a distinctly circumscribed tumor; or it is injected into all the adjacent cellular substance, and extends along the course of the great vessels, from one end of the limb to the other, thus producing an irregular oblong swelling. The first case is named a *a circumscribed false aneurism*; the second, a *diffused false aneurism*. (*Richter's Anfangsgr.* b. i.)

When an aneurismal sac is formed upon a dilated artery, the walls of the vessel are sometimes thinner than usual; and some parts of them may become expanded into pouches, or even engrafted upon the original swelling, the prominent points being always the thinnest. This kind of case is sometimes termed a *sacculated aneurism*, of which there is a good specimen in the Hunterian collection, remarkable also as exhibiting an aneurism opening by ulceration into the pulmonary artery. (See *Guthrie, On Dis. of Arteries*, p. 59.)

Aneurism by dilatation is distinguished by Breschet into four varieties, the names of which are determined by the differences in the shape of the expansion of the arterial tube. For instance, 1. True *sacciform* aneurism: 2. True *fusiform* aneurism: 3. True *cylindroid* aneurism, subdivided into that of the large arteries, and into that of the small arteries, or the *aneurism by anastomosis* of John Bell, and the *erectile tumors* of Dupuytren: 4. True varix-like aneurism, or *aneurisma cirsoideum*. In *sacciform* aneurism, the vessel has at one point of its circumference a small sac, consisting of an expansion of the arterial tunics. This variety is most frequent in the aorta, but sometimes on the carotid and iliac arteries, and even on those of the limbs. In this aneurism, all the arterial tunics are simultaneously dilated; but as the internal and middle ones have but a limited degree of extensibility, the sacciform aneurism does not generally exceed the size of a filbert, though Breschet has noticed some on the aorta as large as a hen's egg. (See *Breschet, Sur Différentes Espèces d'Aneurismes*, p. 12, &c.)

In the *true fusiform aneurism*, the dilatation extends over the whole circumference of the vessel: all the coats participate in it. The calibre of the artery, after becoming wider and wider gradually, for a certain portion of the track of the vessels, then lessens in a manner equally gradual, till it has resumed its natural diameter.

The *cylindroid* aneurism of Breschet might be regarded only as a variety of the fusiform, inasmuch as an abrupt transition from a given calibre to a much more capacious one is never observed. Yet, according to the investigations of Breschet, cases present themselves in which the artery is uniformly dilated through a track of one or two feet, the cylindrical form being here strictly preserved. This pathological fact has been noticed by Breschet in the arteries of the limbs, and in those of the brain, and of the splanchnic cavities. (Op. cit. p. 25.)

In the *true varix-like aneurism*, the artery is described by Breschet as being not only dilated, but tortuous, and occasionally studded with small sacciform tumors. The parietes of the vessel are thin and collapsed; while, in the other case, they are rather thickened. [This is the condition termed *cirsoid*, in which the coats of the vessel are thinned, and the artery itself elongated and tortuous.] Such is Breschet's classification of true aneurism; a classification which, embracing, as it does, aneurism by anastomosis and erectile tumors, and these of different kinds, presents a good deal of novelty.

[Aneurisms may more conveniently be arranged into the *fusiform*, the *sacculated*, and the *dissecting*.

By the fusiform or tubular aneurism is meant that form of the disease in which all the coats of the artery are equally expanded throughout the whole circumference of the vessel. The artery is always elongated as well as dilated. These uniform dilatations are chiefly seated in the back of the aorta, and may attain a very great magnitude.

By the *sacculated* aneurism is meant a tumor that springs from the side of an artery, or of a tubular aneurism, with the interior of which it communicates by a narrow aperture called the mouth of the sac. This form of aneurism is divided into the *true* and the *false* varieties. By the *true* is meant the case in which there is a partial dilatation of all the coats of the vessel. By the *false*, that is when there is a dilatation of one, or at most two, of the coats, with rupture of the rest. There are two varieties of the *false* aneurism — the *circumscribed* and the *diffused*. By the *circumscribed false aneurism* is meant that form of the disease in which the blood is still contained within a sac formed by at least one of the arterial coats, however expanded and altered in its structure this may be. In the *diffused false aneurism* the blood is extravasated into the cellular tissues of the limb or part, through which it may either be widely spread or be confined by the matting together of the parts around into a kind of sac.

[The *dissecting* aneurism is that form of the disease in which the sac is contained in the walls of the artery between its coats. A rupture takes place through the internal coat into the middle one, which is split into two layers, often to a considerable extent. I have observed that dissecting aneurisms arrange themselves in three forms :—1. The blood, after passing through the laminæ of the middle coat, becomes diffused outside the vessel. 2. The blood passing between the laminæ of the middle coat is prevented bursting internally by the thickened outer coat, and bursts again through the internal coat into the interior of the vessel, thus forming a channel through the coat, both ends of which commence with the interior of the vessel. 3. The blood forms a permanent sac in the interior of the coats of the vessel, between the laminæ of the middle coat. In the following pages, however, the definitions of aneurism as given by Mr. Cooper are preserved, in order that the author's meaning may not be departed from.]

The following are the symptoms of a true circumscribed aneurism:—The first thing which the patient perceives is an extraordinary throbbing in some particular situation, and on paying a little more attention he discovers there a small soft pulsating tumor, which in a great measure disappears when compressed, but returns again as soon as the pressure is removed. With the return of pulsation, and of the swelling, a peculiar thrilling feel is experienced, caused by the passage of the blood into the sac. [On the application of the stethoscope, a bellows murmur or a bruit of some kind, perhaps rasping or sawing, will be readily perceived, synchronous with the pulse in the artery.] If the artery be compressed on the distal side of the swelling, this will be rendered still larger and tenser. A spontaneous aneurism is generally slow in its growth, not perhaps exceeding the size of an egg in a year, and rarely that of a flattened orange. (*Guthrie*, op. cit. p. 108.) At first it is generally unattended with pain, or change in the colour of the skin. The pulsation is synchronous with the beat of the artery. It is eccentric and distensile. When once the tumor has originated, it continually grows larger, though very gradually, and at length attains a considerable size. In proportion as it becomes larger, its pulsations often become weaker; and, indeed, when the disease has acquired much magnitude, they are frequently either quite lost, or only distinguishable with the stethoscope. [It does not necessarily follow that the pulsation lessens in force as the aneurism grows larger, on the contrary, the reverse is often observed. It is only when the aneurism has become solid as well as large that the pulsations are less distinct.] The diminution of the pulsation has been partly ascribed to the coats of the artery losing their dilatable and elastic quality, in proportion as they are distended, but chiefly to the lamellated coagulated blood deposited on the inner surface of the sac, particularly in large aneurisms, in which the motion of some of the blood is always interrupted. Immediately such coagulated blood lodges in the sac, pressure can only produce a partial disappearance of the swelling. This deposition of lamellated coagulum in the aneurismal sac is a circumstance of considerable importance; for it has been well explained by Mr. Hodgson, that it is the mode by which the spontaneous cure of the disease is in most instances effected. "One of the circumstances which, in the most early stage, generally attend the formation of aneurism (says this author), is the establishment of that process which is the basis of its future cure. The blood, which enters the sac soon after its formation, generally leaves upon its internal surface a stratum of coagulum, and successive depositions of the fibrous part of the blood gradually diminish the cavity of the tumor. At length, the sac becomes entirely filled with this substance, and the deposition of it generally continues in the artery, which supplies the disease, forming a firm plug of coagulum, which extends on both sides of the sac, to the next important ramifications that are given off from the artery. The circulation through the vessel is thus prevented, the blood is conveyed by collateral channels, and another process is instituted, whereby the bulk of the tumor is removed," &c. (*On the Diseases of Arteries, &c.* p. 114.) Whether there is any truth in Kreysig's conjecture, that some of the lymph may exude from the inside of the sac itself, I cannot presume to say; he owns, however, that the inner concentric layers presenting the appearance of being deposited last, is a circumstance rather against his surmise, though he adverts to some other circumstances which incline him to look upon the opinion as possibly correct. (*German Translation of Mr. Hodgson's Work*, p. 124.)

When the aneurism has not been caused by dilatation, but by a rupture of the inner coats of the vessel, the patient usually refers to some particular period, and generally to one of exertion, when this rupture was indicated by pain of a more or less acute nature, which either continued with a corresponding degree of lameness, or left such a sense of uneasiness as made the patient put his hand frequently on the part. On one of these occasions, the pulsating tumor is discovered. If the aneurism, whether of one kind or another, be in the ham, the patient first limps; then the leg becomes permanently bent; and when the tumor begins to press on the nerves, veins, and absorbents, the toes and leg are extremely painful, and the foot and leg œdematous. (See *Guthrie, On Dis. of Arteries*, p. 109.)

It is the general belief, that the pulsation of the tumor is produced by the jet of blood into it at each stroke of the heart. This opinion, however, is disputed by an eminent writer, who asks, Is it true, that the pulsation of aneurisms proceeds from the entrance of a more considerable stream of blood into the sac, and the distention of the swelling thereby produced? In aneurisms, which have only a narrow communication with the arterial tube, or which are filled with laminated coagula, the idea, says he, is quite inadmissible: the aneurism is rather shaken, as it were, like other different swellings in the vicinity of an artery, by the stroke of the heart occasioning a stretching of the whole arterial system, and at the same time communicating an impulse to the column of blood. (*Kreysig, Germ. Tr. of Mr. Hodgson's Work*, p. 143.) Here I am by no means disposed to coincide with this distinguished physician, whose sentiments appear to me to be refuted by the fact, that whenever any change happens calculated to lessen, or entirely stop the influx of blood into the sac, the pulsation either diminishes, or ceases in proportion. Thus, when Kreysig adverted to the pulsation of aneurisms, in which much coagulated blood was deposited, he might at the same time have mentioned the effect which such deposition has in weakening the pulsation, the layers of coagulated blood, within the tumor, being in the natural mode of cure, "the means by which the force of the circulation is removed from the sac, and the fatal termination of the disease by rupture is prevented." (See *Hodgson, On Diseases of the Art. and Veins*, p. 126.) In proportion as the aneurismal sac grows larger, the passage of blood into the artery beyond the tumor is lessened. Hence, in this state, the pulse, below the swelling, becomes weak and small, and the limb frequently cold and œdematous. On dissection, the lower continuation of the artery is found preternaturally small and contracted. The pressure of the tumor on the adjacent parts may also produce a variety of symptoms, — ulceration, absorption of bone, &c. Sometimes (says Richter) an accidental contusion, or concussion, may detach a piece of coagulum from the inner surface of the cyst, and the circulation through the sac be obstructed by it: nay, he asserts, that the coagulum may possibly be impelled quite into the artery below, so as to induce important changes. The danger of an aneurism arrives when it is on the point of bursting, by which occurrence the patient usually bleeds to death, and this sometimes in a few seconds. In an external aneurism, the fatal event may generally be foreseen, as the part about to give way becomes particularly tense, elevated, thin, soft, and of a dark purple colour. (See *Richter's Anfanfsgr.* band. i.)

External aneurisms do not burst by ulceration, but by the formation and detachment of a slough. I believe this is a fact which was first particularly pointed out in the early editions of my work; and it gives me pleasure to find, that it is a statement which entirely coincides with that subsequently made by several writers of eminence, especially Mr. A. Burns (*On Diseases of the Heart*, p. 225), and Boyer (*Traité des Maladies Chirurgicales*, t. ii. p. 98).

As far as my information extends, Mr. A. Burns first explained the very different mode of rupture which happens in internal aneurisms: these, he observed, generally burst by actual laceration, and not by sphacelation of the cyst. (*On Diseases of the Heart*, p. 225.) But a still more particular account of the process by which external and internal aneurisms burst is delivered by Mr. Hodgson. When the sac points externally (says this gentleman), it rarely or never bursts by laceration, but the extreme distention causes the integuments and investing parts to slough; and upon the separation of the eschar, the blood issues from the tumor. A similar process takes place, when the disease extends into a cavity which is lined by a mucous membrane, as the œsophagus, intestines, bladder, &c. In such cases, the cavity of the aneurism is generally exposed by the separation of a slough, which has formed upon its most distended part, and not by laceration. But when the sac projects into a cavity lined by a serous membrane, as the pleura, the peritoneum, the pericardium, &c., sloughing of these membranes does not take place; but the parietes of the tumor having become extremely thin in consequence of distention, at length burst by a crack, or fissure, through which the blood is discharged. (*On the Diseases of Arteries, &c.* p. 85.) An aneurism, however, which burst into the œsophagus, and which I had an opportunity of examining after the patient's death, was found to have done so by an ulcerative process. The mucous membrane of the trachea is also sometimes perforated by ulceration, the commencement of which is delineated in Cruveilhier's plates. (See *Anat. Pathol.* livr. iii. pl. 3 et 4.)

When the aneurism is of considerable size, the collateral arteries, which originate above the swelling, are manifestly enlarged. This enlargement of the collateral arteries above the disease ensures to the limb below the tumor an adequate supply of blood, when the obstruction to its passage through the diseased artery becomes considerable, or when this vessel has been rendered totally impervious by a surgical operation performed for the cure of the complaint.

In the advanced stage of an aneurism, the skin is found extremely thin, and confounded, as it were, with the aneurismal sac. The cavities of the cellular substance near the disease are either filled with serum, or totally obliterated by adhesion. The adjacent muscles, whether they lie over the aneurism, or to one side of it, are stretched, displaced, dwindled, and sometimes confounded with other parts. It is the same with the large nervous cords situated at the circumference of the tumor: they are pushed out of their natural situation, diminished in size, sometimes adherent to the outside of the sac, and so changed as scarcely to admit of being known again. Lastly, the cartilages and the bones themselves are not exempt from the mischief which the aneurismal swelling produces in all the surrounding parts: they are gradually destroyed, and, at length, not the least trace of their substance remains, just in the same way as the bones of the cranium are destroyed by fungous tumors of the dura mater. (See Dura Mater.) Even the cartilages of the larynx, and rings of the trachea, are sometimes destroyed; this tube is pierced, and the blood escapes into it, or the aneurism bursts into the œsophagus. (*Boyer, Traité des Maladies Chir.* t. ii. p. 99; *S. Cooper, Med. Chir. Trans.* vol. xvi. p. 399, &c.) As I shall hereafter explain, however, the pressure of an aneurismal tumor more quickly produces an absorption of bone than of cartilage. Aneurism of the arch of the aorta, or of the subclavian artery (*Guthrie, On Diseases of Arteries*, p. 63), sometimes occasions a dislocation of the sternal end of the clavicle.

While an aneurism is small and recent, it does not generally cause much pain, nor seriously impede the functions of the limb. But when it has increased, several complications are produced. Thus, the dragging of the long saphenous nerve, by femoral aneurisms, frequently occasions acute pain in the course of this nerve as far as the great toe. The distention of the sciatic nerve by the popliteal aneurism, sometimes brings on intolerable pain, which extends to all the parts to which the nerve is distributed, and which can hardly ever be appeased by the topical use of opiate applications. Pain is often one of the earliest symptoms of aneurisms; it is of two kinds, either lancinating, darting, and radiating along the course of the nerves that are compressed by the tumor, or else of a boring, wearing, gnawing, character, from the compression and erosion of the neighbouring parts by the increase of the sac. The first pain is usually intermittent, the second variety is permanent. The compression of the veins and lymphatics give rise to œdema, numbness, and coldness of the limb. And, finally, the long-continued pressure of the aneurism on the neighbouring bones causes their destruction. (*Boyer*, t. ii. p. 105.)

In true or spontaneous aneurism, the coats of the artery are not always in the same state, the kind of changes observed depending upon the progress of the tumor. In the early stage of the disease, either the whole cylinder of the vessel, or only a part of its circumference, is dilated; but this period is generally of short duration, especially in arteries of middling size, because their middle coat is capable of less resistance than that of the larger arteries like the aorta, where this coat is yellowish, firm, and very elastic. As Breschet remarks, this difference of resistance in the middle coat of the aorta, and the branches given off from it, accounts for the rarity of true aneurisms either in the small arteries, or those of middling size, and their greater frequency in the principal trunk of the arterial system.

At length, in consequence of the increasing distention, some of the coats of the artery possessing the least elasticity give way; and these are found to be the internal and middle coats; while the external one still makes resistance, and continues to be more and more dilated by the lateral impulse of the blood.

The second stage of true or spontaneous aneurism is that in which the surgeon is usually consulted; that in which the tumor increases more rapidly, and therefore begins to excite greater attention. The disease has now made its way through the internal and middle coats of the artery, and the external coat yields with more facility. In this stage, if the artery be only covered by a serous membrane, which soon gives way, the patient's life is endangered, and death often brought on by the rupture of the tumor. Examinations of the dead subject under these circumstances, have frequently led to mistaken notions; and, doubtless, if various swellings of this kind had not been found in different degrees, or stages, in the same individual, one might have been disposed to join Scarpa in the belief, that no aneurism consists of a dilatation of all the arterial coats. (*Breschet, Fr. Transl. of Mr. Hodgson's Work*, p. 128, 129.)

The change of an aneurism from the circumscribed into the diffused state is indicated by a sudden reduction, or stoppage of the pulsations of the tumor, often preceded by a sensation of something breaking, or giving way in the limb, which becomes all at once very painful. The temperature of the foot suddenly falls, and the swelling undergoes a rapid increase, and also becomes more diffused. The two latter circumstances may indeed not be very obvious, when the limb is already very œdematous, or the aneurismal sac has given way in a deep situation, and the blood has escaped into the cellular tissue between the muscles and under the fascia. In these cases, however, there is always some point of the leg or foot marked by a livid discoloration; and as the distention of the cellular tissue with blood, and the augmented interruption of the circulation in the limb, bring on a tendency to gangrene, the patient's pulse becomes accelerated. Here the danger of mortification is much greater than when the sac bursts, and the blood, instead of passing extensively into the cellular tissue, accumulates in one mass. Mr. Lawrence communicated to the Med. Chir. Society an instance in which the mass of blood collected in the thigh was so enormous after the giving way of a femoral aneurism under the skin, that, when the coagula were removed, by means of a free incision, some time after the artery had been tied, the finger could be passed nearly all round the thigh-bone. But, notwithstanding this mass of blood, and profuse suppuration, the patient recovered. The sudden extravasation of so large a quantity of blood into the substance of a limb by an aneurism becoming diffused, may occasion fatal syncope. (See *Med. Chir. Trans.* vol. xvi. p. 321.)

When the sac of an aneurism has burst in the foregoing manner, the propulsion of blood into it from the heart can evidently no longer have the effect of producing a full and sudden distention of it, as more or less of that fluid will either escape from it into the cellular membrane, or collect in one mass out of the aneurismal cavity. In general, however, the pulsations are only weakened at first and several days elapse before they entirely cease. Another cause that has a powerful effect in putting an end to the pulsations, is an increase in the quantity of coagulated blood and fibrine in the sac; the inevitable result of the stream of blood through it becoming more and more retarded in proportion as the obstruction of the circulation in the leg augments. In cases of doubt whether the reduction and stoppage of the pulsation are owing to the circumstances here adverted to, or to the sac having become filled with lamellated blood, without any rupture of it and change of the aneurism from the circumscribed to the diffused state (a condition promising the accomplishment of a complete cure), the stethoscope should be employed, whereby, in the former case, the sound of the jet of blood into the sac, the bellows-sound, as it is termed, will be perceived. This symptom, with others to which I have adverted, would render the state of things sufficiently clear. (See *Med. Chir. Trans.* vol. xvi. p. 320, &c.)

A *false aneurism* is always attended with at least a rupture, or giving way of the inner coat of the vessel, and usually with a breach in both this and the muscular coat, the outer elastic tunic forming the pouch in which the blood collects. But, after the swelling has attained a certain size, this coat also bursts, and then the blood either becomes diffused, or a large circumscribed space is formed for it by the condensation of the surrounding cellular membrane. False aneurisms, when produced by a wound or puncture, are of course from the first attended with a division of all the coats of the vessel. This form of the disease is often seen at the bend of the arm, where the artery is exposed to injury in venesection. (See HEMORRHAGE.) In this circumstance, as soon as the puncture is made, the blood gushes out with unusual force, and in a bright scarlet, irregular, interrupted current; flowing out, however, in an even, and less rapid stream, when pressure is applied higher up than the wound. These last are the most decisive marks of the artery being opened; for blood may issue from a vein with great rapidity, and in a broken current, when the vessel is turgid, and situated immediately over the artery, which imparts its motion to it. The surgeon endeavours precipitately to stop the hemorrhage by pressure, and in general a *diffused false aneurism* is the result. The external wound in the skin is closed, so that the blood cannot escape; but this does not hinder it from passing into the cellular substance. The swelling, thus produced, is uneven, often knotty, and extends upward and downward along the track of the vessel. The pulsation is more feeble than that of a true aneurism, and is sooner lost. The skin is also usually of a dark purple colour. The swelling increases, as long as the internal hemorrhage continues; and if this should proceed beyond certain bounds, mortification of the limb ensues. Such is the *diffused false aneurism* from a wound; a case which Lisfranc regards only as an extravasation of arterial blood, and reluctantly classes with aneurism at all. (*De l'Oblitération des Artères dans le Traitement des Aneurismes*, p. 6.)

The *circumscribed false aneurism*, from a wound or puncture, arises in the following manner. When proper pressure has been made in the first instance, so as to suppress the hemorrhage, but the bandage has afterwards been removed too soon, or before the artery has healed, the blood passes through the unclosed wound, or that which it has burst open again, into the cellular substance. As this has now become agglutinated by the preceding pressure, the blood cannot diffuse itself into its cells, and, consequently, a mass of it collects in the vicinity of the aperture of the artery, and distends the cellular substance in the form of a sac. Sometimes, though not often, the circumscribed false aneurism originates immediately after the opening is made in the artery. This chiefly happens when the aperture in the vessel is exceedingly small, and, consequently, when the hemorrhage takes place so slowly that the blood, which is first effused, coagulates, and prevents the entrance of that which follows into the cavities of the cellular substance, and, of course, its diffusion. A traumatic false aneurism differs materially from one which has taken place spontaneously, or as a consequence of disease; for, in the latter, the artery is generally unsound for some distance above and below the tumor. In the aneurism from a wound, the artery is perfectly sound, except inasmuch as the injury is concerned, and no effort is yet made by nature to obliterate the artery below or beyond the aneurism, which frequently takes place, when an aneurism occurs from disease. There are also other important differences in relation to the collateral circulation, and the requisite surgical operation. (See *Guthrie, On the Diseases of Arteries*, p. 82.)

In aneurism, the separation of the external from the middle coat of an artery is generally effected with difficulty; the external coat becomes stretched and distended, and an aneurismal tumor is formed. To this, however, there are a few uncommon exceptions; for the blood may be forced along the artery, separating the external and middle coats from each other, and forming a pouch several inches in length, which may or may not completely surround the vessel. In one case, reported by Mr. Guthrie, it formed a pouch on the anterior part of the descending aorta, about six inches in length, extending to the sides, and in one place nearly surrounding it. A horizontal fissure, about half an inch in extent, near the upper part of the swelling, allowed the blood to pass through the inner and middle coats, and to effect this separation, *which*, as Mr. Guthrie observes, *could only have arisen from disease previously existing in the part.* (See *Guthrie, On Dis. of Arteries*, p. 40.) Laennec gave an account of a very similar, but of a more extensive case of this kind, in a person who was not suspected during life to have disease of the heart or arteries. (*De l'Auscult.* t. ii. p. 700.) Mr. Guthrie also met with a third example, which is the preparation No. 368 A. in the Museum of the College of Surgeons. Just below the point where the innominata is given off, the inner and middle coats are ruptured along half the circle of the aorta, as cleanly as if cut with a knife. The effused blood has separated the outer from the fibrous coat down to the origin of the aorta. The separation is also continued along the descending aorta for an inch beyond the left subclavian, and the interval filled with blood. The arteria innominata had in the front half of it another transverse rent in all its coats, where the hemorrhage took place which killed the patient. The descending portion of the aorta, and the roots of the great vessels, are covered with atheromatous patches, and in part with bony scales. The coats were all easily separable, and softer and more readily broken than natural. (*Guthrie*, op. cit. p. 43.)

Cases of the foregoing description are sometimes termed *dissecting aneurisms* (vide *ante*, p. 142), of which the late Mr. Shekelton described one modification, not previously noticed by any other pathologist, and the peculiarity of which was, that after the blood had forced its way through the inner and middle coats of the vessel, it not only detached the middle from the outer coat to the extent of four inches, but then forced its way into the canal of the artery again, through the middle and inner coats: thus two channels existed for the passage of the blood. In the end, the formation of the new passage led to the obliteration of the original one, or corresponding portion of the arterial tube. (See *Dublin Hospital Reports*, vol. iii.)

FORMATION OF ANEURISMS.

If the doctrines of Scarpa, published in 1804, had proved correct, the grand distinction of aneurism into *true* and *false* must have been rejected as erroneous: "for," says he, "after a very considerable number of investigations, instituted on the bodies of those who have died of internal or external aneurisms, I have ascertained, in the most certain and unequivocal manner, that there is only one kind or form of this disease, viz. that caused by a solution of continuity, or rupture of the proper coats of the artery, with effusion of blood into the surrounding cellular substance; which solution of continuity is occasioned sometimes by a wound, a steatomatous, earthy degeneration, a corroding ulcer, or a rupture of the proper coats of the artery, I mean the internal and muscular, without the concurrence of a preternatural dilatation of these coats being essential to the formation of this disease; and, therefore, that every aneurism, whether it be internal or external, circumscribed or diffused, is always formed by effusion." (*On Aneurism;* transl. by Wishart, Pref.)

According to Scarpa, it is an error to suppose that the aneurism at the curvature or in the trunk of the aorta, produced by a violent and sudden exertion of the whole body, or of the heart in particular, and preceded by a congenital relaxation of a certain portion of this artery, or a morbid weakness of its coats, ought always to be considered as a tumor formed by the distention or dilatation of the proper coats of the artery itself, that is, of its internal and fibrous coats. Scarpa considers it quite demonstrable, that such aneurisms are produced by a corrosion and rupture of these tunics, and, consequently, by the effusion of arterial blood under the cellular sheath, or other membrane, covering the vessel. If ever there be a certain degree of preceding dilatation, it is not essential to constitute the disease, for it is not a constant occurrence; most aneurisms are unpreceded by it, and, in those rare cases in which an aneurism is preceded and accompanied by a certain degree of dilatation of the whole diameter of the curvature of the aorta, there is an evident difference between an artery simply enlarged in diameter, and the pouch which forms an aneurismal sac.

Careful dissections, says Scarpa, will prove that the aorta contributes nothing to the formation of the aneurismal sac, and that this is merely the cellular membrane, which, in the sound state, covered the artery, or that soft cellular sheath which the artery received in common with the neighbouring parts. This is raised by the blood into the form of a tumor, and is covered, in common with the artery, by a smooth membrane.

This eminent professor does not deny that, from congenital relaxation, the proper coats of the aorta may occasionally yield and become disposed to rupture; but he will not admit that dilatation of this artery precedes and accompanies all its aneurisms, or that its proper coats ever yield so much to distention as to form the aneurismal sac. *The root of an aneurism of the aorta never includes the whole circumference of the artery;* but the aneurismal sac arises from one side of it in the form of an appendix, or tuberosity. On the contrary, the *dilatation of the artery always extends to its whole circumference*, and, therefore, differs essentially from aneurism. Thus he urges, that there is a remarkable difference between a dilated and an aneurismal artery, although *these two affections are sometimes found combined together*, especially at the origin of the aorta. If we also consider that the dilatation of an artery may exist without any organic affection, the blood being always in the cavity of the vessel; that, in an artery so affected, there is never collected any grumous blood, or polypous layers; that the dilatation never forms a tumor of considerable bulk; and that, while the continuity of the proper coats remains uninterrupted, the circulation of the blood is not at all, or not so sensibly changed, we shall be obliged to allow, that aneurism differs essentially from one kind of dilatation of an artery.

Some additional remarks on this topic, more recently published by Scarpa, will be presently considered.

By dissections of arteries, both in the sound and morbid state, Scarpa endeavours to demonstrate what share the proper and constituent coats of the artery have in the formation of the aneurismal sac, and what belongs to the cellular covering, and other adventitious membranes surrounding the artery.

The covering of an artery is merely an adventitious sheath, which the vessel receives in common with the parts in the vicinity of which it runs. On cutting an artery across in its natural situation, the segment of the cut vessel retires and conceals itself in this sheath.

This cellular covering is most evident round the curvature and trunk of the aorta, the carotid, mesenteric, and renal arteries; it is less dense round the trunks of the brachial, femoral, and popliteal arteries. The pleura lies over the cellular sheath of the arch of the aorta, and over that of the thoracic aorta; while that of the abdominal aorta is covered by the peritoneum. Both these smooth membranes adhere to, and surround, two thirds of the circumference of the vessel. The great arteries of the extremities are not covered, in addition to the cellular substance, by any smooth membrane of this sort, but by a cellular sheath, which is demonstrably distinct from the adipous membrane, and serves to enclose the vessels, and connect them with the contiguous parts.

When air, or any other fluid, is injected by a small hole, made artificially between the cellular covering and the subjacent muscular coat of the artery, the injected matter elevates into a tumor the cellular membrane, which closely embraces the artery, without properly destroying its cells, which it distends in a remarkable manner. When melted wax is injected, and pushed with much force, the cellular sheath of the artery is not only raised over the vessel, like a tumor, but the internal cells of that covering are also lacerated; and, on examining afterwards the capsule of the artificial tumor, it appears as if it were formed of several layers, rough and irregular internally, smooth and polished externally. The same thing happens when any injection is pushed with such force into an artery as to rupture the internal and muscular coats at some point of their circumference. Nicholls performed this experiment several times before the Royal Society. (*Philos. Trans.* an. 1728.) As soon as the internal coat is ruptured, the muscular one also gives way; but the external cellular sheath, being of an interlaced texture, and the thin laminæ of which it is composed being not simply applied to one another, but reciprocally intermixed, is capable of supporting great distention, by yielding gradually to the impulse of the blood, without being torn or ruptured.

Scarpa is farther of opinion, that the same phenomena may be observed, when the internal coat of the aorta becomes so diseased as to be ruptured by the repeated jets of blood from the heart. In this circumstance, the blood, impelled by the heart, begins immediately to ooze through the connections of the fibres of the muscular coat, and gradually to be infused into the interstices of the cellular covering, forming, for a certain extent, a kind of *ecchymosis*, or *extravasation of blood*, slightly elevated upon the artery. Afterwards, the points of contact between the edges of the fibres of the muscular coat, being insensibly separated, the arterial blood, penetrating between them, fills the cellular covering of the artery, and raises it after the manner of an incipient tumor. Thus, the fibres and layers of the muscular coat, being wasted, or lacerated, or simply separated from each other, the arterial blood is carried with great force, and in greater quantity than before, into the cellular sheath of the artery, which it forces more outwards; and, finally, the divisions between the interstices of the cellular coat, being ruptured, it is converted into a sac, which is filled with polypous concretions and fluid blood, and at last forms, strictly speaking, the aneurismal sac. The internal texture, although apparently composed of membranes placed one over the other, is, in fact, very different from that of the proper coats of the artery, notwithstanding the injured vessel and aneurismal sac are both covered externally in the thorax and abdomen with a smooth membrane.

Scarpa has examined a considerable number of aneurisms of the arch, and of the thoracic and abdominal trunks of the aorta, without finding a single one in which the rupture of the proper coats of the artery was not evident, and in which, consequently, the sac was produced by a substance completely different from the internal and muscular coats.

The aneurismal sac never comprehends the whole circumference of the vessel. At the place where the tumor joins the side of the tube, the aneurismal sac presents a kind of constriction, beyond which it becomes more or less expanded. This would never happen, or rather the contrary circumstance would occur, if the sac were formed by an equable distention of the tube and proper coats of the affected artery. In incipient aneurisms, at least, the greatest size of the tumor would then be in the artery itself, or root of the swelling, while its fundus would be the least. But, *whether aneurisms be recent and small, or of long standing and large, the passage from the artery is always narrow, and the fundus of the swelling greater in proportion to its distance from the vessel.* The sac is always covered by the same soft dilatable cellular substance which united the artery in a sound state to the circumjacent parts. Such cellular substance, in aneurisms of the thoracic aorta, is covered by the pleura, and, in those of the abdominal aorta, by the peritoneum, which membranes include the sac and ruptured artery, presenting outwardly a continued smooth surface, just as if the artery itself were dilated. But, if the aorta be opened lengthwise on the side opposite the constriction, or neck of the tumor, the place of the ulceration, or rupture, of the proper coats of the artery, immediately appears within the vessel, on the side opposite to that of the incision. The edge of the fissure, which has taken place, is sometimes fringed, often callous and hard, and through it the blood formed for itself a passage into the cellular sheath, which is converted into the aneurismal sac. If, as sometimes happens, in the arch of the aorta near the heart, the artery, before being ruptured, has been somewhat dilated, it seems, at first, as if there were two aneurisms ; but the constriction, which the sac next to the artery presents externally, points out exactly the limits, beyond which the internal and muscular coats of the aorta had not been able to resist the distention, and where of course they have been ruptured. The partition, which may always be seen dividing the tube of the artery from the aneurismal sac, and which is lacerated in its middle, consists of nothing else than the remains of the internal and muscular coats of the ruptured artery.

By carefully dissecting the proper coats of the ruptured aorta in its situation, and comparing them with the cellular substance forming the sac, Scarpa affirms, that the truth of the preceding statement may be indisputably demonstrated.

When an incision is made lengthwise in the side of the vessel opposite the rupture, its proper coats are found either perfectly sound, or a little weakened and studded with earthy points, but still capable of being separated into distinct layers. On the contrary, in the opposite side of the aorta, where the rupture is, the proper coats are unusually thin, and are only separable from each other with difficulty, or even not at all ; they are frequently brittle like an egg-shell, and are disorganised and torn at the place where they form the partition between the ruptured artery and the mouth of the aneurismal sac. Continuing to separate these coats from within outwards, we arrive at the cellular sheath surrounding the aorta. This sheath being much thickened in large aneurisms, and adherent to the subjacent muscular coat of the artery at the place of the constriction of the sac, is likely to be mistaken for a dilated portion of the vessel itself. But, even in such cases, we may at last separate it, without laceration, from the tube of the artery, above and below the injury, and, successively, from the muscular coat, as far as the neck of the aneurism. Then, it is clear, the muscular coat does not pass beyond the partition, separating the cavity of the artery from that of the aneurismal sac, over which it is not prolonged, but terminates at the edge of the rupture like a fringe, or in obtuse points. Errors seem to Scarpa more apt to occur, in consequence of the aorta and sac being both covered by the pleura or peritoneum.

The portion of the aorta within the pericardium being only covered by a thin reflected layer of this membrane, such layer may also be lacerated, when the proper coats give way, and blood be effused into the cavity of the pericardium. Examples of this kind are related by Walter, Morgagni, and Scarpa himself. In the latter instance, on making an incision into the concave part of the aorta, opposite the tumor which had formed under the layer of the pericardium, which had also burst, by a small aperture, its internal coat, corresponding to the base of the swelling, was quite rough, interspersed with yellow hard spots, and actually ulcerated for the space of an inch in circumference. The preparation is preserved in the Museum at Pavia.

But, all other parts of the aorta having, between them and the pleura and peritoneum, a cellular sheath of a stronger and more yielding nature, which allows itself to be distended into a sac, and being strengthened, internally, by polypous layers, and externally by the pleura or peritoneum, oppose for a long while the fatal effusion of blood.

Scarpa believes, that what he calls the chronic steatomatous, squamous degeneration of the artery, is more frequently the cause of its bursting than violent exertions of the whole body, blows, or an increased impulse of the heart. This kind of diseased change is very common in the curvature, and in the thoracic and abdominal trunks of the aorta. In the incipient state of such disease, the internal coat of the artery, loses for a certain space, its beautiful smoothness, and becomes irregular and wrinkled. It afterwards appears interspersed with yellow spots, which are converted into grains, or earthy scales, or into steatomatous and cheese-like concretions, which render the internal coat of the artery brittle, and so slightly united to the adjoining muscular coat, that, upon being merely scratched with the knife, or point of the nail, pieces are readily detached from it, and, on being cut, it gives a crackling sound, similar to the breaking of an egg-shell. This ossification cannot be said to be proper to old age, since it is sometimes met with in subjects not much advanced in life. The whole of the side of the artery, in that portion which is occupied by the morbid affection, is, for the most part, hard and rigid, sometimes soft and fungous ; and, in most cases, the canal of the artery is preternaturally constricted. In the highest degree of this morbid disorganisation, true ulcerations are found on the inside of the artery, with hard and fringed edges, fissures, and lacerations of the internal and fibrous coats of the artery.

Having presented the reader with an abridged account of the most important remarks made by Scarpa in support of the doctrine he defends, I now annex his conclusions. 1. That aneurism is invariably formed by the rupture of the proper coats of the artery. 2. That the aneurismal sac is never formed by a dilatation of the proper coats of the artery, but, undoubtedly, by the cellular sheath, which the artery receives in common with the parts contiguous to it ; over which cellular sheath the pleura is placed in the thorax, and the peritoneum in the abdomen. 3. That if the aorta, immediately above the heart, appears sometimes increased beyond its natural diameter, this is not common to all the rest of the artery : and when the aorta, in the vicinity of the heart, yields to a dilatation greater than natural, this dilatation does not constitute, properly speaking, the essence of the aneurism. 4. That there are none of those marks regarded by medical men as characteristic of aneurism from *dilatation*, which may not be met with in aneurism from *rupture*, including even the circumscribed figure of the tumor. 5. That the distinction of aneurism into *true* and *spurious*, adopted in the schools, is only the production of a false theory ; since observation shows, that there is only one form of the disease, or that caused by a rupture of the proper coats of the artery, and an effusion of arterial blood into the cellular sheath, which surrounds the ruptured artery.

Such were the inferences made by Scarpa, in 1804, one of the most distinguished anatomists and surgeons of his time. Great as his authority was, several eminent modern surgeons, as Richerand, Boyer, Dubois, Dupuytren, Sabatier, Breschet, &c. did not yield to it, but still contended that, in some aneurisms, the coats of the artery were dilated. These professors in France coincided with what has been usually taught upon this subject in the surgical schools of Great Britain. Every lecturer here has been accustomed to describe the distinctions of aneurisms into true and false, or into some cases which are accompanied with dilatation, and into others which are attended with rupture of the arterial coats. Many years ago, Mr. Hodgson, of Birmingham, published a valuable treatise, in which he differs from Scarpa, and joins those surgical writers who believe in the occasional dilatation of the coats of the arteries in this disease. He inquires, " Is every aneurism produced by a destruction of the internal and middle coats of the vessel ? and does not a partial dilatation of these coats occasionally precede, and give rise to, their destruction ? I believe that this is frequently the case. We have seen, that the disorganisation of the coats of an artery, by destroying their natural elasticity, will give rise to permanent dilatation of the whole circumference of the vessel ; and there is every reason to expect, that a loss of its elasticity in a portion only of the diameter of the vessel, will give rise to a partial dilatation of its coats. Indeed, the proofs of a partial dilatation of the coats of an artery, particularly of the aorta, are incontestably established by the possibility of tracing the coats of the vessel throughout the whole extent of the expansion, and by the existence of those morbid appearances in the sac which are peculiar to the coats of the arteries.

" In the year 1811 (says Mr. Hodgson), I dissected an aneurism of the aorta, which was removed from the body of a young woman, by my friend, Dr. Farre. The sac was as large as a small melon, and had proved fatal by bursting into the posterior mediastinum, and subsequently into the cavity of the thorax. This aorta exhibited the formation of aneurism by partial dilatation in three distinct stages. The internal coat was throughout inflamed, and presented a fleshy and irregular appearance. At the arch of the aorta, there was a dilatation not larger than the half of a small pea. About two inches lower in the same vessel was a second dilatation, which would have contained hazel nut; and immediately above the diaphragm was the large aneurism which had proved fatal. I removed that portion of the vessel which contained the smallest dilatation, and macerated it until its coats could be separated without violence. I found that the dilatation existed equally in the three coats of the vessel, and, when separated each presented the appearance of a minute aneurism. The second dilatation exhibited the same circumstances in a more advanced stage. The coats of the vessels were more intimately adherent to each other than in a natural state, but, it was evident that the dilatation consisted in a dilatation of the internal, the middle, and the external coats of the aorta. In the large aneurism, the disorganised internal and middle coats could be traced for some distance into the sac, when the parts contained in the posterior mediastinum, and the vertebræ, formed the remainder of the cyst. There can be little doubt that this sac commenced in a dilatation of the coats of the vessel, similar to those appearances which existed in the superior portion of the dissection, and the artery appeared to illustrate the formation of aneurism by partial dilatation in three distinct stages." (*Hodgson,* *On the Diseases of Arteries and Veins*, p. 66, 68. See also *G. Andral, Précis d'Anat. Pathol.* t. ii. p. 361.) So far as Kreysig's information extends, nobody before Mr. Hodgson had examined the structure of an aneurismal sac in this accurate manner, viz. by maceration, and the results, he thinks, are not liable to the slightest objections. (See the *German Transl. of Mr. Hodgson's Work, with Notes by Kreysig and Koberwein*, p. 109. Hanover, 1817.)

Mr. Hodgson has seen this partial dilatation in almost all the arteries which are subject to aneurism, at the divisions of the carotids and iliacs, in the arteries of the brain, &c.; and he agrees with Dr. Baillie (*Morbid Anatomy, &c.*), Laennec (*Cerattius, Beschreib. d. Krankh. Preparate d. Anat. Theatres zu Leipz.* p. 408, 8vo. 1819), and others, that aneurisms, at the origin of the aorta, are generally formed by dilatation of the coats of the vessel.

"Partial as well as general dilatation (says Mr. Hodgson) frequently precedes the formation of aneurism in the arteries of the extremities. A gentleman had a large aneurism in the thigh, which had undergone a spontaneous cure. Upon examining the limb after death, the popliteal artery was found to be thickened and covered with calcareous matter. A small pouch, which would have contained the seed of an orange, originated from the side of this artery. This little sac was evidently formed by a dilatation of the coats of the vessel. A man died from the sloughing of an aneurism in the ham; in the femoral artery there was a small aneurism, about as large as a walnut. The external coat was dissected from the surface of the tumor to a considerable extent. The internal and middle coats were evidently dilated, and contributed to the formation of the sac. The dilatation of these coats was gradual, and they continued for a considerable distance to form the sac, when they were inseparably blended with the surrounding parts." (Op. cit. p. 70.) In one particularly interesting case of popliteal aneurism recorded by Breschet, where the internal coat, and in part also the fibrous, could be traced over the swelling, there was likewise an aortic aneurism, extending from the heart to four inches above the bifurcation of the aorta, where the swelling ended in an abrupt and circular manner. The middle and external tunics were perfectly healthy; and the internal, with the cellular tissue around it, alone diseased. In fact, when the lining of the artery was removed at the points where any morbid alterations were seen, these were also taken away, and the fibrous tunic left unchanged. In the limb, indeed, where the popliteal aneurism existed, all the arteries were aneurismal, and afforded most convincing evidence of all their coats contributing to the dilatations. (See *Breschet, Mém. Chir. sur différentes Espèces d'Aneurysmes*, p. 40, &c.)

While Mr. A. Burns bears testimony to the fidelity and accuracy of Scarpa's general detail, he adds, that perhaps it may not be uniformly found, that "the root of an aneurism never includes the whole circumference of the tube of an artery." We have, says he, a preparation in which the reverse has taken place. In this case, the whole cylinder of the vessel, from the heart to beyond the curvature, is equally dilated; and dilated to such an extent, that the tumor measures no less than ten inches in circumference. Scarpa limits dilatation, says Mr. Burns, to that state of an artery in which the coats remain in their natural relation to each other, and in which they are not altered in their texture, nor lined on their inner surface with "polypous layers." "This, however, was not the case in the instance which I have brought forward. In it you have seen that the coats were much dilated, and also very much altered in their structure. Externally and internally, they had assumed the look of the membranes of the fœtus, only they were thicker and denser, but they were equally gelatinous, and nearly as transparent; and, on their inner surface, they were crusted over with laminæ of coagulated lymph. By peeling off this incrustation, after the sac had been inverted, we saw plainly, that, although the internal coats were, round the complete cylinder of the vessel, much diseased, and considerably dilated, yet they were not dilated in the same degree as the external coverings of the artery. At irregular distances, longitudinal rents were formed in the fibrous coats, and these chasms were filled with coagulating lymph. The internal coats, over the whole circumference of the vessel, had assumed the diseased condition which in aneurism is generally confined to a part of the cylinder. In this tumor, all the coats continued for a time to dilate equally; but at length the internal gave way, forming longitudinal rents, through which the external coats could be seen, after the lymphatic coating had been scraped off. In this instance, had the sac been dissected in the early stage, it would have presented precisely the same appearances as those described by Dr. Monro, and the one (the aneurism) lately examined by the surgical editor of the *London Med. Review.*" Mr. Burns afterwards expresses doubts, whether the sac ever acquires a large size without dilatation. The case reported in the latter periodical work was the largest that he knew of, in which all the coats were found uniformly dilated. The sac, which was as large as the fist, was lined throughout with flakes of bone; and though the internal coat of the vessel was thus patched, and extremely thin and brittle, it did not, on minute inspection, any where exhibit a solution of continuity. Mr. A. Burns further states, that the above case, reported by himself, was the only one, out of fourteen, which did not corroborate Scarpa's description. (*On Diseases of the Heart, &c.* p. 204.) Mr. Wilson, after mentioning the frequency of aneurism in the aorta, carotid, subclavian, and axillary arteries, and its rarity in the brachial, tells us, that he knows of no example of aneurism below the elbow, where the swelling could not be traced to a wound of the coats of the artery. He adds, that true aneurism has not unfrequently occurred in the internal and external iliac arteries, in the inguinal, femoral, and very frequently in the popliteal. It has taken place in the posterior tibial artery, but he knows of no instance of it in the anterior tibial or peroneal arteries. "I have (says he) met with only one instance of true aneurism affecting any of the branches of the aorta, which are distributed to the abdominal viscera. In the year 1809, on inspecting the body of a clergyman, in the presence of the late Sir. W. Farquhar, a tumor, very much resembling the heart in colour, shape, and size, appeared to hang down from the under surface of the left lobe of the liver. When this tumor was opened, and carefully inspected, it appeared to have been formed by the left branch of the hepatic artery having become very much enlarged and aneurismal. It had burst, and the blood which had escaped was found in an imperfect cyst, partly in a fluid, and partly in a coagulated state, forming a large proportion of the tumor." (See *Lectures on the Blood, and on the Anatomy, Physiology, and Surgical Pathology of the Vascular System*, p. 379, 380, 8vo. Lond. 1819.)

The facts adduced by Mr. Hodgson appear sufficiently conclusive, and from them the following doctrine is clearly deducible: —

First, That numerous aneurisms are formed by destruction of the internal and middle coats of an artery, and the expansion of the external coat into a small cyst, which giving way from distention, the surrounding parts, whatever may be their structure, form the remainder of the sac.

Secondly, That sometimes the disease commences in the dilatation of a portion of the circumference of an artery. This dilatation increases until the coats of the vessel give way, when the surrounding parts form the sac, in the same manner as when the disease is in the first instance produced by destruction of the coats of an artery. (P. 74.)

The conclusions of Mr. Hodgson are supported by the observations of numerous writers.

The learned Sabatier says, there can be no doubt, that many aneurisms depend upon the dilatation of the arterial coats: but, *in far more numerous examples, the internal tunics are ruptured, and it is the cellular coat alone which separates from them, and enlarges, so as to form the aneurismal sac.*

It is difficult to conceive, he observes, how all the coats of an artery can dilate and yield sufficiently to form the investment of such immense tumors as some aneurisms are. Indeed, that very tunic, which composes the greater part of the thickness of the vessel, and which is termed the *muscular coat*, is known to consist of fibres whose texture is firm, and little capable of bearing extension. However, Haller, in describing a very large aneurism, situated in the aorta, near the heart, relates, that the innermost coat of this vessel was ruptured and torn, the loose jagged edges of the laceration being visible in the aneurismal sac. These were squamous, bony, and of little thickness; while the muscular and cellular coats were quite sound. Donald Monro noticed the same thing in five different aneurisms; in the course of the femoral and popliteal arteries of a man, who had been confined a long while to his bed, after being operated upon for bubonocele. Monro succeeded in tracing the fibres of the muscular coat over the swellings, so that he had no doubt of this tunic being dilated.

According to Richerand, when an aneurism is recent and of small size, the dissection of the tumor exhibits a simple dilatation of the arterial coats; while, in the other cases, where the aneurism is large, and has existed a considerable time, the internal and middle coats of the vessel are invariably lacerated. In the early stage of the disease, the blood which fills the aneurismal sac is fluid; and, on the contrary, in cases where the internal tunics of the artery are ruptured, the sac contains more or less coagulated lymph. The external or cellular coat composes the greater part of the cyst; and the coagulated lymph, with which it is filled, is arranged in layers, the density of which is described as being greater in proportion to the length of time which they have been deposited. Such as are nearest the sac are, therefore, most compact, and contain the smallest quantity of the colouring matter of the blood; more deeply, the concretions of lymph resemble simple coagula; and, lastly, the blood, which is still nearer the arterial tube, retains its fluidity.

After the aneurismal sac has been cleansed from the fibrine and coagulated blood which it contains, its parietes will appear to be almost entirely formed of the cellular coat of the artery. Towards the bottom may be observed the aperture, arising from the laceration of the internal and middle coats, which, being much less elastic than the external, are ruptured in an early stage of the disease. It is when these two tunics give way, that the aneurismal tumor undergoes a sudden and considerable increase in its size; for then the cellular coat alone has to sustain all the pressure of the blood, which, now becoming effused into a more ample cyst, loses a great deal of its impetus, coagulates, and forms fibrous masses; circumstances to which may be ascribed the hardness of the swelling, the weakness of its pulsation, &c. (*Nos. Chir.* t. iv. p. 82, ed. 2.)

The reality of true internal aneurisms was insisted upon by C. F. Ludwig, in a programma written expressly on that subject. (*Diagnostices Chir. Fragm. de Aneurysmate Interno*, Lips. 1805.) An interesting case, exemplifying an aneurismal dilatation of all the coats of the abdominal aorta, was published by Professor Nægele of Heidelberg. The swelling was as large as a man's head, and weighed about five pounds. The aorta began to be dilated at the point where it passes into the cavity of the abdomen between the crura of the diaphragm. This dilatation extended gradually down to a point, about four finger-breadths from the bifurcation of the aorta into the iliac arteries, at which point, strictly speaking, the large aneurismal sac commenced. The length of the whole dilated part of the vessel was eleven inches; that of the sac six; and its diameter five inches. The artery was not equally dilated in every direction, the expansion being most considerable laterally and forwards. Nægele and Ackermann found that the three coats of the aorta, the internal, muscular, and cellular, were all equally dilated. These professors traced the muscular coat with the scalpel from the top to the bottom of the tumor, and not the slightest doubt could be entertained that the case was a true aneurism. (*F. C. Nægele, Epistola ad T. F. Baltz, quâ Historia et Descriptio Aneurysmatis, quod in Aorta abdominali observavit, continetur.* Heidelb. 1816.)

In the valuable cases collected by H. F. Janin, convincing evidence will be found of there being one kind of aneurism attended with rupture of the coats of the artery, the cellular coat alone forming the aneurismal sac; and another with an equal dilatation of all the coats of the artery. Of the latter, Janin relates three unequivocal cases. Breschet's investigations, which are supported by the evidence of *post mortem* examinations, leave also no doubt about the truth of aneurism by dilatation, of which he describes not less than four kinds, as already stated, viz. the *aneurisma verum sacciforme;* the *aneurisma verum fusiforme;* the *auenrisma verum* *cylindroidum* (comprising aneurism by anastomosis and erectile tumors); and, lastly, the *aneurisma cyrsoideum*, or the *varix arterialis* of Dupuytren; a rarer affection, in which the arteries undergo very similar changes to those exhibited in varicous veins. (*Breschet in Mém. Chir. sur différentes Espèces d'Aneurysmes*, 4to. Paris, 1834.) Lisfranc also admits, with all the best modern surgeons, the reality of aneurism accompanied by dilatation of all the coats of the arteries. (*De l'Oblitération des Artères dans les Aneurismes*, p. 11.)

[Pathologists at present seem to incline to the opinion, that although many of the so-called true aneurisms may not be so in reality, yet that there can be no doubt that, in their early stages at least, many aneurisms are of the true kind. Dr. Peacock has pointed out, that small digital pouches are often found springing from the walls of some of the large arteries, through the whole extent of which the external, middle, and internal coats can be demonstrated to exist. After an aneurism has attained a certain size, its coats become so fused together, and so incorporated with the neighbouring tissues, that the true juncture cannot be made out. For a true aneurism to exist, I am of opinion that two conditions are necessary: first, that the tumor be small; second, that the mouth of the sac be large. I cannot conceive a large aneurism with a small mouth to be a true one, for as the mouth of the sac corresponds exactly in size to that portion of the arterial coats that has been dilated, it is not easy to understand how a large sac can be dilated out of a small segment of the wall of the artery, though there be some outgrowth of this, as in tubular aneurism.]

When these two different affections are situated in the thorax, or abdomen, it is impossible to discriminate them from each other before death. The symptoms, occasioned by the pressure of the tumor on the viscera must be nearly the same, whether caused by a morbid dilatation, or an aneurism. The means for retarding their fatal termination is also the same in both forms of the disease. With regard to the possibility of cure, however, Scarpa says, that there is great difference; for, when the case is an internal aneurism, there may be some slight hope of a radical cure by the efforts of nature and art, which hope can never be entertained in a case of morbid dilatation; a fact which is accounted for by no laminated coagula being deposited in the latter disease. (*On Aneurism, transl. by Wishart*, p. 124, ed. 2.) A great deal of the latter statement coincides with the observations of Mr. Hodgson, who particularly notices, that he has never met with lamellated coagula in such sacs as consist either in a general or partial dilatation of the coats of the vessel. (*On Diseases of Arteries, &c.* p. 82.) Whether this ever takes place in such cases may still be a question, because, if Professor Nægele has given a correct description of the aneurism of the abdominal aorta, already mentioned — which aneurism was of large size, and consisted of a dilatation of all the coats of the vessel — there was in this rare example a large quantity of these layers of coagulated blood. Yet, whether the Professor actually means the fibrine arranged in laminæ, or only common coagulated blood, which, as every one knows, may be found either in the cysts of dilated or of ruptured arteries, may admit of doubt. The statement, therefore, made by Hodgson and Scarpa, and which agrees with the later observations of Breschet (see *Mém. Chir. sur différentes Espèces d'Aneurismes*, p. 70), may not be contrary to what was really seen by Nægele and Ackermann. The following case, however, observed by Laennec, and quoted by a modern writer, must (if correctly reported) afford not only an unequivocal specimen of aneurism by dilatation of all the coats of the aorta, but of laminated coagula within its cavity. "In homine enim, qui repentè sub atrocissimis pectoris doloribus corruit, præter aortam adscendentem in aneurysma ita expansam, ut neonati infantis caput æquaret, cystidem aneurysmaticam immediatè suprà arteriæ cœliacæ ortam magnitudine nucis juglandis invenit, quæ luculenter ostendit sinum communicantem cum arteriæ cylindro per foramen magnitudine amygdalæ, diametro totius arteriæ illo loco non mutato. Saccus hic cultro anatomico accuratè ac subtiliter subjectus, eamdem structuram, easdem ostendit membranas, quibus gaudebat arteria e cujus latere excreverat; cæterum *massis grumosis sive fibrosis erat impletus*. Inde igitur patet, hoc aneurysma sacciforme et laterali et partiali quidem tunicarum aortæ dilatatione ortum esse." (*J. H. G. Ehrhardt, De Aneurysmate Aortæ*, p. 13, 4to. Lips. 1820.)

Certainly, it seems difficult to explain in what the difference consists, which prevails between the state of the internal coat, in *preternatural* dilatation, and in *true* aneurism, so that the blood does not coagulate in the former, while it is deposited in concentric layers in the latter. (See *Guthrie, On Dis. of the Arteries*, p. 85.) Perhaps, says the latter gentleman, there is not at a late period any difference between a preternatural dilatation or bulging on one side of an artery, and a true aneurism; a state remarkably well shown in one of the preparations in the College Museum, No. 411 H.; and he adds, "At all events, preternatural dilatations of a large size, and departing from the course of the vessel from which they arise, do generally lose their distinguishing character of freedom from concentric layers of coagula, so that the distinction between them, under these circumstances, is lost;" unless we regard it, with Scarpa, as essentially founded on the existence of fissures in the internal coat in the aneurism, and of the absence of such change in the simple dilatation.

[The reason why coagulum is not deposited in a preternatural dilatation of an artery, would appear to be, that in no part of the tumor is the blood at rest or out of the current of the circulation, so as to allow it time to deposit its fibrine; whereas, in a sacculated aneurism, it is withdrawn from the general circulation, and thus has time for a coagulum to form.]

From what has been stated then, it appears that there is only one principal point of difference between Scarpa and other writers; and this resolves itself into the question, whether a dilatation of an artery, arising at one particular side of the vessel, and lined by its internal coat, ought not to be regarded as an aneurism, because its communication with the tube of the artery is more capacious than what exists in other aneurisms, where the inner coat has given way, and because it rarely (perhaps never) contains laminated coagula, unless fissures happen to exist at some points of the inner arterial tunic thus expanded?

The greater number of aneurisms increase gradually, and sooner or later incline to the side on which the least resistance is experienced. De Haen mentions an aneurism of the aorta, which first made its appearance between the second and third ribs of the left side, and which, instead of growing larger, as is usual, subsided, and could neither be seen nor felt, for more than a month before the patient's decease, although, on opening the body, a tumor of the arch of the aorta was found, three times as large as the fist. De Haen imputes the sudden disappearance of the swelling to its weight, the yielding of the parts with which it was connected, and to its gravitating into the chest when the patient lay on his right side; for the difficulty of breathing, and other complaints, produced by the pressure on the lungs, underwent a material increase as soon as the tumor ceased to protrude.

The pulsations, which accompany true aneurisms, continue to be strong, until the inner coats of the vessel give way, or the layers of coagulated blood lodged in the sac are numerous. Hence, when soft swellings, situated near any large arteries, lose their pulsatory motion, their course, precise situation, and other circumstances, ought to be most carefully investigated before any decision is made about the mode of treatment.

[Together and synchronous with the pulsation, there is a bruit in the aneurismal sac, usually of a bellows, sawing, or rasping character. This is most intense when the aneurism is soft, but diminishes in distinctness as the tumor becomes consolidated by the deposit of laminated fibrine within it. It is loudest opposite the mouth of the sac, and ceases when the flow of blood through the tumor is arrested by the compression of the artery leading to it.]

In many instances, the most fatal accidents have happened, in consequence of incisions having been made in aneurisms, which were mistaken for abscesses, because there was no pulsation. Vesalius was consulted about a tumor of the back, which he pronounced to be an aneurism. Soon afterwards, an imprudent practitioner made an opening in the swelling, and the patient bled to death in a very short time. Ruysch relates, that a friend of his opened a tumor near the heel, not supposed to be an aneurism, and the greatest difficulty was experienced in suppressing the hemorrhage. De Haen speaks of a patient, who died in consequence of an opening, which had been made in a similar swelling at the knee, although Boerhaave had given his advice against the performance of such an operation. Palfin, Schlitting, Warner, Dupuytren, and others, have recorded mistakes of the same kind. (*Sabatier*, t. iii. p. 167.) Ferrand, surgeon of the Hôtel Dieu, mistook an axillary aneurism for an abscess, plunged his bistoury into the swelling, and killed the patient. "*J'ai été témoin d'erreurs semblables, commises par les praticiens non moins fameux; et si des anéurismes externes on passe à ceux des artères placées à l'intérieur, les erreurs ne sont ni moins ordinaires ni de moindre conséquence.*" (*Richerand*, *Nosogr. Chir.* t, iv. p. 75, ed. 2.)

Notwithstanding a pulsation is one of the most prominent symptoms of an aneurism, it is not to be inferred, that every swelling which pulsates is unquestionably of this description; for, as Mr. Warner has explained, it does happen that mere imposthumations, or collections of matter, arising from external as well as internal causes, are sometimes so immediately situated upon the heart itself, and at other times upon some of the principal arteries, as to partake, in the most regular manner, of their contraction and dilatation. He details the particulars of a boy, about thirteen years of age, whose breast-bone had been badly fractured, and who was admitted into Guy's Hospital a fortnight after the accident had happened. The broken parts of the bone were removed some distance from each other. The intermediate space was occupied by a tumor of a considerable size; the integuments were of their natural complexion. The swelling had as regular a contraction and dilatation as the heart itself, or the aorta could be supposed to have. Upon pressure, the tumor receded; upon a removal of the pressure, the tumor immediately resumed its former size; all these are allowed to be distinguishing signs of a recent true aneurism. The situation and symptoms of this swelling were judged sufficient reasons for considering the nature of the disease as uncertain; on which account it was left to take its own course. The event was, the tumor burst in about three weeks after his admission; discharged a considerable quantity of matter; and the patient did well by very superficial applications. (*Cases in Surgery*, ed. 4, p. 155.)

[The diagnosis of pulsating tumors of bone, whether encephaloid or not, from aneurism, is attended by no little difficulty. In many cases, the situation of the tumor, away from any large arterial trunk, its incompressibility, irregular outline, and firmer connection, or rather incorporation, with the bone, will enable the surgeon to avoid the error of confounding it with an aneurism. But in other instances, when seated at the brim of the pelvis, in the gluteal region, or in other situations where aneurisms are apt to occur, the greatest difficulty will occur, and the most experienced surgeons have erred in their diagnosis, and have ligatured the artery, on the supposition that they had to do with an aneurism, when, in reality, it was a case of pulsating tumor of bone. It may be observed, that these pulsating osseous growths are chiefly connected with the heads of the long bones.]

Under certain circumstances, a psoas abscess may be mistaken for an aneurism; as, for instance, when it occasions a small, soft, moveable swelling over the femoral artery in the groin, accompanied by a strong pulsatory motion. The tumor may be lessened by pressure, even in the erect position, and rapidly returns on the discontinuance of such pressure, as would be the case in aneurism. The pulsation is manifest; but, after the swelling has been lessened by pressure, its sudden resumption of size in the erect position is not accompanied by the peculiar pulsatory thrill felt in an aneurism. In a psoas abscess, the swelling does not return in the same degree on the removal of the pressure, as in a case of aneurism. During the retrocession of the purulent fluid, the course of the artery may be more readily examined. In cases of psoas abscess, the swelling has generally been preceded by pains in the back and loins, of some standing, which continue with weakness of one or both extremities. (See *Guthrie, On Dis. of Arteries*, p. 120.)

As Mr. Wilson has observed, any encysted, or even solid tumor, situated in the neighbourhood of, or upon, a large artery, may have a considerable degree of motion communicated to it from the pulsation of the artery. The thyroid gland, when a bronchocele is formed, occasionally receives a pulsatory motion from the carotid arteries. This may be mistaken for an aneurism ; from which disease, however, it can be discriminated by placing our fingers behind the tumor, and drawing it forwards, when the pulsation ceases. But there are other criteria for distinguishing a swelling, on or near an artery, from an aneurism. In such a case the whole tumor moves at once, without any alteration of size. In an aneurism, the swelling does not simply move, it expands. A tumor of the thyroid gland, having apparently a pulsatory motion, may be known not to be an aneurism of the carotid, by observing, that, from its connection with the larynx, it follows the movements of the latter in deglutition. Aneurisms, not of very long standing, and not containing a large mass of laminated coagula, may also be diminished, or rendered more or less flaccid, by pressing the artery leading to the disease. (See *Wilson on the Blood, Anatomy, Pathology, &c. of the Vascular System*, p. 385 ; and *Burns on the Heart*, p. 257.) In cases of much ambiguity, the stethoscope will sometimes convey the necessary information. In a doubtful instance of aneurism of the groin, Sir Benjamin Brodie found all obscurity cease on the application of this instrument. (*Sir A. Cooper's Lectures*, vol. ii. p. 46.)

Whenever an aneurism of immoderate size beats strongly, and for a long while, against the bones, as the sternum, ribs, clavicle, and vertebræ, they are in the end injured or destroyed, the aneurismal tumor elevating the integuments of the thorax, or back, and pulsating immediately under the skin. Scarpa, with the best modern writers, attributes the effect to absorption, in consequence of the pressure.

[The *pressure effects* of aneurisms are important. Accompanying veins are narrowed, thickened, and even obliterated. Arterial trunks in the neighbourhood of the tumor may be obliterated by its pressure, as sometimes happens at the back of the neck, or eroded and opened, as I have seen happen in the pulmonary artery from an aortic aneurism ; or the parent trunk itself may be obliterated by the pressure of the sac. Nerves are stretched and rendered tortuous, waving, or are flattened out into ribbon-like expansions. Organs suffer serious interruptions to their functions, and the elimination of their secretions may be interfered with by the compression of their ducts. By pressure on the trachea and œsophagus respiration and deglutition may be seriously impeded. The bones become eroded, and if flat may be perforated by as smooth and circular an aperture as if cut by the trephine.]

The carious and corroded state of the bones in aneurism is never attended with the formation of pus ; " at least, the discovery of pus in its vicinity has not been remarked by those who have examined such cases. In this respect, therefore, it differs essentially from common caries, or ulceration of bones. Exfoliation also is very rarely attendant upon it : from which circumstance, one important practical observation is deducible, namely, that if the aneurism be cured, the bones will recover their healthy state, without undergoing those processes which take place in the cure of caries or necrosis. (See *Hodgson, On the Dis. of Arteries and Veins*, p. 80.) That this process of absorption in bone, in consequence of the pressure of an aneurism, may be caused by other tumors, is finely exemplified in a thigh-bone preserved in the Museum of University College. The bone has been reduced by the pressure of a tumor, which grew at the back of the limb, to a mere spindle, that has not been able to resist the efforts of the muscles, by which it has been twisted in a singular degree. The absorption of bone from the pressure of aneurisms, is of that description, termed by Mr. Hunter *progressive*, in which, as Mr. Guthrie observes, the action of the small arteries, necessary to constitute inflammation, is wanting, and consequently there is little comparative pain at the commencement of the process, and no formation of matter. (See *Guthrie, On Diseases of Arteries, &c.* p. 57.)

Mr. Hodgson confirms the remark made by Dr. W. Hunter (*Med. Obs. and Inquiries*, vol. i. p. 384), Scarpa (*On Aneurism*, p. 100, ed. 2), and others, that cartilage is less rapidly destroyed by the pressure of an aneurism than bone. This fact is strikingly illustrated in a case of aneurism of the thoracic aorta recorded in another modern publication : the bodies of the vertebræ, from the fourth down to the ninth were carious ; the four lowest in particular ; yet the intervertebral cartilages were not materially affected. (*F. L. Kreysig, Die Krankheiten des Herzens*, b. iii. p. 176, 8vo. Berlin, 1817.) In the Museum of University College are fine specimens of the perfect state of the intervertebral substance, though the bodies of the vertebræ have greatly suffered.

A case is related by Pelletan, to which I refer the reader, as exemplifying not only the degree, in which internal aneurisms may injure the vertebræ, but also the occasional possibility of such diseases being mistaken for rheumatism, or a lumbar abscess. (See *Clinique Chir.* t. i. p. 97—100.)

CAUSES OF ANEURISM.

An aneurism will not follow the kind of weakness of the sides of an artery, which must necessarily arise from removing its external and middle coat, some morbid changes seeming to be essential to bring on a protrusion of the inner coat. Neither will a mechanical division of the inner tunics lead to an aneurismal dilatation of the outer coat. The latter fact is proved by what happens when a tight ligature is placed upon an artery, as well as by the experiments of M. Amussat who purposely broke the internal coats in numerous places, by pinching the vessels with forceps, and detaching the inner coats from the outer, by a process somewhat similar to what he adopts in torsion of the arteries. By proceedings of this kind, he never succeeded in producing the beginning of an aneurism. The inference, therefore, is, that some description of morbid change in the coats of the artery is necessary for the formation of aneurism, so long as the occurrence is resisted by a perfect state of one of those coats ; or else we must arrive at the still more certain conclusion, that in the experiments undertaken by Hume, Amussat, and others, the irritation of the artery was followed by inflammation of it, coagulation of the blood, and such an effusion of fibrine, within and around it, as would fully account for no aneurismal tumor being the result.

One very interesting point, in relation to spontaneous aneurism, and particularly adverted to by M. Malgaigne, is the almost exclusive restriction of this disease to the aortic system. Thus, in more than three hundred aneurisms, observed by M. Lisfranc, or recorded by others, he has met with only two instances of an aneurismal disease of the pulmonary artery, and these not free from objection. (*Lisfranc, Des diverses Méthodes, &c. pour l'Oblitération Des Arteres*, p. 8, 8vo. Paris, 1834.) This remarkable fact is suspected to depend upon the aortic arteries containing, between their inner and fibrous coats, a dense, hard, fragile tissue, only capable of being taken off in scales, and designated by M. Malgaigne the *sclerous* coat. When concretions of different kinds, calcareous, steatomatous, or cartilaginous, present themselves in the aorta, they are seated, according to M. Malgaigne, almost exclusively, in this sclerous coat, a texture not existing in the pulmonary artery or its branches.

In many instances, it is difficult to assign any cause for the commencement of aneurism. Among the circumstances which predispose to the disease, however, the large size of the vessels may undoubtedly be reckoned. Those trunks which are near the heart have much thinner parietes, in relation to the magnitude of the column of blood with which they are filled, than arteries of smaller diameter; and since the lateral pressure of this blood against the sides of the arteries is in a ratio to the magnitude of these vessels, it follows, that aneurisms must be much more frequent in the trunks near the heart, than in such as are remote from the source of the circulation. (*Richerand, Nosogr. Chir.* t. iv. p. 72, edit. 2.) The whole arterial system is liable to aneurisms; but, says Pelletan, experience proves, that internal arteries are much more frequently affected, than such as are external. (*Clinique Chir.* t. i. p. 54.)

The curvatures of the arteries are another predisposing cause of the disease, and have a manifest effect in determining the formation of the great sinus of the aorta, the dilatation which exists between the arch and the origin of this large artery, and which is the more considerable the older the person is: Monro even thought, that one half of old persons have an aneurism at the beginning of the aorta. And with respect to aneurisms in general, which are preceded by calcareous depositions, thickening, and disease of the coats of the vessel, they are most frequent in persons of advanced age. Aneurisms from wounds are of course often seen in individuals of every age. In old people, the coats of the arteries are subject to a disease, which renders them incapable of making due resistance to the lateral impulse of the blood. The disease here alluded to is what is described in a foregoing part of this article; one common effect of which is the deposition of calcareous matter between the inner and muscular coats of the arteries, or in the sclerous coat of Malgaigne. "People in the early part of life," says Mr. Wilson, "are not very subject to these calcareous depositions; but, I have occasionally met with them in the arteries of very young people. I have seen a well-marked deposition of the phosphate of lime in the arteries of a child under three years of age." He adds, that few persons, above the age of sixty, are free from these ossifications. (*On the Blood, and on the Anatomy, Pathology, &c. of the Vascular System*, p. 375. Lond. 1819.)

[Cachexy, in whatever way induced, whether by mercury or syphilis, disposes to aneurism by inducing those structural changes in the arterial coats that ultimately lead to their dilatation.]

According to Sir Astley Cooper, the time of life when aneurism generally occurs, is between the ages of thirty and fifty; an age, when exercise is considerable, and strength on the decline. In very old age the disease is not so common. However, he operated successfully on a case of popliteal aneurism, where the patient was eighty-four, or eighty-five years old. He operated, with success, on another man, sixty-nine years of age. He has also seen a boy, only eleven years old, with aneurism of the anterior tibial artery. The man of more than eighty is the oldest, and the boy of eleven the youngest, aneurismal patient he has ever seen. (See *Lectures*, vol. ii. p. 40.)

On the subject of the comparative frequency of aneurism at various periods of life, M. Lisfranc refers to 120 cases, in which the age of the patient is specified, and from which he drew up the annexed table: —

Age.	Cases.	Age.	Cases.
13	1	40 to 45	20
15 to 20	3	45 to 50	17
20 to 25	5	50 to 55	11
25 to 30	12	55 to 60	6
30 to 35	24	60 to 70	3
35 to 40	15	70 to 80	3

Thus, M. Lisfranc finds, what Sir Astley Cooper had ascertained long ago, that aneurisms are most common between the ages of thirty and fifty: that ten years on one side or the other of these ages make a remarkable difference,—under twenty, and after sixty, the disease being exceedingly rare. Aneurisms by anastomosis, however, which are entirely a different affection from the cases now under consideration, are chiefly met with in children and young persons under fifteen, and seldom in adults. M. Lisfranc knows of no example of aneurism by anastomosis in an old person. (*De l'Oblitération des Artères, &c.* p. 12, 13.)

Richerand affirms, that, out of twelve popliteal aneurisms, which he had seen in hospital or private practice, ten were caused by a violent extension of the leg. This statement, he says, will derive confirmation from the following experiment. Place the knee of a dead subject on the edge of a firm table, and press on the heel, so as forcibly to extend the leg, far enough to make the ligaments of the ham snap. Now dissect the parts, cut out the artery, and examine its parietes in a good light, when the lacerations of the middle coat will be observable, and rendered manifest by the circumstance of those places appearing semitransparent, where the fibres are separated, the parietes at such points merely consisting of the internal and external tunics. (*Nosogr. Chir.* t. iv. p. 73, 74, ed. 2.) But the insufficiency of this explanation is clear enough from the fact, that such violence as is requisite to break the ligaments of the knee, cannot be imagined to happen in the accidents which ordinarily bring on aneurism in the ham.

The implicit belief of Richerand, that the laceration of the middle coat of an artery will bring on an aneurism, while the inner coat is perfect, will appear to be unfounded, when Amussat's experiments are remembered, and also those of Hunter, Home, and Scarpa, who even dissected off the external and middle coats of arteries, without being able in this manner to cause an aneurism. Nay, where the experiment has been made of applying a tight ligature to an artery, and immediately removing it again in order to determine whether the division of both the inner coats of the vessel would terminate in an obliteration of the tube of the vessel, no aneurism has been the consequence.

Pelletan accounts for the frequency of popliteal aneurisms somewhat differently from Richerand: speaking of the two principal motions of the knee, viz. extension and flexion, he remarks, that the first of these is so limited, that it is actually an incipient flexion necessarily produced by the curvature backward both of the condyles of the femur and those of the tibia. This curvature, which would seem to protect the popliteal artery against any dangerous elongation, that might otherwise be caused by a forcible extension of the joint, becomes the very source of such an elongation in persons who are accustomed to keep their limbs bent, or who, from this state, proceed hastily and violently to extend the leg. The arterial tubes are really shortened, when the limbs are in the state of flexion, and lengthened, when the extension of the members renders it necessary. Hence, says Pelletan, it is manifest, that an habitually shortened state of these vessels, and their sudden elongation, must be attended with hazard of rupturing their parietes. (*Clinique Chirurgicale*, t. i. p. 112.)

The opinion of Pelletan, however, is quite untenable: because Mr. Hodgson has several times repeated the experiment mentioned by Richerand, and found, as this gentleman did, that the coats of the artery were never lacerated, unless the degree of violence had been such as to rupture the ligaments of the knee. (*On Diseases of Arteries, &c.* p. 64.)

Aneurisms are exceedingly common in the aorta, and they are particularly often met with in the popliteal artery. The vessels which are next to these most usually affected, are the crural, common carotid, subclavian, and brachial arteries. The temporal and occipital arteries, and those of the leg, foot, forearm, and hand, are far less frequently the situations of the present disease. But, although it is true, that the larger arteries are the most subject to the ordinary species of aneurisms, the smaller arteries seem to be more immediately concerned in the formation of one peculiar aneurismal disease, now well known by the name of *aneurism by anastomosis*, of which I shall hereafter speak.

According to surgical writers, the causes of aneurisms operate either by weakening the arterial parietes, or by increasing the lateral impulse of the blood against the sides of these vessels. It is said to be in both these ways, that the disease is occasioned by violent contusions of the arteries, the abuse of spirituous drinks, frequent mercurial courses, fits of anger, rough exercise, exertions in lifting heavy burthens, &c. In certain persons aneurisms appear to depend upon a particular organic disposition. Of this description was the subject whose arteries, on examination after death, were found by Lancisi affected with several aneurisms of various sizes. I have known a person have an aneurism of one axillary artery, which disease got spontaneously well, but was soon afterwards followed by a similar swelling of the opposite axillary artery, which proved fatal. I have seen another instance, in which an aneurism of the popliteal artery was accompanied with one of the femoral in the other limb. Boyer mentions a patient, who died of a femoral aneurism in La Charité, at Paris, and who had also another aneurism of the popliteal artery, equal in size to a walnut. (*Traité des Maladies Chir. &c.* t. ii. p. 102.) The greatest number of aneurisms that Sir Astley Cooper has seen in one patient is seven; and it is a remark made by this eminent surgeon, that when an aneurism occurs in the ham, the disease is frequently of a local nature; but that, when it is between the groin and ham, disease of other arteries is very commonly met with. (See *Lectures*, vol. ii. p. 37.) One memorable case, proving the existence of a disposition to aneurisms in the whole arterial system, is mentioned by Pelletan: "J'ai pourtant vu plusieurs fois ces nombreux aneurismes occupants indistinctement les grosses ou les petites artères, mais surtout celles de capacité; *j'en ai compté soixante-trois sur un seul homme, depuis le volume d'une aveline jusqu'à celui de la moitié d'un œuf de poule.*" (*Clinique Chir.* t. ii. p. 1.) M. Jules Cloquet relates a case, in which all the arteries were covered with aneurismal tumors, from the size of a hemp-seed to that of a large pea. Some existed on the aorta; but larger numbers on the arteries of the limbs. Altogether, there were some hundreds of them. Excepting in the situations of the tumors, the structure of the arterial coats had undergone no alteration. Here they were dilated and thinned. In none of them was any rupture of the internal or middle coat observed. The dilatations were continued into the small arteries, in which, however, they were less conspicuous than in those of superior size. (See *J. Cloquet, Pathologie Chir.* p. 86, pl. 2. 4to. Paris, 1831.) These aneurisms corresponded to the sacciform aneurisms of Breschet.

Aneurisms, and those diseases of the coats of arteries which precede the formation of aneurism, are much less frequently met with in women than in men. (*Lassus, Pathologie Chir.* t. i. p. 348.) A few years before John Hunter died, Mr. Wilson heard him remark, that he had only met with one woman affected with *true* or spontaneous aneurism. (*Anatomy, Pathology, &c. of the Vascular System,* p. 376.) The influence of the periodical loss of blood, during menstruation, on the vascular system of the female has not been sufficiently considered in reference to the less frequent occurrence of aneurism in women than in the opposite sex. Doubtless the relief from over distention enjoyed by the bloodvessels during the middle period of life in females, when the catamenia are present, is one of the principal causes of the difference observed in the liability to this disease in the two sexes. Mr. Hodgson drew up the following table, exhibiting the comparative frequency of aneurisms in the two sexes, in different cases of this disease, and also in the different arteries of the body, as deduced from examples, either seen by himself, during the lives of the patients, or soon after their death: —

	Total.	Males.	Females.
Of the ascending aorta, the arteria innominata, and arch of the aorta -	21	16	5
Descending aorta - -	8	7	1
Carotid artery - -	2	2	0
Subclavian and axillary -	5	5	0
Inguinal artery - -	12	12	0
Femoral and popliteal -	15	14	1
	63	56	7

This table does not include aneurisms arising from wounded arteries, nor aneurisms by anastomosis. (*On the Diseases of Arteries and Veins*, p. 87.) Sir Astley Cooper confirms the fact of the much greater frequency of aneurism in the male than the female sex. Women, he says, rarely have aneurism in the limbs. In forty years' experience, he has seen only eight cases of popliteal aneurism in women, but an immense number in men. Most of the aneurisms, which he has seen in females, have been in the ascending aorta, or the carotids. (*Lectures*, vol. ii. p. 41.) Mr. Guthrie has met with but three popliteal aneurisms in women; and he calculates that aneurism of the ham occurs from twenty to thirty times in men for once in women. "The structure of the vessels (he observes) is the same, but the mode of life is different. The exertion in general is infinitely greater in the man than the woman; and I think this, combined with the freer use of ardent spirits, a much more likely cause than either syphilis or mercury." (*On Dis. of Arteries*, p. 87.)

In relation to the comparative frequency of aneurism in the two sexes, M. Lisfranc states, that in 154 cases, the particulars of which have been collected by him, and whose situations brought them within the reach of operative surgery, the proportion of male patients was 141; of females 13; or nearly as 11 to 1.

[Crisp states, that of 551 aneurisms of all kinds, seven-eighths occurred in men. It is interesting to observe, however, that this proportion does not hold good for all aneurisms. Thus, those of the carotid are as frequent in women as in men, whilst of all other aneurisms, there are 18 in men to 1 in women. Dissecting aneurisms are more frequent in women.]

With respect to the comparative frequency of aneurism in different arteries, M. Lisfranc refers to 179 cases, all spontaneous, those of the aorta not entering into the computation; from which 179 cases he gives the following table: —

1.	Popliteal artery - - -	59
2.	Femoral { in the groin - -	26
	at other points -	18
3.	Carotid - - - - -	17
4.	Subclavian - - - -	16
5.	Axillary - - - -	14
6.	External iliac - - -	5
7.	Brachio-cephalic - - -	4
8.	Brachial - - - - -	3
9.	Common iliac - - -	3
10.	Anterior tibial - - -	3
11.	Gluteal - - - - -	2
12.	Internal iliac - - - -	2
13.	Temporal - - - -	2
14.	Internal carotid - - -	1
15.	Ulnar - - - - -	1
16.	Peroneal - - - -	1
17.	Radial - - - - -	1
18.	Palmar arch - - - -	1

It was observed by Morgagni, and it has been noticed in this country, that popliteal aneurisms occur with particular frequency in postilions and coachmen, whose employments oblige them to sit a good deal with their knees bent. In France, the men who clean out dissecting-rooms and procure dead bodies for anatomists, are said almost all of them to die of aneurismal diseases. Richerand remarks, that he never knew any of these persons who were not addicted to drinking. (*Nosogr. Chir.* t. iv. p. 74, ed. 2.)

Aneurisms are supposed by M. Roux to be much more frequent in England than in France; a circumstance which he refers to the mode of life and kind of labour, to which a large part of the population of England is subjected. Indeed, he connects this surmise with a reason for the very cultivated state of this part of knowledge in England; thinks that we have been placed in favourable circumstances for perfecting the treatment of aneurisms; and acknowledges, that we have contributed more than his countrymen, both in the last and present century, to the improvement of this branch of surgery. (*Roux, Parallèle de la Chirurgie Angloise avec la Chirurgie Françoise, &c.* p. 249.)

In some instances, axillary aneurisms seem to have arisen from violent extension of the limb. (See *Pelletan*, *Clinique Chir.* t. ii. p. 49, and 83.) In other examples, related by the same practical writer, aneurism arose from reiterated contusions and rough pressure on parts. (Op. cit. p. 10, and 14. Also *Guthrie*, *On Dis. of Arteries.*)

The extremity of a fractured bone may injure an artery, and give rise to an aneurism; instances of which are recorded by Pelletan (Op. cit. t. i. p. 178), and Duverney (*Traité des Mal. des Os*, t. 1). In Pelletan's case, the disease followed a fracture of the lower third of the leg. An aneurism of the anterior tibial artery, from such a cause, is also described by Mr. C. White. (*Cases in Surgery*, p. 141.)

The following case of an aneurism of the humeral artery after amputation, is recorded by Warner:— C. D. was afflicted with a caries of the joint of the elbow, which was attended with circumstances rendering amputation necessary. The operation was performed at a proper distance above the diseased part, and the vessels were taken up with needles and ligatures.— In a few days, the humeral artery became so dilated above the ligature upon it, as to be in danger of bursting. Hence it was judged necessary to perform the operation for the aneurism, which was done, and the vessel secured by ligature, above the upper extremity of its distended coats. Every thing now went on for some time, exceedingly well; when suddenly the artery again dilated, and was in danger of bursting above the second ligature. These circumstances made it necessary to repeat the operation for the aneurism. From this time every thing went on successfully, till the stump was on the point of being healed; when, quite unexpectedly, the artery appeared a third time diseased in the same manner as it had been previously, for which reason, a third operation for aneurism was performed, followed by no relapse. "Could the several aneurisms of the humeral artery (says Mr. Warner) be attributed to the sudden check alone, which the blood met with from the extremity of the vessel being secured by ligature? or is it not more reasonable to suppose, that the coats of the artery, nearly as high up as the axilla, were originally diseased and weakened?" The latter seemed, to this judicious writer, the most probable way of accounting for the successive returns of the disease of the vessel: since it is found from experience, that such accidents have been very rarely known to occur after amputation either of the arm or thigh, where nearly the same resistance must be made to the circulation in every subject of an equal age and vigour, who has undergone such operation. If it were supposed, that the several dilatations of the coats of the vessel arose merely from the check in the circulation, it appeared to Mr. Warner not easy to account for the final success of this operation; especially when we reflect, that the force of the blood is increased in proportion to its nearness to the heart. (See *Cases in Surgery*, p. 139, 140, ed. 4.) Ruysch has related an observation somewhat similar. (*Obs. Anat. Chir.* t. i. p. 4.) In 1813, M. Roche published another occurrence of this kind, which happened in the posterior tibial artery. (See *Lisfranc*, *De l'Oblitération des Artères*, p. 97.)

PROGNOSIS.

In cases of aneurism, the prognosis varies according to a variety of important circumstances. The disease may generally be considered as exceedingly dangerous; for, if left to itself, it almost always terminates in rupture, and the patient dies of hemorrhage. There are some examples, however, in which a spontaneous cure took place; and aneurismal swellings have been known to lose their pulsation, become hard, smaller, and gradually reduced to an indolent tubercle, which entirely disappeared. After death, the artery, in such instances, has been found obliterated, and converted into a ligamentous cord, without any vestige of the aneurism being left. Aneurisms are also sometimes attacked with mortification; the sac and adjacent parts slough away; the artery is closed with coagulum; and thus a cure is effected. Lastly, tumors, having all the characters of aneurisms, have been known to disappear under the employment of such pressure as was certainly too feeble to intercept entirely the course of the blood. Such examples of success, however, are not common; and whenever they happen, it is because the entrance of blood into the sac is prevented by the coagulation of that already contained in it, and because the artery above the swelling is filled with coagulum. They must, in fact, have been cured on the very same principle which renders the surgical operation successful.

[The way in which the *spontaneous cure* of an aneurism takes place has been especially investigated of late years by Mr. Bellingham. It occasionally, but very rarely happens, that in consequence of inflammation the sac becomes consolidated, and the artery obliterated. But more frequently the spontaneous cure takes place by the deposition in the interior of the sac, of successive layers of laminated fibrine, by which the flow of blood through the sac is partially interfered with, until at length it is completely interrupted. This process is most commonly met with in arteries of the second and third order of magnitude; never, I believe, in the aorta. It can only occur in sacculated aneurisms, and is much favoured by any circumstance that diminishes the force and lessens the amount of blood passing through the sac.]

Nothing is subject to more variety than the duration of an aneurism previously to its rupture; the tumor bursting sooner or later, according as the patient happens to lead a life of labour, or ease, temperance, or moderation. [Even the bursting of an internal aneurism may not immediately kill the patient. There is usually hemorrhage for some hours or days from an aneurism about to give way, before the final rupture takes place, and the fatal event may be retarded for weeks by the accidental plugging up of the orifice in the sac by a coagulum. Aneurisms prove fatal very frequently by their *pressure effects.* The compression exercised by an aneurism of the arch of the aorta upon the vagus nerve, upon the trachea, or bronchi may occasion fatal results.]

Every aneurism so situated that the artery can neither be compressed, nor tied above the swelling, has generally been considered absolutely incurable, except by a natural process, the establishment of which is not sufficiently often the case to raise much expectation of a recovery on this principle. But it should be recollected, that sometimes the size of the swelling appears to leave no room for the application of a ligature above it, while things are in reality otherwise, in consequence of the communication between the sac and the artery bearing no proportion to the magnitude of the tumor itself. At the present day, also, enlightened by anatomical knowledge, and encouraged by successful experience, surgeons boldly follow the largest arteries, even within the boundaries of the chest and abdomen, as I shall presently relate; and numerous facts have now proved, that few external aneurisms are beyond the reach of modern surgery. It being certain, that aneurisms cannot be commonly cured, except by an obliteration of the affected artery, it follows, that the circulation must be carried on by the superior and inferior collateral branches, or else the limb would mortify. Experience proves, that the impediment to the passage of the blood through the diseased artery, obliges this fluid to pass through the collateral branches, which gradually acquire an increase of size. It is therefore a common notion, that it must be in favour of the success of the operation, if the disease be of a certain standing; and, in direct opposition to the sentiments of Kirkland, Boyer even asserts, that the most successful operations have been those performed on persons who have had the disease a long while. (*Maladies Chirurg.* t. ii. p. 116.)

There is this objection to delay, however,—the tumor becomes so large, and the effects of its pressure so extensive and injurious, that, after the artery is tied, great inflammation, suppuration, and sloughing, often attack the swelling itself, and the patient falls a victim to what would not have occurred had the operation been performed sooner.

The large size of an aneurism, as Mr. Hodgson has rightly observed, is a circumstance which materially prevents the establishment of a collateral circulation. When the tumor has acquired an immense bulk, it has probably destroyed the parts in which some of the principal anastomosing branches are situated; or by its pressure it may prevent their dilatation. (*On the Diseases of Arteries and Veins*, p. 259.) The practice of permitting an aneurism to increase, that the collateral branches may become enlarged (says this gentleman), is not only unnecessary but injurious, inasmuch as the increase of the tumor must be attended with a destruction of the surrounding parts, which will render the cure of the disease more tedious and uncertain. (P. 266.)

The most successful operations which I have seen, were performed before the aneurismal swellings were large. However, notwithstanding the great disadvantages of letting the swelling become bulky before the operation, the fact has not always made due impression, and a few surgeons are yet blinded with the plausible scheme of giving time for the collateral vessels to enlarge. I remember a patient who had been advised to let the operation be postponed on such a ground, though the swelling in the ham was already as large as an egg.

Mr. Guthrie is of opinion, that the collateral branches begin to enlarge shortly after the commencement of the disease, as a part of the curative process, which nature, in most instances, endeavours to set up; "the essential points of which are, in an extremity—1. The obliteration of the artery above and below the tumor. 2. The coagulation of the blood within it. 3. The enlargement of the collateral branches above and below it."

"It is necessary (he afterwards observes), that this enlargement of the collateral branches should take place, because in many cases, the artery beyond or below the tumor is obliterated long before any operation is performed. The main supply of blood is already cut off from the extremity, and the operation adds very little to the derangement of the circulation which has already taken place below the tumor."

These facts appear to Mr. Guthrie to prove, what, indeed, cannot be doubted, that the collateral circulation is not in the same stage of preparation, in a limb whose main artery has been divided, as in one where an aneurism has existed for some time. They also explain why mortification is more common after wounded arteries, than after operations for aneurism. (See *Guthrie, On Dis. of Arteries*, p. 139.)

In a case of wounded artery, I should say, that the greater tendency to mortification is likewise promoted by the following circumstances:—The common injection and distention of the cellular tissue with blood, the frequent simultaneous injuries of the collateral vessels and considerable veins, and sometimes of important nerves, the weakness often resulting from profuse external hemorrhage, and the depth and extent of the wound to various other textures.

Although Mr. Guthrie considers, that the doctrine of the power of the collateral vessels always to carry on the circulation in aneurism has been carried rather too far, and that the allowance of some little time for them to enlarge themselves for that purpose is useful; there may appear but a trivial difference between him and other surgeons, or, perhaps, none at all, when his belief is recollected, that such enlargement occurs in an early stage of the disease, and his precept is remembered, "that an aneurism should never be allowed to attain that size, which may render it injurious to the surrounding parts. (Op. cit. p. 140.) As I believe, that the early editions of my surgical writings contain the first condemnation of the old plan of delaying the operation till the collateral vessels had had time to increase in size, this is a practical point in which I feel some interest; and the more I have seen and read of the present disease has only served to confirm the accuracy of the practical advice long ago delivered in my works on the advantages of early operations for aneurism.

The effects of the pressure of aneurisms upon the bones, are justly regarded as an unpleasant complication, when they take place in an extensive degree, and, according to some writers, they may sometimes induce a necessity for amputation. (*Boyer, Traité des Mal. Chir.* t. ii. p. 117.) However, I have never seen a case of this description; and Mr. Hodgson, as we have already explained, informs us, that the affection of the bones is hardly ever attended with exfoliations, or the formation of pus, so that if the aneurism can be cured, the bones will generally recover their healthy state. without undergoing those processes which take place in the cure of caries, or necrosis. (*On Diseases of Arteries and Veins*, p. 80.) At the same time, there can be no doubt, that where the tumor has been allowed to attain a large size, before an attempt is made to cure it, and where, from this cause, both the neighbouring soft parts and the bones have suffered considerably, the completion of a cure—that is to say, the full restoration of the use of the limb—must be far more distant than in other cases, where the cure is attempted in an earlier stage. Here, then, we see another reason against the pernicious doctrine of waiting for the enlargement of the anastomising vessels, in addition to that which has been urged in the previous column.

The age, constitution, and state of the patient's health, are also to be considered in the prognosis; for they undoubtedly make a great difference in the chance of success after the operation.

The operation, however, should not be rejected on account of the age of the patient, if the circumstances of the case in other respects appear to demand it; for it has often succeeded at very advanced periods of life. "I have seen several aneurisms cured by the modern operation, in patients above sixty years of age." (*Hodgson* p. 304.) Similar cases have fallen under my own notice. In cases of popliteal aneurism, Sir Astley Cooper operated with success on one patient aged eighty-five, and on another sixty-nine years old, with the same favourable result.

When an aneurism exists in the course of the aorta, the violent action of the heart, excited by an operation in the extremities, may cause it to burst, and prove instantaneously fatal. Two cases occurred a few years ago in this metropolis, in which the patients died from such a cause during operations for popliteal aneurisms. (See *Hodgson, On Diseases of Arteries*, p. 306; *London Med. Rev.* vol. ii. p. 246; and *Burns, On Diseases of the Heart*, p. 228.) Were the co-existence of the internal aneurism known, the operation for the other tumor would be improper, and the surgeon should limit the treatment to palliative means.

Experience proves, however, that the circumstance of there being two aneurisms in the limbs should not prevent the operation, which is to be practised at separate periods. Facts, in support of this statement, are quoted by Mr. Hodgson. (P. 310.)

An aneurism may form spontaneously, and yet the person may recover after an operation, without having a recurrence of the disease in any part. Mr. Guthrie knew a man who survived the operation for popliteal aneurism in both limbs for twenty-five years, and died at last of fever. (*On the Diseases and Injuries of Arteries*, p. 61 and 121.)

OF THE SPONTANEOUS CURE, AND GENERAL TREATMENT, OF ANEURISMS.

The obliteration of the sac, in consequence of a deposition of lamellated coagulum in its cavity, as Mr. Hodgson has well described, is the mode by which the spontaneous cure of aneurism is in most instances effected. The blood soon deposits upon the inner surface of the sac a stratum of coagulum; and successive depositions of the fibrous part of the blood by degrees lessen the cavity of the tumor. At length the sac becomes entirely filled with this substance, and the deposition of it generally continues in the artery on both sides of the sac as far as the giving off of the next large branches. The circulation through the vessel is thus prevented; the blood is conveyed by collateral channels; and another process is instituted, whereby the bulk of the tumor is removed. (*On the Diseases of Arteries*, *&c.* p. 114.) Such desirable increase of the coagulated blood in the sac is indicated by the tumor becoming more solid, and its pulsation weak, or ceasing altogether. In aneurisms of the limbs, the cure by coagulation is believed by Mr. Guthrie to be promoted by two natural processes, viz. the enlargement of the collateral branches, and the effort made to close or shut up the lower openings from the aneurism. He states, that in the Hunterian collection, there are several examples of all the openings into the aneurism, save the upper one, having been closed during life. It does not appear to him, however, that the coagulation of the whole of the blood in an aneurismal tumor is the necessary consequence of the closure of the lower opening; and unless this happens, the swelling will continue to increase. (See *Guthrie*, *On Diseases of Arteries*, p. 90.)

Amongst Mr. Hodgson's plates may be seen one representing an aneurism of the femoral artery, or rather a dilatation of it, involving the whole of its circumference, and where the blood continued to pass through a narrow channel in the centre of the lamellated blood, nearly in its natural course. Had nature been allowed more time for the completion of her processes, what would have been the mode of cure? Probably the obstruction of the central channel by solid blood, the determination of the circulation to the collateral vessels, and then the gradual removal of the tumor by the absorbents. Whether a case, reported by Mr. Guthrie as one of an external aneurism cured with the artery remaining pervious, is an unequivocal example of this occurrence, I cannot undertake to determine. (See *Guthrie*, *On Diseases of the Arteries*, p. 100.)

Another mode, in which the disease is spontaneously cured, happens as follows:—An aneurism is sometimes deeply attacked with inflammation and gangrene; a dense, compact, bloody coagulum is formed within the vessel, shutting up its canal, and completely interrupting the course of the blood into the sac. Hence, the ensuing sphacelation, and the bursting of the integuments and aneurismal sac, are never accompanied by a fatal hemorrhage; and the patient is cured of the gangrene and aneurism, if he has strength sufficient to bear the derangement of the health necessarily attendant on so considerable an attack of inflammation and gangrene. I remember a femoral aneurism in the York Hospital, where a cure was accomplished in this manner. Mr. Guthrie has seen three cases of inguinal aneurism, attacked by inflammation and sloughing. (*On Diseases of Arteries*, p. 96.) One was the case under Mr. Albert, in the York Hospital, where the patient recovered; in the two others the patients died, worn out by the discharge and the extension of ulceration to the hip-joint; without which last complication, Mr. Guthrie deems it probable that both patients would have recovered — the ends of the artery, above and below the disease, having been obliterated.

When a patient dies of hemorrhage, after the mortification of an aneurism, it is because only a portion of the integuments and sac has sloughed, without the root of the aneurism, and especially the arterial trunk, being similarly affected. For cases illustrative of this statement, refer to *Hodgson*, *On Diseases of Arteries*, p. 103, *&c.*

All surgeons will concur with Mr. Guthrie, that the attempt at a cure by sphacelation is attended with so much peril, that, if possible, it should be prevented by a surgical operation. Yet "*the operation should never be had recourse to after mortification* (that is to say, a deeply extending sphacelation) *has begun.* If the patient dies of the mortification, the operation is useless; and if he survives it, the operation is unnecessary." (See *Guthrie*, *On Dis. of Arteries*, p. 98.) When the inflammation and sloughing are superficial and very limited, the operation would be indicated, because, unless the arteries were first taken up, the patient would die of hemorrhage on the slough being loosened. Sir A. Cooper, however, tied the external iliac artery in two cases of inguinal aneurism when gangrene existed, and though the tumors burst, no hemorrhage ensued. The coagulum was discharged, the sac granulated, and the sores gradually healed. (See *Med. Chir. Trans.* vol. iv.)

A third way in which an aneurism may be spontaneously cured, is by the tumor compressing the artery above, so as to produce adhesion of its sides, and obliteration of its cavity. This mode of cure must be uncommon: it has been adverted to by Sir E. Home, Scarpa, Dr. John Thomson, and others; but some facts, tending to prove it, have been collected by Mr. Hodgson, and are published in his meritorious work. (See p. 107, &c.)

Rare as this mode of cure is, I do not coincide with Mr. Guthrie in looking upon this account as a mere theory (op. cit. p. 98); for we know by dissection, that the pressure of an aneurismal tumor upon the artery connected with it, may lead to the obliteration of the part or vessel pressed upon. Mr. Lawrence has mentioned in his lectures the particulars of a case, where the pressure of the sac of an aneurism in the groin, upon the artery lower down, had rendered the artery in this situation impervious.

A fourth mode of cure is illustrated in a case, related by Sir Astley Cooper: a man, in Guy's Hospital, had an aneurism just below the groin He was sitting before the fire, when he felt something burst in the upper part of his thigh. On examination, he found no blood had escaped, and, in fact, the aneurism had not yet reached the skin, so as to be adherent to it. His thigh, however, was enormously swelled; he was unable to use his limb, and was put to bed. For three days afterwards a pulsation was perceptible in the aneurism; but it then ceased, and the size of the limb began to diminish. At the end of four months, the aneurismal swelling had considerably subsided; he could use the limb; and in less than six months, he was discharged from the hospital. He afterwards fell a victim to the rupture of another aneurism in the abdomen. On examination of the body, it was found, that the aneurism in the thigh, just below Poupart's ligament, had burst under the fascia lata, and the femoral artery has been obliterated by the pressure of the large quantity of effused blood.

"The surgical treatment of aneurism (says Mr. Hodgson) consists in the obliteration of the cavity of the artery communicating with the sac, so that the ingress of the blood into the latter is either entirely prevented, or the stream which passes through it is supplied only by anastomosing branches, and consequently the force of the circulation is so much diminished, that the increase of the tumor is prevented, and the deposition of coagulum is promoted. By the absorption of its contents, and the gradual contraction of the sac, the cure is ultimately accomplished. The blood is conveyed to the parts, which it is destined to supply, by collateral vessels, some of which, being gradually enlarged, constitute permanent channels for the circulation. The obliteration of the artery is effected by the excitement of such a degree of inflammation in its coats, as shall produce adhesion of its sides. These objects have been attempted by the compression, or the ligature, of the artery." (P. 165.)

Such are the principles of the ordinary mode of cure; but it appears, from certain facts recorded by Mr. Wardrop, Dr. Bush, Dr. Mott, and other practitioners, that some aneurisms may be cured by a surgical operation, which was first suggested by Brasdor, or, according to Bichat, by Desault, and the design of which is to hinder the free transmission of blood through the aneurismal sac by tying the artery on that side of it which is most remote from the heart. This practice, however, is only allowable in certain examples, in which the application of a ligature in the common way is no longer practicable, because its success is much less probable, as might easily be anticipated, since the plan does not comprise the very desirable object of directly preventing the entrance of blood into the aneurismal sac. To this subject, however, we shall presently return.

According to Scarpa, *a complete cure of an aneurism cannot be effected, in whatever part of the body the tumor is situated, unless the artery, from which the aneurism is derived, be, by nature or art, obliterated, and converted into a perfectly solid, ligamentous substance, for a certain extent above and below the place of the ulceration, laceration, or wound.*

Notwithstanding aneurisms cannot in general be cured, as Scarpa has explained, unless the artery be rendered impervious for some extent above and below the tumor, I believe we must make an exception to this observation, with respect to the few aneurisms of the aorta (especially those of its arch), which, according to the records of surgery, have been diminished and cured by Valsalva's treatment. In such examples, we are not to suppose that the aorta becomes obliterated at its very beginning; but that the diminution of the quantity of circulating blood, the reduced impetus of this fluid, the lessened distention of the aneurismal sac, the general weakness induced in the constitution, and the increased activity of the lymphatic system, — all necessary effects of Valsalva's method, — have combined to bring about a partial subsidence of the tumor.

"It is a common opinion (says Mr. Hodgson), that the radical cure of an aneurism cannot take place without the obliteration of the artery from which the disease originates. It is probably owing to this idea, that aneurisms of the aorta have generally been considered as incurable diseases, and consequently that so little attention has been given to their treatment." (P. 118.) The facts, however, which this gentleman has related, satisfactorily prove — 1st, That a deposition of coagulum may take place in an aneurismal sac, to such an extent as entirely to block up the communication between its cavity and that of the artery from which it originates. 2ndly, That a sac, thus filled with coagulum, cannot prove fatal by rupture; and, 3rdly, That the gradual absorption of its contents, and the consequent contraction of the sac, may proceed to such an extent as to effect *the cure of the disease, without any obstruction taking place in the calibre of the vessel* from which it originates. (See cases 20, 21, 22, &c. *Hodgson, On Diseases of the Arteries, &c.* p. 119, &c.) In support of this doctrine, some facts are also cited from Corvisart. (*Essai sur les Maladies du Cœur*, p. 313, &c.)

A part of these cases, it is true, are not viewed exactly in this light by Kreysig, who argues (as I think without much probability), that they might have been only adipose swellings, connected with, or formed in, the parietes of the artery, — a disease described by Stenzel. (*German Transl. of Mr. Hodgson's book*, p. 174.)

Corvisart himself, instead of regarding such tumors as aneurisms *in the progress of cure*, conceived them to be aneurisms *in the course of formation*; and, on this point, Mr. Guthrie suspects that he was correct; because "the contents of the tumor were a substance of *less consistence than suet*, whilst in all the cases of spontaneous cure, in which, from the history, the previous existence of aneurism was known, the contents have always been *firm*, or *very firm*. (*Guthrie, On Dis. of Arteries*, p. 38.) But whatever may have been the nature of the swelling referred to by Corvisart, the fact of sacciform aneurisms of the aorta being sometimes entirely filled up by solid blood, and the disease cured on this principle, with the great channel of the aorta itself remaining pervious, is now universally acknowledged.

That a punctured artery may occasionally be healed, and still continue pervious, Scarpa himself proves, by a case which he examined, where an aneurism took place from the wound of a lancet in bleeding. In the article HEMORRHAGE, we shall see that Jones's experiments show the same thing, and the particular circumstances in which it may happen. But the occurrence is rare, and Scarpa says that it can hardly be called a *radical* cure, as the cicatrix is always found in a state ready to burst and break, if the arm be, by any accident, violently stretched or struck where the wound was situated.

In the spontaneous cure of aneurisms, arising from arteries of inferior size to that of the aorta, repeated examinations have proved, that the deposition of coagulum does not merely fill up the sac, but obliterates the tube of the artery, above and below the disease to the next important ramifications. Yet, even here, exceptions probably take place; for Mr. Hodgson has brought forward one instance, in which a small sac, which originated from the anterior artery of the cerebrum, was completely filled with firm coagulum, which did not extend into the cavity of the vessel. (*On Diseases of Arteries*, p. 132.) And he reports the particulars of a *true* femoral aneurism, communicated to him by Sir A. Cooper, in which, after the patient's death, the femoral artery was found dilated into a sac, which was lined on all sides with very firm layers of coagulum, in the centre of which was an irregular canal, through which the circulation was continued. As the inside of this canal presented a membranous appearance, it was inferred that the aneurism had been cured. (Op. cit. p. 134.) Here I may be permitted to remark, that, if this case be correctly reported, viz. if it were a true aneurism by dilatation of all the arterial coats, and the inside of it was *every where* lined by firm layers of coagulum, it amounts to a proof that such a deposition is not entirely confined to aneurisms by rupture, as Scarpa supposes. And, in addition to this fact, I may mention, as referring to the same question, a case of aneurism from dilatation of the arterial coats, observed by Guattani, where the same process took place. "Arteriæ iliacæ ovalem hanc partem aneurysmaticam polyposa substantia variæ densitatis adeò infarctam esse denotebam, ut tunicarum ejusdem forma penitus destructa in uniformem massam, spongiæ cerâ imbutæ similem, transformata videretur. (Hist. xvii. *Collect. Lauth.* p. 158.)

Whenever the ulcerated, lacerated, or wounded artery is accurately compressed against a hard body, like the bones, it ceases to pour blood into the surrounding cellular sheath, because its sides being kept in firm contact, for a certain extent above and below the breach of continuity, become united by the adhesive inflammation, and converted into a solid ligamentous cylinder. Molinelli, Guattani, and White give examples and plates illustrative of this fact. When aneurisms get well spontaneously, the same fact is observed after death, as Valsalva, Ford, &c. have demonstrated. I have myself seen, in St. Bartholomew's Hospital, an instance in which a man had had a spontaneous cure of an aneurism in the left axilla, but afterwards died of hemorrhage from another aneurismal swelling under the right clavicle: the artery on the left side was found completely impervious. Dr. Albert had under his care, in the York Hospital, Chelsea, a dragoon, who recovered spontaneously of a very large aneurism of the external iliac artery: the tumor sloughed, discharged about two quarts of coagulated blood, and then granulated, and finally healed up. Paoli relates a similar termination of a popliteal aneurism, and Moinichen and Guattani give other examples. Hunter found the femoral artery quite impervious, and obliterated, at the place where a ligature had been applied fifteen months before. Boyer noticed the same fact in a subject, eight years after the operation. Petit describes the spontaneous cure of an aneurism at the bifurcation of the right carotid: the subject having afterwards died of apoplexy, the vessel, on dissection, was found closed up and obliterated from the bifurcation as far as the right subclavian artery. Desault had an opportunity of opening a patient, in whom a spontaneous cure of a popliteal aneurism was just beginning: he found a very hard, bloody thrombus, extending for three finger-breadths into the tube of the artery, above the sac, and so firm, that it resisted an injection, and made it pass into the collateral branches.

Both the spontaneous and surgical cures of aneurisms have generally two stages: in the first, the entrance of the blood into the aneurismal sac is interrupted; in the second the parietes of the artery approach each other, and, becoming agglutinated, the vessel is converted into a solid cylinder. This doctrine is corroborated by the tumor first losing its pulsation, and then gradually diminishing and disappearing.

In order that compression may make the opposite sides of an artery unite, and thus produce a radical cure of an aneurism, Scarpa says, the degree of pressure must be such as to place these opposite sides in firm and complete contact, and such as to excite the adhesive inflammation in the coats of the artery. The point of compression must also fall above the laceration or wound of the artery; for when it operates below, it hastens the enlargement of the tumor: and Scarpa adds, that, in practice, bandages which are expulsive and compressive, are more useful for making pressure than any tourniquets or instruments, many of which are contrived to operate, without retarding the return of blood through the veins.

In order that pressure may succeed, the coats of the vessel, at the place where it is made, must be sufficiently free from disease to be susceptible of the adhesive inflammation. When the arterial coats, round the root of the aneurism, are much diseased, Scarpa considers them as insusceptible of the adhesive inflammation, although compressed together in the most scientific manner, and even when tied with a ligature, which only acts by making circular pressure on the vessel.

Some advise trying compression in every case of aneurism, whether small, circumscribed, soft, flexible, indolent, or elevated, diffused, hard, and painful. But, in the latter case, Scarpa represents compression as decidedly hurtful. He says also, that every bandage which compresses the aneurism, and also circularly constricts the affected part, is always injurious. The bandage, likewise, which compresses only the aneurism, and directs the point of pressure below the rupture in the vessel; that which, on account of the great size, exquisite sensibility, depth of the root of the aneurism, and fleshy state of the surrounding parts, cannot effectually compress the artery against the bones, so as to bring the opposite sides of the vessel into contact; and, lastly, the compression applied to a spontaneous aneurism, attended with a steatomatous, ulcerated, earthy disease of the arterial coats;

— ought to be considered as more likely to do harm than benefit. In cases of a completely opposite description, bandages have produced, and may produce, a radical cure, and should not be entirely disused. (*Scarpa, On Aneurism*, ed. 2, p. 221.)

Guattani first employed compression systematically for the cure of aneurisms; and out of fourteen cases in which he adopted the plan, four were cured by it. Be it remarked, that this distinguished surgeon applied, first charpie and compresses over the tumor, and then a roller, with only moderate tightness, from the lower part of the swelling to the upper part of the limb. The bandage, which was kept wet with an astringent refrigerant lotion, was changed about once in three weeks. The patient was kept on a very low diet, perfectly quiet in bed, and a few general bleedings were practised. Mr. Freer details some other examples of success, and so does Lisfranc (Op. cit. p. 29); but, in general, pressure has hitherto been applied to the tumor itself, — a method less likely to answer than that of making pressure on a sound part of the artery. Mr. Freer recommends the employment of Sennfio's instrument, or the following method :—First place a bandage, moderately tight, from one extremity of the limb to the other; then put a pad upon the artery, a few inches above the tumor; next, surrounding the limb with a tourniquet, let the screw be fixed upon the pad, having previously secured the whole limb from the action of the instrument by a piece of board, wider than the limb itself by which means the artery only will be compressed, when the screw is tightened. The tourniquet should now be twisted till the pulsation in the tumor ceases. In a few hours the limb will become œdematous and swelled, when the tourniquet may be removed, and the pressure of a pad and roller will afterwards be enough. In experiments which this gentleman made on the radial arteries of horses, these vessels were found to become inflamed, and to be rendered impervious, by such a process. (*Freer*, p. 112.) Dubois is stated to have cured an aneurism of the thigh by steady pressure on the vessel for twenty-four hours. (*Med. Chir. Trans.* vol. iv. p. 437.)

Sir A. Cooper describes another machine for compressing the femoral artery, in cases of popliteal aneurism: it was used by Sir W. Blizard. —"The points of support for this instrument, were the outer part of the knee and the great trochanter, a piece of steel passing from one to the other; and to the middle of this a semicircular piece of iron was fixed, which projected over the femoral artery, having a pad at its end, moved by a screw, by turning which the artery was readily compressed, and the pulsation in the aneurism stopped, without any interruption to the circulation in the smaller vessels." But although the patient on whom it was tried possessed unusual fortitude, he was incapable of supporting the pressure of the instrument longer than nine hours. (*Med. and Phys. Journal*, vol. viii.) Mr. White, of the Westminster Hospital, tried pressure, by means of a newly invented spring, supposed to possess peculiar advantages. "The woman bore the pain heroically for five days, but the parts compressed sloughed deeply. The cure was completed; but (says Mr. Guthrie), the pain, danger, and risk incurred, were infinitely greater than any which could have been sustained from the usual operation." (*On Dis. of Arteries*, p. 142.) Few patients, indeed, can endure the pressure of such instruments a quarter of this time, when they are put on sufficiently tight to afford any chance of obliterating the artery; and, on account of the suffering which they produce, they are rarely used by modern surgeons.

THE TREATMENT OF ANEURISM BY COMPRESSION.

[In consequence of the dangers and difficulties attendant upon the use of the ligature, surgeons have for many years past endeavoured to treat aneurism by compression. The employment of direct pressure on the aneurism was almost naturally suggested as a means to counteract the extension of the disease by the pressure of the blood from within, and has, consequently, been applied from a very early period in the treatment of the affection. This plan of treatment was first employed by Bourdelot, at the close of the seventeenth century; afterwards by Genga, Heister, Guattani, and others. These surgeons made the pressure directly upon the sac; and Guattani and Flajani relate several cures that they effected in this way; but the method was so uncertain in its results, and so dangerous, from irritating and inflaming the sac, that it fell into disuse. The French surgeons introduced a modification of the pressure plan, by laying open the sac, clearing out its contents, and applying the pressure directly over the ends of the vessel. Deschamps exposed the artery leading to the sac, and compressed this with an instrument he termed the "presse artère." These barbarous modes of treatment, however, were entirely set aside by the facility and comparative success of the Hunterian operation, and compression in aneurism was rarely practised by surgeons after the great step made by John Hunter in the treatment of this disease. Yet we find that John Hunter himself, Blizard, and Freer attempted, though with but little success, to cure this disease by pressure on the artery leading to the sac. Pelletan and Dubois appear to have been the first who employed the pressure upon the artery above the sac, instead of upon the aneurism itself: this was in 1810. Since this period various attempts were made methodically to treat aneurisms in this way; but the merit of having introduced the practice of compression in the treatment of aneurism into modern surgery, of having given it a definite place in our art, and of having established the true principles on which it acts, incontestably belongs to the Dublin surgeons; amongst whom, the names of Hutton, Bellingham, Tufnell, and Carte deserve especial mention. In the early trials of the cure of aneurism by compressing the artery on the cardiac side of the tumor, the surgeons who employed this method acted on an erroneous theory, and the principle not being understood, the practice was bad. It was supposed that it was necessary for the cure to take place, that the *whole* flow of blood through the artery should be entirely arrested, that inflammation of the vessel at the point compressed should be set up, and that the consolidation of the aneurism depended upon the obstruction of the vessel consequent upon this inflammation. This led to compression being exercised so forcibly, with the view of exciting inflammation in the artery, that the patient could seldom bear it for a sufficient length of time to effect a cure, sloughing of the skin commonly resulting as a necessary consequence of the severe pressure to which it was subjected. To the Dublin surgeons belongs the very great merit, not only of having pointed out the error of this doctrine, but of having distinctly laid down as the principle of the practice, that the aneurism was cured, when the artery leading to it was compressed, in precisely the same way as when a spontaneous cure takes place, or when the Hunterian operation is performed—viz. by the deposit of stratified fibrine in the sac, and by the consequent consolidation of this, aided by the contraction of the walls of the sac; and that, as in the case of the ligature of the vessel, it was not necessary for the whole of the circulation through the artery to be entirely and permanently arrested, but merely for it to be lessened in quantity and force to such an extent as to be compatible with the formation of laminated fibrine in the sac; and it was clearly shown by examination after death that if the pressure were properly conducted, the artery was in no way injured or occluded at the part compressed. This recognition of the true principles on which compression of the artery leading to the sac cures the aneurism, has led to important results; for, as the severe pressure that was formerly considered necessary is now known, not only to be useless, but to be absolutely injurious, no amount of compression is exercised beyond what is requisite to restrain and moderate the flow of blood into the sac; no attempt being ever made to compress the artery so severely as to lead to its obliteration by inflammation.

Though I have stated generally that aneurisms, when treated by compression, are cured by the deposit of laminated fibrine, I think this remark ought to be confined to the common sacculated form of the disease. In the tubular variety, which is certainly of far less frequent occurrence in the extremities, the cure of the aneurism takes place by contraction of the sac, and by its becoming filled by fibrine in a somewhat irregular manner. Illustrative of this mode of cure, there is a preparation in the Museum of University College.

The success of the treatment by compression depends greatly upon a scrupulous attention to a number of minor circumstances, which, though trivial in themselves, become of importance when taken as a whole. During the whole of the treatment, also, the patient's general health should be attended to, in accordance with those dietetic and medical principles that have already been laid down in speaking of the constitutional treatment of the disease, having for their object the increase of the fibrination of the blood. The irritability of the heart and arteries must also be subdued, and the irritation of the system lessened, by the use of opiates, and the patient should be put into a comfortable bed, with firm and well secured pillows and mattresses, so that his position be not changed. As it is principally in aneurism of the lower extremity that this plan of treatment can be employed, we shall proceed to describe the method of its application here; and, in doing so, I would remark, that much of the success of the treatment depends on a scrupulous attention to minute details.

The limb having been bandaged smoothly, with a soft or air pad upon the tumor, so as to approximate its sides, and laid comfortably on pillows, the thigh should be shaved, and dusted with hair-powder. The apparatus must next be applied, and much of the success of the treatment will depend upon the kind of instrument used. The ordinary horse-shoe, or Signorini's tourniquet, was the one first employed, and this will, in many cases, answer the purpose perfectly well; but as it is somewhat difficult to regulate the pressure with this instrument, and as it is not unfrequently exercised too powerfully, it has generally given place, at the present day, to the very ingenious apparatus of Dr. Carte, which, as it substitutes an elastic force derived from vulcanised india-rubber bands for the unyielding pressure of the screw, accommodates itself better to the limb, and is less likely to produce injurious compression. This instrument, as well as the other contrivances which have at various times been invented for the treatment of aneurism by compression, are described by Drs. Bellingham and Tufnell, in their works on this subject, to which I must refer for a fuller account than I can here give. In some cases, the circulation through the artery may conveniently be controlled by the pressure of a weight laid over it in the groin as it passes over the pubes; usually from a four to a seven pound weight is sufficient for this purpose. In this way, when only one compressor is applied on the limb, the flow of blood may be checked during the time that the screw is loosened. Care must of course be taken that the weight do not slip off. It is best made of lead, cast in a conical shape, and may be retained *in situ* by having a wide leather socket made to fit it, shaped somewhat like the hopper of a mill; its broad end should be upwards, and the narrow end press on the vessel.

In applying the compressor, especial care must be taken that it is well padded in every part, so as not to gall the skin. In some of the early cases in which I saw compression employed in London by means of the horse-shoe tourniquet, much inconvenience resulted from want of attention to this particular. The tendency to fretting of the skin is much lessened by powdering the limb, and the removal of the cuticular hairs by shaving, diminishes materially the irritation produced by the instrument. In order to keep up continuous pressure, and, at the same time, to prevent any one part of the skin being injuriously galled, it is of very great consequence that two instruments should be used at the same time, so that when one is screwed up, the other should be loose; these instruments need not be placed closely together. If the aneurism be in the ham, it will be sufficient for one to be applied to the groin, whilst the other is put upon the middle of the thigh. In using the instrument, the great point, as Dr. Tufnell most properly remarks, is to control the circulation with the minimum of pressure; in order to do this, the first instrument should be screwed up so that all pulsation ceases in the tumor, but still not so tightly as to arrest all the flow of blood through it. As the pressure exercised by this becomes painful, it must be slightly loosened, and the second one screwed up. In this way an alternation of pressure can be kept up without much pain or inconvenience. If possible, the patient should be taught how to manage the instrument himself, and will often find an occupation and amusement in doing so. If, however, it excite much pain or irritation, as it does in some subjects, it may be necessary to give opiates. The pressure should, if possible, be continued during sleep, but if it prevent the patient taking his natural rest, the suggestion made by Dr. Tufnell, of unscrewing the instrument slightly, and when the patient is asleep, gently tightening it again without awakening him, may advantageously be adopted; it is indeed surprising how very little unscrewing will relieve the pain of the compression. A large cradle should then be placed over the patient's body, so that the weight of the bed-clothes may be taken off the apparatus, and that the patient may manage it without risk of disturbance. Should there be still much uneasiness, the instrument might be taken off for a few hours, and compression kept up in an intermittent manner. Even under such circumstances as these consolidation of the sac may ensue.

The effects upon the tumor vary considerably. In some cases it rapidly and suddenly solidifies; more commonly, however, this is a gradual process, the aneurism becoming more painful and solid, with less pulsation and bruit. As the solidification takes place, there is usually a good deal of restlessness, a feeling of general uneasiness, and of constitutional disturbance, which is best quieted by opiates. As the pressure is continued, and the tumor begins to harden, the anastomosing vessels enlarge, with a good deal of burning pain in the limb generally, and arterial pulsations in situations where usually none are felt. The abnormal pulsation, in these cases, is always found to occur in much the same situations, the same vessels appearing to undergo dilatation. Thus Tufnell has made a remark, which I have had more than one opportunity of verifying, that in the treatment of popliteal aneurism by compression, three arteries will be found to be enlarged, one of which passes over the centre of the tumor, another over the head of the fibula, and the third along the inner edge of the patella; he also states that the severe burning pain which is felt in these cases, is owing to the artery accompanying the communicans peronei nerve being enlarged. After complete solidification of the tumor has taken place, the compression ought to be continued for at least forty-eight hours, so as to secure against the occurrence of a relapse.

The duration of the treatment varies very greatly. In some cases the tumor has become solidified in a few hours or days. In other instances again the treatment must be protracted for more than three months before a cure resulted. Of twenty-six cases of femoral or popliteal aneurism cured by compression, in the London Hospitals, the average time, according to Mr. Hutchinson, was nineteen days. Much of course will depend, in this respect, on the constitution of the patient, and on the condition of the tumor; those circumstances which are most favourable to the spontaneous cure of the aneurism will also influence the rapidity of the cure by compression.

Of the great value of compression in the treatment of aneurism there can be no doubt; but yet it cannot be looked upon as taking the place of the ligature in the cure of this disease, except in those cases in which the tumor is situated in the arteries of the lower extremity, below the middle of the thigh. In aneurisms occurring in the vicinity of the trunk, as in the iliac, the carotid, subclavian, and axillary arteries, it is quite inapplicable. Spontaneous aneurism being extremely rare in the upper extremity, and as the traumatic forms of the disease which occur here, generally require that the sac should be laid open, it is seldom found necessary to have recourse to it in this part of the body, though it may be, and has been, successfully applied to the brachial artery.

The great question with regard to compression appears to me, after all, to be whether it possesses any special advantages over the ligature, in the treatment of femoral and popliteal aneurisms to which its employment is necessarily chiefly confined. The principal objections that have been urged against compression are that its employment is more painful and tedious than the use of the ligature, and that those cases that are unpromising to the ligature, or that require amputation rather than it, are equally unfavourable to compression, and cannot be saved by the employment of this means.

To these objections I think it may with justice be answered, that the pain attendant on the employment of compression depends very greatly upon the skill and care with which the apparatus is applied and managed throughout, and that much depends upon the kind of instrument that is used, being certainly much diminished when Carte's elastic instrument is employed. With regard to the relative tediousness of the treatment under the two plans, it would appear that in reality there is but little difference; for although some cases in which compression is used, are prolonged over a considerable space of time, yet they do not occupy more than is often consumed when accidents of various kinds follow the use of the ligature; and it not unfrequently happens in compression, what can never occur after the employment of the ligature, that the patient is cured of his disease in a few hours or days. Taking, however, the average of the Dublin cases, we shall find that the treatment lasted twenty-five days, and in the recent London cases but nineteen, and this is not very different from what happens with the ligature; for of fifty-four cases recorded by Crisp, in which the femoral artery was tied, the average time for the separation of the ligature was eighteen days, and if to this a week more be added for the closure of the wound, and for the treatment of the various accidents so often accompanying and following the ligature, we should probably be within the mark, and yet only bring the duration of the treatment of the two methods to the same level.

After all, surgeons will eventually be guided in their estimate of the value of the two plans of treatment, not so much by the question of submitting their patients to a slightly more painful or tedious treatment, as to the comparative risk of life attendant upon one or other method. Upon this point the statistics have yet to be made; partly because the cases of the treatment of aneurism by compression have not as yet been very numerous, and partly because the unsuccessful cases of ligature have not been so commonly published as the successful ones. If, however, we compare the 32 cases of femoral and popliteal aneurism treated in Dublin up to February, 1851, as given by Dr. Bellingham (*Med. Chir. Trans.* vol. 34), with the results of the 188 cases of femoral and popliteal aneurism, recorded by Norris, in which the artery was ligatured, we shall find, that of the 32 compression cases 26 were cured; in 1, the ligature was applied after pressure had failed; in 2, amputation was performed; in 1, death occurred from erysipelas; in 1, from chest disease; and in 1 case the pressure was discontinued. Thus it would appear, that 6 out of the 32 failed, being in the proportion of 1 to 5·3 cases, and 2 died, being in the ratio of 1 to 16. Of the 188 cases in which the artery was ligatured, 142 were cured, 46 died, 6 were amputated, in 10 the sac suppurated, and in 2 gangrene of the foot occurred. Thus the deaths after ligature were in the proportion of 1 to 4, and the failures or serious accidents, of 1 to 3, showing clearly a very considerable preponderance in favour of the treatment by compression. Besides which, in many patients who recovered after the ligature, various accidents, such as gangrene, erysipelas, secondary hemorrhage, &c., resulted as the direct consequences of the treatment, and these do not happen when pressure is employed.

If the compression fails, the ligature may then often be advantageously applied; and as has been shown by the known cases, with a better success than if compression had not previously been tried, that treatment having caused the collateral circulation to enlarge, and thus lessened the tendency to gangrene.

It should also not be forgotten that in some cases, such as when aneurism is complicated with heart disease, or occurs in a very broken and unhealthy constitution, in which the operation necessary for the application of the ligature would scarcely, or not at all, be admissible, compression may be safely employed.

After carefully considering the relative merits of the two plans of treatment, I think we may conclude that, though in some few cases neither method can be adopted, and amputation is the sole resource, yet, that in others compression can be employed when it would not be safe to have recourse to the use of the ligature; and that in all ordinary cases of femoral and popliteal aneurism especially, compression should be preferred to the ligature, inasmuch as it is not a more tedious, and an infinitely safer method of cure. At the same time it must not be forgotten that its success depends very greatly on the continuous care bestowed upon the case during the progress of the treatment.]

MANIPULATION, GALVANO-PUNCTURE, AND PERCHLORIDE OF IRON.

[Mr. Fergusson has proposed to treat some aneurisms by a procedure which he terms "manipulation." This consists in squeezing the aneurismal tumor in such a way as to detach a portion of the coagulum within it, which, being carried on with the current of blood into the distal end of the artery, obstructs this; and thus, by impeding the circulation through the sac, may lead to the gradual consolidation of the tumor. This procedure has as yet been employed to too limited an extent to enable us to form an estimate of its value, and can scarcely be considered, nor is it intended to be of very general application. To such aneurisms, however, that are not amenable to ordinary surgical treatment, as those situated at the root of the neck, more particularly of the subclavian artery, it might possibly be advantageously applied. It is scarcely necessary, however, to point out the obvious danger of rupture of the sac, or of the diffusion of the aneurism on the separation of the coagulum, to make surgeons adopt due caution in carrying out this method of treatment.

The attempt to procure consolidation of an aneurismal sac by the employment of electricity or galvanism is of comparatively recent date. It appears to have been first practised by Mr. B. Phillips, about the year 1832. Little attention, however, was given to this mode of treatment until a few years back, when it was revived by some of the French and Italian surgeons, especially by Petrequin and Burci. The principle on which this operation is conducted consists in endeavouring to produce coagulation in the aneurismal sac, by decomposing the blood contained in it, by means of the galvanic current. In some instances, the attempt to do this has induced, and, in all, it must occasion the liability to inflammation of the sac and of the surrounding structures; as the change that is sought to be effected in the contained blood, consists not in the deposit of its fibrine, but in the coagulation of it *en masse*. It has of late been recommended to conjoin the employment of compression of the artery, either above or below the sac, with the transmission of the galvanic current through it, there being in this way less liability for the coagulum that is deposited to be broken down and washed away, as would happen if the current of blood were allowed to pass through the sac whilst it is in the act of forming.

The coagulation of the blood is effected by introducing two acupuncture needles into the sac in opposite directions, and keeping them in contact with one another, after connecting them with a galvanic battery of moderate tension, when coagulum becomes deposited around one of the needles. The operation should be continued for periods varying from ten minutes to a quarter of an hour, and requires to be repeated several times. Petrequin recommends that the direction of the current be changed from time to time, so that a number of clots may be formed in the sac. In this way a soft mass of coagulum may occasionally be formed in the tumor, so as to fill it up more or less completely, and to prevent the passage of blood through it. Occasionally it happens, however, that the blood has continued fluid, and the sac pervious, no coagulation having been effected; and in other instances, again, the amount of inflammation that has been set up in the sac has been so great as to give rise to its sloughing, to the occurrence of secondary hemorrhage from it, and to the loss of the patient's limb or life. This inflammation may, in some cases, doubtless, have been the result of the injury inflicted upon the sac by the introduction of the needles, and by the charring of the tissues by them; but, in other cases, I think it probable that it may have taken place from the rapid coagulation of the contained blood, an occurrence that we have already seen tends especially to inflammation, suppuration, and sloughing of the aneurismal sac. The pain of the operation is always very considerable, so much so, that patients who have been subjected to it once have refused to submit to a repetition of it.

Up to July, 1851, M. Bonnet had collected 23 cases of aneurism treated in this way; of these, 8 were of the brachial artery, 7 of the popliteal, 2 of the subclavian, and 1 of each of the following: the ophthalmic, the temporal, the carotid, the thoracic aorta, the ulnar, and one unknown. Of these the proceedings failed in 13 instances; 9 cases were reported as successful, but in 7 of these, M. Bonnet states that doubts must be entertained both as to the results and as to the treatment, for the cure took place not by galvano-puncture alone, but in some by the conjoined influence of compression and the application of ice; and in others, as the result of inflammation and suppuration of the sac. There are, consequently, only two cases in which the cure can clearly be attributable to this means alone, and without the occurrence of any serious accident.

When we compare the galvano-puncture with ligature or compression, in the treatment of external aneurism, it is, I think, impossible to hesitate for a moment in giving a decided preference to the latter modes of treatment. Not only is the principle on which it is attempted to procure obliteration of the sac in galvano-puncture a vicious and peculiarly dangerous one, viz. by the coagulation of the blood, and the inflammation of the wall of the sac; but the results that have hitherto been obtained by this method are not such as would justify a prudent surgeon in submitting his patient to experiments of this kind, when he possesses so certain and comparatively safe a mode of cure as that by deligation or compression. In *internal* aneurisms, or in those cases in which the disease is so situated at the root of the neck, that the artery can neither be ligatured with safety or compressed, galvano-puncture may perhaps be employed with some advantage, in conjunction with proper medical treatment.

The injection of aneurismal sacs with a solution of the perchloride of iron has also of late been practised, with the view of coagulating their contents, but such treatment is not only coarse and unscientific, but dangerous; and when compared with the ligature or compression of the artery leading to the sac, must be looked upon as a retrograde step in surgery.]

Lisfranc is acquainted with several cases in which ice was tried, either alone, or in combination with general means and compression. The successes were nearly equal to the failures; so that, according to Lisfranc, experience ascribes a good deal of efficacy to this treatment. He refers, however, to some recent investigations made by M. Moulinié, principal surgeon of the Hôpital St. André, at Bordeaux, which give a very different view of the subject. (See *Lisfranc*, *Des diverses Méthodes pour l'Oblitération des Artères*, p. 25.) The latter surgeon is, on the whole, rather in favour of the practice: he observes, that in all the examples in the Bordeaux Hospital, the application of ice was not aided by other means; and that it was tried without discrimination. When an aneurism is free from pain, and is neither inflamed nor too large, he thinks that the plan can hardly produce any dangerous effects. In order not to occasion sloughing, he advises the use of ice to be suspended every two or three hours or oftener. When the swelling is large, the parts very tense, their texture changed, and the skin thin, the practice is likely to accelerate the formation of a slough; and Breschet confirms a remark made by Mr. Hodgson, that some patients cannot continue this treatment beyond a few minutes, while others find it absolutely insupportable. (*Fr. Transl. of Mr. Hodgson's Work* t. i. p. 212—229.)

After all, the means, most to be depended upon, for curing aneurisms, is tying the artery above the tumor. This more certainly prevents the great ingress of blood into the sac, and, what is quite as important, more certainly excites adhesive inflammation within the tied part of the vessel, and, by holding the opposite sides of it steadily in contact, brings about their union and an obliteration of the tube of the vessel with tolerable regularity. The chief current of blood into the sac is thus stopped, the contents of the aneurism are afterwards gradually absorbed, and the tumor dwindles away in proportion. The natural course of the blood being now permanently interrupted in the arterial trunk, it passes more copiously into the collateral branches; and these enlarging and anastomosing with others, which originate from the large arteries beyond the obstruction, the necessary circulation is carried on. (See ANASTOMOSIS.)

According to Scarpa, the circumstances chiefly preventive of success, especially in the popliteal and femoral aneurisms, are the following: rigidity, atony, or disorganisation of the principal anastomoses, between the superior and inferior arteries of the ham and leg; sometimes depending on advanced age, or on it, *together with the large size of the aneurism, which, by long-continued pressure, has caused a great change in the neighbouring parts;* or sometimes on steatomatous, ulcerated, earthly, cartilaginous disorganisation of the proper coats of the artery, not confined to the seat of the rupture, but extending a great way above and below the aneurism, and also to the principal articular arteries, and, occasionally, to portions of the whole track of the superficial femoral artery. In such circumstances, the ligature is apt to fail in closing the trunk of the artery; and, if it should succeed, the state of the anastomosing vessels will not admit of a sufficient quantity of blood being conveyed into the lower part of the limb. Hence, when the patient is much advanced in life, languid, and sickly; when the internal coat of the artery is rigid, and incapable of being united by a ligature; when the aneurism is of long standing, and considerable size, with caries of the os femoris, or tibia; when the leg is weak and cold, much swelled, heavy, and œdematous:—Scarpa considers the operation contra-indicated. I must, however, declare in this place, that I have seen large aneurisms as well as aneurisms in persons of advanced age, cured by the Hunterian plan; and, with respect to the affection of the bones, though it may be an unfavourable circumstance, its consequences are generally less serious than those of ordinary caries.

In the articles HEMORRHAGE and LIGATURE, I have described the effects of the ligature upon a tied artery, and particularly the various processes which arise from its application, and terminate in the permanent obliteration of the vessel. There, I have explained what are the best ligatures for use, as well as the safest manner of applying them. Confining myself at present to what expressly relates to aneurism, I shall merely annex the following general directions:—

First, The cord should be thin and round, such a ligature being most likely to effect a clean division of the internal and middle coats of the vessel, and not liable to produce extensive ulceration or sloughing. Lisfranc and others, who apprehend that a very thin silk ligature may make its way too rapidly through the external coat, prefer a strong round thread, or several united together, the flattened form being avoided. (*Lisfranc*, op. cit. p. 52.)

Secondly, The ligature should be tight, in order to insure the complete division of the internal and middle coats, and to prevent its detachment; it being almost impossible, even with the thinnest ligature, entirely to cut through a healthy artery.

Thirdly, The vessel should be detached from its connections only to such an extent as is necessary for the passage of the ligature underneath it.

Fourthly, The immediate adhesion of the wound should be promoted by all such means, as are known to promote that process in general. (See *Hodgson*, *On Dis. of Arteries*, p. 225, 226.)

Fifthly, The ligature should be applied, if possible, to a sound portion of the artery. When the artery is affected with atheromatous or calcareous depositions at the part where some method must be tried for its obliteration, M. Lisfranc rejects the ligature and prefers compressing, or plugging the vessel, or, at all events, some means which will not occasion so much risk as the ligature of rapidly dividing the artery. (*De l'Oblitération des Artères*, p. 64.) If we were compelled to tie a diseased portion of artery, the chance of secondary hemorrhage, I believe, would not be lessened by following M. Lisfranc's advice. It is right to state, however, that the plan of plugging an ossified artery was sometimes adopted by Baron Dupuytren and M. Roux, though probably not in cases of aneurism. According to M. Manec, they used as a plug a piece of bougie, and then applied a common ligature.

Sixthly, it should not be placed too near a collateral branch, which would prevent the formation of the internal clot, and the process of obliteration of the vessel would be likely to be interfered with.

In the course of his experiments upon brutes, to ascertain the operation of the ligature, Dr. Jones arrived at a fact, which offered the probability of leading to an improvement in the operation for aneurism. (*Treatise on Hemorrhage*, chap. iii.) When a small firm ligature is applied to an artery, it causes the division of the internal and middle coats; and if it be afterwards removed, an effusion of lymph takes place between the cut surfaces into the cavity of the vessel. *If several divisions of the internal and middle coats be thus effected in the vicinity of each other*, the effusion of lymph was found by Dr. Jones to be sufficiently extensive to obliterate the cavity of the vessel. Dr. Jones mentions *several divisions* as necessary; an important fact, which has generally been overlooked, and the application of one ligature supposed to be all that was specified. Indeed, several divisions of the inner coat constitute in reality the process introduced by M. Amussat, and termed by him *Des Mâchures*. In the year 1800, Mr. A. C. Hutchison tied the brachial arteries of two dogs, and removed the ligatures immediately after their application: in both instances, as he assures us, the complete obliteration of the canal of the artery was the consequence of the operation. (See *Pract. Obs. in Surgery*, p. 103.) If, immediately after the operation for aneurism, the ligature could be removed, and yet the vessel became obliterated, it would be highly advantageous, as there would then be left in the wound no extraneous substance to prevent its union, or promote secondary hemorrhage, by extending the sloughing, or ulcerative process too far. It is to be regretted, that the repetition of the experiment by others has not been attended with success. Mr. Hodgson tried it, but the artery did not become impervious. (See *Experiments A. and B.*, p. 228, 229, of this gentleman's work.) Mr. Dalrymple, of Norwich, made the experiment not less than seven times on horses, and three times on sheep, and failed, in every instance, to obtain the same result as Dr. Jones. Not only was no coagulum formed, but even when the animal had been suffered to live until the thirteenth, fifteenth, and eighteenth days after the operation, the canal of the artery was not found obliterated. In each case, indeed, its calibre was contracted; but it was still capable of transmitting a lessened column of blood. (*Travers in Med. Chir. Trans.* vol. iv. p. 442.) Thus it appears that an effusion of lymph is an invariable consequence of the operation, and, as Mr. Travers has observed, the want of union is therefore owing to the opposite sides of the vessel not being retained in a state of contact, so as to allow of their adhesion. The presence of the ligature, in the common mode of its application, effects this object; and for the success of Dr. Jones's experiments it appeared only necessary that the opposite sides of the wounded vessel should be retained in contact until their adhesion was sufficiently accomplished to resist the passage of the blood through the tube. This object might probably be effected by compression; but the inconveniences attending such a degree of pressure, as would retain the opposite sides of an artery in contact at the bottom of a recent wound, are too great to permit its employment. It occurred to Mr. Travers, that if a ligature were applied to an artery, and suffered to remain only a few hours, the adhesion of the wounded surfaces would be sufficiently accomplished to insure the obliteration of the canal; and by the removal of the ligature at this period, the inconveniences attending its stay would be obviated. The danger, produced by the residence of a ligature upon an artery, arises from the irritation, which, as a foreign body, it produces in its coats. Ulceration has never been observed to commence in less than twenty-four hours after the application of a ligature; whilst it is an ascertained fact, that lymph is in a favourable state for organisation in less than six hours, in a wound the sides of which are preserved in contact. (*Jones*, chap. iv. exp. 1.) If it be sufficient, therefore, to insure their adhesion, that the wounded coats of an artery be kept in contact by a ligature only three or four hours, ulceration and sloughing may in a great degree be obviated by promoting the immediate adhesion of the wound. Justified by this reasoning, Mr. Travers performed several experiments, by which he ascertained, that if a ligature were kept six, two, or even one hour upon the carotid artery of a horse, and then removed, the adhesion was sufficiently advanced to effect the permanent obliteration of the canal. It appeared probable, that the same result would be obtained upon the healthy artery of a human subject. (See *Travers's Obs. in Med. Chir. Trans.* vol. iv.: and *Hodgson*, *On the Diseases of Arteries and Veins*, p. 228 et seq.

Sir Astley Cooper performed one operation for a popliteal aneurism, with the view of ascertaining the efficacy of such a method on the human subject. He completely stopped the flow of blood for thirty-two hours, and then removed the ligature; but the pulsations of the tumor commenced again. He next applied the ligature forty hours longer, at the end of which time no pulsation recurred on the ligature being taken away. On the twelfth day, however, a considerable bleeding took place, and it was necessary to take up the vessel anew.

Mr. A. C. Hutchison tried this method, as modified by Mr. Travers, in an operation, which he performed for a popliteal aneurism in a sailor, in Nov. 1813. A double ligature was passed under the femoral artery. The ligatures were tied with loops, or slip knots, about a quarter of an inch of the vessel being left undivided between them. All that now remained of the pulsation in the tumor, was a slight undulatory motion. Nearly six hours having elapsed from the application of the ligatures, the wound was carefully opened, and the ligatures untied and removed, without the slightest disturbance of the vessel. In less than half a minute afterwards, the artery became distended with blood, and the pulsations in the tumor were as strong as they had been before the operation. Mr. Hutchison then applied two fresh ligatures; hemorrhage afterwards came on; amputation was performed, and the patient died. (See *Practical Obs. in Surgery*, p. 102, &c.) Now, as Mr. Hutchison chose to apply other ligatures, on finding that the pulsation returned, the above case only proves that the artery is not obliterated in about six hours, and we are left in the dark respecting the grand question, namely, whether the vessel would have become obliterated by the effusion of coagulating lymph and the adhesive inflammation, notwithstanding the return of circulation through it. As for the hemorrhage which occurred, I think it might have been expected, considering the disturbance and irritation which the artery must have sustained in the proceedings absolutely necessary for the application of not less than four ligatures, and the removal of two of them. According to my ideas, only one ligature ought to have been used, and none of the artery detached. We also have no description of the sort of ligatures which were employed; an essential piece of information in forming a judgment of the merits of the preceding method. The application, removal, and reapplication of ligatures are not consistent with the wise principles inculcated by the late Dr. Jones; and have, in more instances than that recorded by my friend Mr. Hutchison, brought on ulceration of the artery, and hemorrhage.

The limits of this work, prevent me from entering into the particulars of the interesting experiments, undertaken by Mr. Travers, upon the arteries of animals, for the purpose of ascertaining the earliest period when a ligature might be removed from an artery, without any risk of the vessel not being duly obliterated. A full detail of them may be seen in another work (See *Med. Chir. Trans.* vol. iv. and vi.); and others, in relation to the same question, may likewise be perused in Scarpa's appendix to his great work on aneurism. (*Memoria sulla Legatura delle principali Arterie degli Arti, &c.* fol. Pavia, 1817.) The cases above related, and other considerations, long ago satisfied me, that, flattering as the suggestion of Dr. Jones was, the plan of removing the ligature, previously to its natural separation, would never answer in the operation for the cure of aneurism, unless either an obliteration of the arterial tube would follow with reasonable certainty the taking away of the ligature directly after it had been applied and it had divided the inner coats of the vessel; or, at all events, unless the ligature could be withdrawn at a determinate period, when either the same obliteration would surely ensue, or be already complete; and all this, with such regularity and infallibility in every case, that the surgeon would have no chance of being called upon to apply another ligature, do a second operation, or disturb the artery in any kind of way whatsoever.

At length, in the prosecution of this inquiry, in which Mr. Travers evinced a full determination to be guided by no motive but the love of truth, he tried the temporary application of the ligature in a case of brachial aneurism, which was operated upon Feb. 14, 1817. The artery was tied an inch and a half above the bend of the elbow with a noose ligature. The pulsation in the radial artery immediately ceased. On the 16th, at four o'clock in the afternoon, the ligature was removed with little difficulty, after having remained on the artery *fifty hours.* No pulsation ensued in the vessel below the point, where the ligature had been applied, and the case was completely successful.

On the 28th November, 1817, in a case of popliteal aneurism, Mr. Travers tied the femoral artery at one o'clock. On the 29th, at four in the afternoon, the ligature was removed without difficulty, after having been on the vessel *twenty-seven hours.* At this period no pulsation could be felt in the sac; but, at seven in the evening, a faint pulsation was perceptible. On the 30th, the pulsation, though very distinct, was less strong than before the operation. On the 2nd, 3rd, and 6th of December, the pulsation is described as still continuing. On the latter day, pressure was applied, by means of a roller, from below the knee to the groin, and was continued for a month, during which time the pulsation in the sac evidently became more feeble. On the 10th of January, the tumor became tense, and severely painful, and no pulsation in it could be distinguished. The next day, the swelling was more diffused and less prominent; and on the 12th, as the disease underwent no amendment, Mr. Travers tied the artery again, about two inches above the place where the former ligature had been applied. The next day the pain had diminished. The ligature was afterwards allowed to separate of itself; and the case went on favourably to the cure. According to Mr. Travers, the first of these cases tends to prove, that *the continuance of the ligature upon the artery for a period of fifty hours*, as certainly and completely answers the purpose of its application as if allowed to remain until thrown off by the natural process.

In the second case, Mr. Travers infers from the suspension of pain, and the diminished strength of the pulsation, for a month after the application of the temporary ligature, that a degree of impediment to the current of blood in the artery had been produced; circumstances, which once led him to entertain hopes, that the cure of the aneurism was gradually accomplishing. At length, however, the increase of the tumor, and the aggravation of pain, and inflammatory symptoms, dispelled such expectation, and it was thought necessary to tie the femoral artery a second time, and adopt the common mode.

There are one or two points about this case on which the author does not particularly dwell though they require consideration, ere one can form a correct judgment of the accuracy of one of his positions, "that non-pulsation of the sac is a sign auspicious, or otherwise, simply as it stands connected with increase or diminution of bulk, and pain." (*Med. Chir. Trans.* vol. ix. p. 415.) The first question is, how are we to account for the sudden accession of pain, the absence of pulsation, the increase of the swelling, and the other changes which happened on the 10th of January? Judging from the particulars given, I should say, that at this period, the aneurismal sac gave way, and the disease changed from the circumscribed into the diffused form; an alteration which would account for the pulsation being entirely lost, the increase of pain, and the extension of the swelling, &c. Now, although the circumstance of the sac giving way, or the increase of pain, swelling, &c. on the 10th of January, may be taken as an argument, that the application of the ligature for *twenty-seven hours*, had failed in producing obstruction enough in the vessel to retard the progress of the disease, we ought to remember, that at the time when these changes happened, a trial of pressure was making, to which one might impute the change of the aneurism from the circumscribed to the diffused form, with quite as much probability, as to the enlargement of the sac by blood sent into it through the imperfectly obliterated artery. However this may be, certain it is, that the second operation was done, when no pulsation existed in the swelling; and, perhaps, therefore, the case would have been doubly interesting, had the artery not been tied a second time, until circumstances had unequivocally proved, that this cessation of pulsation, attended as it was with an inflammatory state of the tumor, would not ultimately have ended in the cure of the disease.

Here, however, I may be speaking rather in the spirit of an experimenter, whose curiosity has not been fully satisfied, than as a surgeon, who should always be governed by the paramount consideration of extricating his patient from danger; and this will appear the more likely, when I add, that my mind has long been made up about the inexpediency of the temporary ligature, as an innovation in surgery. The last case induced Mr. Travers to relinquish the temporary ligature; and, amongst other reflections, which inclined him to give up the practice, he candidly states, "that the adhesive union is prevented by the enclosure of a foreign body in the wound, long before suppuration has commenced. Suppuration is as certain to take place, though the ligature be removed after a few hours, as if it were left to be cast off; and the granulating process is more languidly performed, after an interruption, in its early stage, for the purpose of removing the obstacle to union, than where no such interruption has been given, and the obstacle has been removed by nature's own means. Hence, it follows, that the theory, which, in removing the ligature within a given time, proposed the double advantage of a quicker, as well as a surer process, fails in both points, when brought to the test of practice upon the human subject." (See *Med. Chir. Trans.* vol. ix. p. 416, 417.)

We have seen, that when a temporary ligature, which had been applied to the brachial artery *fifty hours*, was withdrawn by Mr. Travers, pulsation in the aneurismal tumor at the bend of the elbow did not return, and the disease was cured; but that, in another instance, where the ligature had been allowed to remain on the femoral artery only *twenty-seven hours*, a feeble pulsation was renewed a few hours afterwards in a popliteal aneurism, and as the swelling became painful and more diffused, some weeks after this experiment, though no pulsation could then be perceived, the femoral artery was tied a second time, and the ligature left to separate in the usual manner.

But, from a case more recently published, it would seem, that the employment of a temporary ligature for only *twenty-four hours* on the femoral artery, may obliterate the vessel, and accomplish the cure of a popliteal aneurism. The patient was a sea-faring man, aged thirty-two; and the operator, Mr. Roberts of Carnarvon; Mr. Evans and Mr. Carrey, other surgeons of that town, being present at the application, and also at the removal of the ligature. No pulsation recurred in the tumor; the edges of the wound were brought together with adhesive plaster; and in eleven days the part was quite healed. (*Med. Chir. Trans.* vol. xi. p. 100.) This is the strongest case, I believe, which has been adduced in support of the use of the temporary ligature, whether we consider the short time for which it was applied, the permanent cessation of all pulsation, the quickness with which the wound healed, or the complete recovery of the use of the limb; for when the patient was met six months after the operation, "he could go to the mast-head with as great facility as at any period of his life." This fact proves, also, that there is a degree of irregularity in the period when the temporary ligature may be removed, without the pulsation in the tumor below the constricted part ever returning. Whether the variety is to be referred to temperament, the kind of ligature used, its greater tightness in one case than another, or other circumstances, is not at present determined.

The greatest advocate, which this practice has gained, is Scarpa, whose sentiments, however, about the most advantageous form of ligatures, and mode of applying them in cases of aneurism, are at variance with what is inculcated by the best and most experienced surgeons in this country. Instead of using a fine ligature, composed of a single piece of thread, twine, or silk, he employs a cord consisting of from four to six threads, according to the size of the artery which is to be tied; and, instead of aiming expressly at the division of the internal coats of the vessel with his ligature, as the generality of English surgeons do, for reasons explained in another part of this work (see HEMORRHAGE), he prefers a largish ligature, and interposes, between the artery and the knot, a small cylinder of linen spread with ointment, with the view of preventing the inner coats of the vessel from being divided. His reasons for this practice may be explained in a few words: he admits, that whenever there is a concurrence of all the circumstances, capable of inducing, in the tied artery, the proper degree of adhesive inflammation, above and below the place where a single circular ligature has been applied, this method is adequate to produce a speedy and steady closure of the arterial tube. But, says he, it sometimes happens, at least in man, that the pressure made by the circular ligature produces the ulcerative process more quickly in the artery, than the adhesive inflammation. In fact, the circular ligature ulcerates the artery in general about the third day after the operation; and the adhesive inflammation does not always complete its course in this period of time. During this delay of the adhesive inflammation, the ulcerative process, occasioned by the pressure of the ligature, attacks more quickly even than surgeons generally suppose, the external cellular sheath of the artery, and penetrates into the cavity of the yet pervious vessel; and this, of course, with increased quickness, when the inner coats of the artery are already divided by the ligature. The dangers of non-adhesion and too rapid ulceration of the artery, Scarpa thinks, are placed at the greatest distance by preserving undivided all the three coats of the vessel under the pressure of the ligature; and hence his partiality to larger ligatures than are now used by the best surgeons in England, and to the interposition of a cylinder of linen between the knot and the vessel, as recommended by Paré, Heister, and Platner. If, however, he has had reason to suspect that a simple circular ligature has frequently failed in England, because other innovations have been occasionally substituted for it, and because *we should not have sought for a better, if we had already had the best*, how much more vulnerable is his own practice on a similar principle; since, generally speaking, it has not retained half so many approvers as they who still express their preference to other methods, and more especially to the use of a single ligature, uncomplicated with other extraneous substances! Is it probable, he asks, that the single circular ligature, which was formerly used with doubtful success by the greatest surgeons, should now have become, as is pretended, the most certain means of preventing secondary hemorrhage? "It is now wished (says he) to ascribe the failures of Mr. Hunter, and of many other operators, not to the circular ligature, but to the improper treatment of the wound in general, and in particular to the introduction into it of lint, and, more especially, to the irritation occasioned by the ligature of reserve." On the contrary, it is argued by Scarpa, that, though Mr. Hunter, after his first trial, simplified the local treatment, though all skilful surgeons merely covered the wound with a pledget of soft ointment, and most of them omitted the reserve-ligature, yet, notwithstanding these reforms, secondary hemorrhage, after the use of a simple circular ligature, was not rendered less frequent. (*On Aneurism* p. 23, ed. 2.) With respect to the latter general assertion, its incorrectness may be learned by reference to the details of Mr. Hunter's own operations, and by going into the principal hospitals of this metropolis, where the use of a simple circular ligature for the cure of aneurisms rarely fails, so far as secondary hemorrhage is concerned. Why then did the operation more frequently fail here in former times? The answer is plain: the kind of ligature now employed in England cannot be compared to what was used in Mr. Hunter's time, or even to what was here in fashion forty years ago. And, besides the universal rejection of ligatures of reserve, practitioners now have a more thorough comprehension of what ought to be avoided in the operation, have a just fear of separating and disturbing the artery too much, know how to appreciate the advantage of closing the wound, and attach due importance to the choice of smaller or more eligible ligatures. (See HEMORRHAGE and LIGATURE.) When, therefore, Scarpa supposed, that in England the practice with the circular ligature in the treatment of aneurism is materially the same now as heretofore, and that secondary hemorrhage is as frequent, he did not avail himself of all the information on the subject which he might have acquired from Mr. Wishart, the able translator of his writings on aneurism, or from an attentive perusal of Mr. Hodgson's valuable treatise.

In an equality of circumstances, conducive to the success of the Hunterian operation, Scarpa thinks that the fact is not proved, as it is presumed to be, that the rupture of the internal and middle coats of the artery does excite the adhesive inflammation and union of the artery more effectually, than is done by the simple compression and close contact of its two opposite internal parietes in a sound and uninjured state. This remark is partly true, and partly incorrect, at the same time that it involves a question, which must be deferred till we come to the article HEMORRHAGE. The truth in the observation is, that an artery may generally be rendered impervious with tolerable certainty, by compressing its opposite parietes steadily and firmly together for a certain time, without dividing its inner coats: the inaccuracy of it depends upon the fact, that surgeons have no instrument, nor contrivance (not excepting even the ligature of four or six threads, with the interposition of the cylinder of linen spread with ointment), which can retain the opposed undivided surfaces of the inner coats of the vessels closely together in the manner commended by Scarpa, and for the due time, without the objection of denuding more of the artery than need be done in the application of a small ligature; or without the serious inconvenience and risk necessarily attending the introduction of a larger quantity of extraneous matter into the wound than is desirable, with the view of averting all chance of the ulceration of the artery reaching beyond prudent limits. And, when metallic instruments are used for the same purpose, objections not less real are incurred, as will be hereafter more particularly explained.

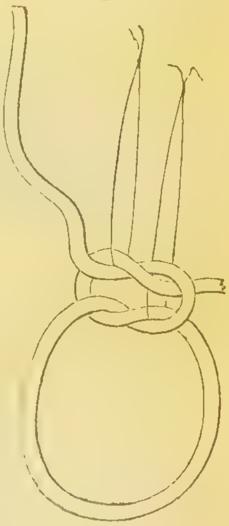
Scarpa considers that his mode of ligature ought to be preferred, as combining the triple advantage of preserving entire all the three coats of the artery; of exciting quickly, and in a proper degree, the adhesive inflammation in them; and of retarding, as much as possible, the ulcerative process of the arterial tube.

Partly impressed, however, with the truth of the tenets laid down by Dr. Jones (see HEMORRHAGE), Scarpa enjoins attention to the following rules:—1. *Not to insulate and detach the artery any further than is necessary for allowing a ligature to be passed around it.* 2. Not to let the cylinder of linen exceed a line in length, or a little more above and below the breadth of the tape, which is about a line for the large arteries of the extremities. 3. That the ligature be not too tight. 4. And *that it be never applied immediately below the origin of a large lateral branch.* (See *Scarpa*, *On Aneurism*, p. 44, ed. 2.)

Some further consideration of Scarpa's mode of applying the ligature will be introduced in the article HEMORRHAGE; and I now proceed to notice his sentiments concerning the advantage which may be derived from removing the ligature in cases of aneurism, as soon as the tube of the vessel has been obliterated by the adhesive inflammation. From the facts recorded by Scarpa, it is inferred, that, with the kind of ligature and the cylinder of linen used in his practice, the closure of the artery by the adhesive inflammation and the two internal coagula are sufficiently far advanced *on the third or fourth day after the operation*, to resist the impulse of the blood ; and hence (says he) there is no rational motive for waiting beyond this time for the spontaneous separation of the ligature, or for allowing it, by its further presence, to ulcerate, and even open the artery at the principal point of adhesion. He then comments on the advantages to the wound, derived from the removal of all extraneous matter from it on the third or fourth day. With respect to the general opinion of such removal, however, he makes one exception, viz. the case of great and evident debility from sickly constitution, or very advanced age, as it is observed that, in such patients the reunion of a simple wound is frequently protracted to the sixth day. *In cases of this description, Scarpa recommends delaying the removal of the ligature to the completion of the fifth, or sixth day*, but under the express condition, that the ligature has been applied with the interposition of a cylinder of linen ; as it is proved that a common circular ligature causes ulceration of the artery before the third day, and it is not till the sixth day that the external coat of the vessel begins to ulcerate, when the other modification of the ligature is adopted. (P. 50.)

Scarpa supports the preceding advice by four cases, in which his kind of ligature was applied, and withdrawn at the end of the third, or fourth day, and the arterial tube obliterated. However, I do not think that, in England, these cases, when minutely and attentively considered, will be regarded as inducements to persevere in the use of temporary ligatures. In every instance the wound is described as suppurating, and sometimes *plentifully*. In one, the foot mortified, and amputation became necessary. In another, the very day after the disturbance of removing the ligature, the thigh was attacked with erysipelas, and, on the eighth day the wound is represented as being *foul*, and the erysipelas not yet cured. It is but fair to add, that M. Roux seems to have operated on Scarpa's plan, with results much more encouraging ; for he is stated to have taken up the principal arteries of the neck and limbs in this way nearly fifty times, and lost but five or six of the patients from hemorrhage or sphacelus. (See *Lisfranc, De l'Oblitération des Artères*, p. 71.)

Independently of the uncertainty of the period, when the arterial tube is closed by the adhesive inflammation in various patients, it appears to me that the disturbance of the vessel and wound, by the steps necessary for the loosening and removal of the ligature, will ever form an insuperable objection to the practice. Scarpa appears to have some apprehension of this kind himself ; for he remarks : "In the act of removing the ligature, there can be no doubt it is of great consequence that the artery be not rudely handled, or stretched. And, indeed, if, on untying the running knot, the subjacent knot could be with the same facility untied, we could not wish for a better mode of performing this part of the operation. But, the knot, although a simple one, is not so readily untied as the running knot, on account of the moisture with which the threads forming the ligature are soaked, or because the ligature has been previously waxed." (P. 64, ed. 2.) In fact, his apprehensions then lead him to suggest the scheme of placing, previously to making the knot, a thread longitudinally, on each side of the cylinder ; and, at the time of removing the ligature, the threads are to be drawn in opposite directions, in order to undo the knot, without displacing or stretching the artery. This reminds me of the ingenious contrivance of Mr. John Barker, of Ipswich, whereby the ligature, at any period judged advisable, is removed without any disturbance of the wound : it is rendered perfectly intelligible by the annexed diagram.



Instead of one small ligature, which is all that an English surgeon leaves in the wound, Scarpa recommends his ligature of four or six threads, a roll of linen, and two other threads ; a quantity of extraneous substances, which cannot fail to be a source of serious irritation and mischief. I shall therefore take leave of the proposal of removing the ligature on the third or fourth day, or any other particular day, with expressing my belief, that, if there were only the following objection to the plan it would never be adopted in this country ; namely, all the advocates for this practice, excepting Mr. John Barker, whose plan has considerable merit, renounce the infinite advantage of bringing the edges of the wound together directly after the operation. Had the suggestion of Dr. Jones proved invariably correct, and the ligature admitted of being withdrawn immediately after the inner coats of the vessel had been divided by it, the case would have been very different, as there would then have been no foreign body at all left in the wound ; the parts might have been immediately brought together with the greatest chance of union by the first intention, and no subsequent disturbance either of the artery, or of the wound, would have been incurred. At the same time, I admit, that if the removal of the ligature at the end of a given time should ever prove the best practice, then Mr. Barker's ingenious contrivance for undoing and extracting the ligature without any irritation of the parts, or keeping the wound open for the purpose, may become a proposal of great practical importance. At present, I am decidedly of opinion, that it is best to leave the ligature till it becomes loosened, which usually happens between the tenth and twentieth days after the operation. (See *Lisfranc, De l'Oblitération des Artères*, p. 63.)

The next practice which I shall notice, is that of applying two ligatures to the artery, and cutting it through in the interspace. This suggestion may be said to be as ancient as the time of Celsus, who advised the method to be followed in the treatment of a wounded artery. (*De Medicinâ*, lib. v. c. 26, § 21.) The fact is curious, though I mention it without the least intention of detracting from the great merits of several modern surgeons, that the Greeks were acquainted with the practice of tying the artery with two ligatures, and dividing it between them, high above the tumor, as will appear by a reference to Ætius. (4 Serm. tetr. 4, cap. x.) In the same ancient work, we are directed to open the aneurismal tumor at the bend of the elbow, and when the blood has been evacuated, to tie the artery twice, and divide it.

This method of applying two ligatures to the artery, and dividing the vessel between them, a method spoken of by Ætius, was revived in France about eighty years ago by Tenon, who, as well as some later surgeons, was totally unacquainted with its antiquity. (See *Pelletan*, *Clinique Chir.* t. 1, p. 192.) At one time it had also modern advocates in Abernethy and Maunoir, each of whom supposed the plan an invention of his own. (See *Surgical and Physiol. Essays*, part iii. 8vo. Lond. 1797; and *Mémoires Physiologiques et Pratiques sur l'Aneurisme*, *&c.* 8vo. Genève, 1802.) Some of its advocates suspected that too rapid an ulceration of the artery and secondary hemorrhage, arose from the traction exercised in opposite directions by the upper and lower portion of the vessel; and they conceived that each end of the divided artery formed a circular prominence beyond the ligature, calculated to hinder it from slipping. Hence, according to their view, the less frequency of secondary hemorrhage after amputations, than after operations for aneurism.

When an artery is laid bare, and detached from its natural connections, and the middle of such detached portion tied with a single ligature, as was John Hunter's practice, Abernethy conceived that the vessel, so circumstanced, would necessarily inflame, and be likely to ulcerate. The occurrence of bleeding from this cause at first led to a practice, which this gentleman justly censures, viz. applying a second ligature above the first, and leaving it loose, but ready to be tightened in case of hemorrhage. As the second ligature, however, must keep a certain portion of the artery separated from the surrounding parts, and must, as an extraneous substance, irritate the inflamed vessel, it must make its ulceration still more apt to follow. The great object, therefore, which Abernethy insisted upon, was that of applying the ligature close to that part of the artery which lies amongst its natural connections: a just principle, the truth and utility of which still remain incontrovertible, though there may be a better way of accomplishing what Abernethy intended, than the measures which he was led to recommend.

The peculiarity in Abernethy's first operation consisted in applying two ligatures round the artery, close to where it was surrounded with its natural connections. For this purpose he passed two ligatures of middling size beneath the femoral artery; and having drawn one upwards, the other downwards, as far as the vessel was detached, both the ligatures were firmly tied. The event of this case was successful. An uneasy sensation of tightness, however, extending from the wound down to the knee, and continuing for many days after the operation, made Abernethy determine, in any future case, to divide the artery between the two ligatures, so as to leave it quite lax.

Abernethy next relates the particulars of a popliteal aneurism, for which Sir Charles Blicke operated and divided the artery between the ligatures. The man did not experience the above kind of uneasiness; and no hemorrhage ensued when the ligatures came away, although there was reason to think that the whole arterial system had a tendency to aneurism, as there was also another tumor of this kind in the opposite thigh.

The reasoning which induced Abernethy to revive this ancient practice was ingenious; for, when the artery was tied with two ligatures, and divided, in the foregoing manner, it was argued that it would be quite lax, possess its natural attachments, and be as nearly as possible in the same circumstances as a tied artery upon the face of a stump. Strictly speaking, however, as Mr. Hodgson first pointed out, an artery tied in two places, and divided in the interspace, cannot be regarded as placed exactly in the same condition as an artery tied in amputation. In the latter case the retraction of the vessel corresponds with that of the surrounding parts, which are divided at the same instant, and therefore its relative connections stand as before the operation. But, in the operation for aneurism, the retraction of the artery takes place without being attended with a corresponding retraction of its connections. How far the retraction of the artery is beneficial, or injurious, is by no means evident; and the advantages arising from it, may, in most situations, be obtained without dividing the vessel, by placing the limb in a bent position. One important object, however, is gained by the division of the artery; namely, that it is generally in that case tied close to its connections, and it is very evident how liable the application of the ligature in the middle of a denuded extensive portion of the vessel must be to produce ulceration or sloughing of its coats. The same object, however, will be gained by tying the undivided artery close to its connections at the end nearest to the heart; and the existence of a single ligature at the bottom of the wound will be less liable to give rise to suppuration and the formation of sinuses, than the employment of two. When an artery is divided, the portions situated beyond the ligatures must slough, and prove an additional cause of suppuration in the wound. Experience has amply proved the safety of employing a single ligature, and it is at present used by many of the most experienced operators in this country. (See *Hodgson*, *On the Diseases of Arteries*, *&c.* p. 221, &c.)

According to Scarpa, numerous examples of the failure of the plan of applying two ligatures, and cutting through the artery in the interspace, are already generally known. He speaks of one failure which occurred to Abernethy himself. But I entertain doubts how far any inference against the method can be drawn from Monteggia's instance, in which a ligature of reserve was used. Nor can I understand how a circumstance, which Scarpa strongly insists upon, can be well founded; I mean, the danger of the ligature being forced off the mouth of the artery by the impulse of the blood. Any risk of this kind cannot exist if the ligature be duly applied, as Dr. Jones has particularly explained; and, at all events, how can it be greater here than after amputation, where it is not usually made a subject of complaint? Indeed, the several examples of secondary hemorrhage, after this method, quoted by Scarpa from the practice of Monteggia, Morigi, and Assalini, may be more rationally imputed either to reserve-ligatures having been also used, or the common fear in Italy of applying the ligatures tightly; in which event one can readily suppose that the ligature might really slip, or, by remaining a long time on the vessel, give rise to dangerous ulceration. Thus, Morigi speaks of one case, in which the bleeding occurred on the *nineteenth day.* (*Scarpa*, *On Aneurism,* p. 14, ed. 2.) On the whole I am disposed to believe that when this method has been executed precisely according to Abernethy's directions, it has not often failed; and I am acquainted with only one case in London, in which it was followed by secondary hemorrhage. However, in the year 1807, Mr. Norman, of Bath, tied the femoral artery with two ligatures, and divided the vessel between them; the upper ligature came away on the sixteenth day after the operation; the lower one on the fifteenth; and the following day a profuse hemorrhage came on, the patient losing a pound of blood. Pressure with a compress and wet bandage was continued for some time, and the wound healed. (See *Med. Chir. Trans.* vol. x. p. 123.) This is the only case of secondary hemorrhage, which Mr. Norman has met with after operating for aneurisms.

Scarpa very properly remarks, that the application of two ligatures, and dividing the artery in the interspace, can never be an eligible mode, where the smallness of the space, the depth of the artery, and the importance of the surrounding parts do not permit the vessel to be separated and insulated to such an extent as is required for dividing it, with a probability of the division of it being sufficiently distant from the two ligatures. Such, for example, are the cases of ligature of the carotid in the vicinity of the sternum; of the iliac above Poupart's ligament; of the internal iliac, a little below its origin from the common iliac; of the axillary artery between the point of the coracoid process and the acromial portion of the clavicle; or of the subclavian in its passage between the scaleni muscles. Scarpa then comments on the difficulty, and even impossibility, of taking up the end of the truncated artery again in many situations, were hemorrhage to ensue; and he joins Mr. Hodgson in thinking the advantages of the method, even where it is practicable, by no means demonstrated. Nay, he goes further; for he agrees with Heister, Callisen, and Richter in setting it down as worse than useless, on account of the portion of the artery between the ligatures being converted into a dead and putrid substance, which rests upon the bottom of the wound, from which it cannot be removed until the two ligatures are separated. Here, deeply impressed with the truth of principles, which, perhaps he has rather lost sight of in speaking of his own particular method, he comments on the little probability of the wound uniting, under the disadvantage of two ligatures hanging out of it, and of sloughs at its bottom. He argues correctly, that the laying bare, and insulating a large portion of artery, would often be objectionable on the ground that it could not be done without the surgeon being obliged to apply the principal ligature too near the origin of a large lateral branch; as would happen in a case of femoral aneurism, situated *an inch and a quarter* below the origin of the profunda. Thus, a coagulum could not be formed, and the artery would be in danger of not being closed. On the contrary, by employing only a single ligature, at *an inch and a quarter* below the origin of the profunda, the operation would be simple and successful. (*Scarpa, On Aneurism,* p. 19—21, ed. 2.)

The above considerations would certainly lead me to avoid the practice of detaching an artery from its surrounding connections any more than is absolutely necessary for the conveyance of a single ligature under it; but I fully concur with Sir Astley Cooper in the prudence of using two ligatures, and applying them in the way recommended by Mr. Abernethy, whenever the artery has been extensively separated from its sheath in the operation.

The frequent occurrence of accidents after the introduction of Mr. Hunter's operation might have been ascribed to more probable causes than the condition of an undivided artery, upon which the ligature was applied. The employment of numerous ligatures gradually tightened, or the introduction of extraneous bodies into the wound, were alone sufficient to produce ulceration of the artery: and such practices were adopted in most of the cases in which secondary hemorrhage took place.

After the reasons which have been specified against the plan of tying the artery with two ligatures, and dividing it in the interspace, it may appear superfluous to notice a modification of this practice, intended as a security against the slipping of the ligature. But, as the proposal has had the approbation of some men of eminence, the subject may still be worthy of notice.

Sir Astley Cooper published a case of popliteal aneurism, in which the femoral artery had been tied with two ligatures, as firmly as could be done without risk of cutting it through. "But (says he) as I was proceeding to dress the wound, I saw a stream of blood issuing from the artery, and when the blood was sponged away, one of the ligatures was found detached from the vessel. Soon after, the other was also forced off; and thus the divided femoral artery was left without a ligature, and unless immediate assistance had been offered him, the patient must have perished from hemorrhage." The same kind of accident occurred in Mr. Cline's practice. For the prevention of it, Sir Astley at first tried the method of conveying the ligatures, by means of two blunt needles, under the artery, an inch asunder, and close to the coats of the vessel, excluding the vein and nerve, but passing the threads through the cellular membrane surrounding the artery. When these were tied, and the artery had been divided between them, the ligatures were prevented from slipping by the cellular membrane through which they passed. Afterwards, however, he tried a different mode of securing the ligature, suggested to him by Mr. H. Cline. "An incision being made on the middle of the inner part of the thigh, and the femoral artery exposed, the artery was separated from the vein and nerve, and all the surrounding parts, to the extent of an inch; an eye-probe, armed with a double ligature, having a curved needle at each end, was conveyed under the artery, and the probe cut away. The ligature nearest the groin was first tied; the other was separated an inch from the first, and also tied. Then the needles were passed through the coats of the artery, close to the ligatures between them, and the ends of each thread were again tied over the knots made in fastening the first circular application of the ligatures. Thus, a barrier was formed, beyond which the ligature could not pass." This operation was successful. (*Med. and Phys. Journ.* vol. viii.) A similar proposal appears to have been mentioned by Dionis, and some subsequent writers, especially by Richter, in the 13th chapter of his *Anfangsgründe der Wundarzneykunst*, b. i. ed. 3, 1799.

The preceding method is so contrary to the grand principle of always avoiding the detachment of the artery from its surrounding connections, and is so inconsistent with the wise maxim of completing the operation with as little disturbance of the vessel as possible, that it is not surprising that it should have met with only a small number of followers. In fact, it is not only liable to every objection which can be urged against the double ligature and division of the artery, as formerly proposed by Celsus, and a few of the moderns, but on account of its greater tediousness, more extensive separation and destruction of the vessel, and other reasons, is still less worthy of imitation.

Where ligatures slip off directly after their application, I conclude that the arteries either cannot have been tied with sufficient tightness, or else that the noose becomes slack, from causes which will be understood by considering what is said on this matter in the article HEMORRHAGE. The inner coats of the artery, we know from the experiments of Dr. Jones, ought to be cut through when the artery is properly tied, because the circumstance is always useful in promoting the effusion of lymph within the vessel, and the process of obliteration by the adhesive inflammation: it may also be advantageous in keeping the ligature from slipping.

With respect to ligatures of reserve, the interposition of agaric, cork, and other hard substances between the knot and the artery, these contrivances are now so fully rejected by all good surgeons, for reasons which will be quite intelligible after the perusal of another part of this work (see HEMORRHAGE), that I shall not at present detain the reader with animadversions on their danger. As for several kinds of metallic compressors intended to be applied to the exposed artery, for the purpose of rendering it impervious, they are inventions which have been made and extolled by some surgeons of high repute, whose names would give importance even to a less meritorious proposition.

Dubois conceived that hemorrhage might sometimes proceed from the circumstance of a ligature making its way too fast through the artery. He thought also that the sudden stoppage of the current of blood by a tight ligature might bring on gangrene of the limb, particularly when the aneurism was not of long standing, so that the collateral branches had not had time to enlarge. Dubois, therefore, proposed a method of *gradually* stopping the flow of blood through the artery; and by this ingenious imitation of the process of nature, to promote the gradual dilatation of the collateral arteries, and obviate all risk of gangrene in the lower part of the limb. This gentleman put his plan in execution, and two instances of success are recorded. The cases were popliteal aneurisms. A ligature was passed under the artery in the manner of Hunter; its two ends were then put through an instrument called a serre-nœud, with which the compression was gradually increased. It is stated that, in one of these cases, the plan made the artery inflame and become impervious, in the course of the first night, so that on the following day the throbbing of the tumor had ceased. (*Richerand, Nosogr. Chir.* t. iv. p. 109, edit. 4.) Here, however, it is to be suspected that the pressure of the apparatus was greater than was calculated: and that the stoppage of the pulsation was more owing either to this cause, or to the coagulation of the blood, in the sac and adjoining portion of the artery, than to the process of obliteration, which could hardly have been so rapidly accomplished.

Assalini's compressor is an instrument, calculated, as its inventor states, to produce an obliteration of the trunks of arteries, without dividing or injuring their coats. It is nothing more than a small pair of silver forceps, the blades of which are broad and flat at their extremities, between which the artery is compressed. A spring, composed of a piece of elastic steel, is attached to the inside of one of the handles, and, by pressing against the opposite handle, retains the flat ends of the blades in contact. This spring is intended to be very weak in its operation; but, by means of a screw which passes through the handles, the pressure admits of being regulated and increased at the option of the surgeon.

A representation of Assalini's compressor may be seen in his *Manuale di Chirurgia, parte primâ*, p. 113. In the same book, or in my friend Mr. Hodgson's valuable *Treatise on the Diseases of Arteries and Veins*, which every practical surgeon ought to possess, a case may be perused, in which this instrument was successfully employed by Professor Monteggia, and withdrawn entirely, as early as sixty hours after its application. This last distinguished surgeon also used the compressor in an example, in which the femoral artery was wounded, and bled in an alarming degree. After forty hours, the pressure was lessened; and, in four hours more, as not a drop of blood issued from the vessel, and there seemed to be no good in leaving an extraneous body in the wound any longer, the instrument was taken out altogether. (See *Assalini's Manuale di Chirurgia*, p. 110.)

When Assalini was in England, he acquainted Mr. Hodgson, that in two cases of popliteal aneurism, in which he had himself employed this means of obliterating the femoral artery, the instrument was removed at the expiration of twenty-four hours; no pulsation returned in the tumors; and the patients were speedily cured.

With respect to the particular merit of this invention, it certainly possesses the recommendation of ingenuity: but it operates much in the same manner as several other mechanical contrivances of the *serre-nœud* of Dessault, the *presse-artère* of Deschamps, that of Mr. Crampton (see *Med. Chir. Trans.* vol. vii.), the pincers of Baron Percy, &c. If there be a real advantage in the division of the internal coats of an artery by the ligature, as the experiments of Jones seem to prove, and as many of the best surgeons in this country inculcate (see HEMORRHAGE and LIGATURE), then the compressor cannot be an eligible means of obliterating an artery. It may be said, however, that experience has proved its efficacy; but, let it be recollected that almost every method of operating upon aneurisms has sometimes answered. Further experience is requisite to determine whether Assalini's compressor would succeed as often as, or more frequently than, the scientific application of the right kind of ligatures (see LIGATURE), which may perhaps seem slower in their effect, only because they are not in general removed as early as Assalini's instrument. In fact, the experiments of Mr. Travers have now proved that the ligature is the quickest in its operation. (See *Med. Chir. Trans.* vol. vi. p. 643, &c.)

In 1816, some ingenious observations were published by Mr. Crampton, on the effects of the ligature and of compression in obliterating arteries. The purport of his remarks is to prove, like the later observations of Scarpa: 1st, That the obliteration of an artery can *very certainly* be effected, independently of the rupture or division of any of its coats; 2ndly, That this operation of the ligature, so far from being essential to the process, not unfrequently defeats it. (See *Med. Chir. Trans.* vol. vii. p. 344, 345.)

With respect to the first of these assertions, I presume, that all practical surgeons have known and admitted it, especially if the words *very certainly* be left out. Every system of surgery, for half a century past, has recorded the occasional cure of aneurism by different modes of compression by which the adhesive inflammation is excited in the artery, or the coagulation of the blood in the aneurismal sac brought about. As, however, the most experienced surgeons have found the method less certain than the use of the ligature, it is not represented, by any modern writers, as deserving equal confidence; though there are circumstances in which simple pressure may be sometimes tried, with the hope of doing away all occasion for an operation. The cases, however, in which compression is applied directly to the artery itself by means of ligatures, with the intervention of other substances, as advised by Scarpa, &c., or by various contrivances, like those of the serre-nœud, the presse-artère, and Assalini's forceps, all require the exposure of the artery; and if commendable, therefore, cannot be so on the principle of saving the patient the pain of an operation, but because they are more effectual than the employment of the ligature. This last point remains to be proved. From the comparatively small number of instances, in which the preceding modes of compression have been practised, several examples of failure might be quoted.

With regard to Mr. Crampton's second assertion, that the division of the inner coats of the vessel, so far from being essential to the process of obliteration, not unfrequently defeats it, I think the last part of the observation is altogether unproved. We must admit, that the division of the inner coats is not essential, because arteries sometimes become obliterated under a variety of circumstances in which such division is not made; but still, the great question remains, whether it renders the process more certain. Mr. Crampton founds his conclusions, that it not unfrequently prevents the obliteration, and gives rise to secondary hemorrhage, upon a very few uncommon cases in which aneurismal swellings have taken place above the ligature. (See *Warner's Case*, p. 156, *of this Dictionary*.) Here Mr. Crampton presumes that the occurrence happened from the division of the inner coats of the artery, though Warner himself suspected, with more probability, that it proceeded from a diseased state of the vessel. Besides, this event, be it produced in whatever manner it may, is so rare, that I only know of three examples of it on record, and have never known it occur during the many years that I have been in the constant habit of seeing numerous operations performed. In Warner's time, also, the ligatures used were so thick, that they must have been more likely just to press the sides of the artery together, like Mr. Crampton's *presse-artère*, than effect a complete division of the inner coats of the vessel, as is accomplished by the small ligatures in modern use.

Those metallic instruments, intended to be applied directly to an exposed artery, for the purpose of obliterating it by compression, are liable, as Scarpa remarks, to all the inconveniences which are inseparable from the presence of hard bodies, introduced and kept for several days in the bottom of a wound; especially when this is recent, in which case they cannot be retained in a proper direction without difficulty, or exactly at such a depth as will not be attended with hurtful pressure upon the wound itself, and important parts in its vicinity. And, with regard to the forceps of Assalini, Monteggia has observed, "*If the obliteration of the artery is retarded; the forceps equally divides the artery by causing the death of the included portion. I also saw, in one case, the extremity of the instrument resting at the bottom of the wound on the subjacent femoral vein, rupture its anterior half also, although we were sure it had not been included by it.*" (*Instituz. di Chir.* ed. 2, t. ii.) And although Cumano, in a case of popliteal aneurism, obtained, on the fourth day, the closure of the femoral artery, by means of Assalini's forceps, he does not conceal that the cure of the wound was rather difficult; and, in comparing the ligature with the forceps, he adds his belief, that if an equal result is derived from both, the preference will be given to the ligature, unless the other instrument be brought to such perfection that the inconveniences will be removed from which he found it not exempt, though the operation succeded. (*Annali di Méd. del Dottore Omodei*, Settembre, 1807, p. 309; and *Scarpa*, *On Aneurism*, p. 45, ed. 2.) Some experiments were a few years ago instituted by Mr. Travers, in order to determine the merit of Assalini's forceps, compared with the ligature; and his conclusions from the facts elucidated in the investigation is, that the ligature is a more powerful means of effecting the obliteration of the tube of an artery. (See *Med. Chir. Trans.* vol. vi. p. 643, &c.)

The substance called silkworm gut, used by anglers, was proposed to the profession for securing arteries, in the year 1818. (See *Experiments in favour of a new substance for tying Arteries, and for Suture, by Joseph M‘Sweeny, M.D.* in the *Edinburgh Medical and Surgical Journal*, vol. xiv. p. 597.) It is described as round, smooth, amazingly strong, only as thick as horse-hair, thus adapted for cutting the internal coat of an artery; and it admits of being firmly knotted when moistened. In all the experiments where it was used, the wound healed kindly over it, and on killing the animal it was found unchanged. In the year 1826, Mr. Fielding drew the attention of surgeons to the subject of silkworm gut, not aware of Dr. M‘Sweeny's experiments. This substance was employed for securing arteries, in various operations, with complete success; the wounds healed quickly over it, Mr. Fielding has the merit of having first used it successfully in operations on the *human body.* (See *Trans. of the Medico-Chirurgical Society of Edinburgh*, vol. ii. p. 340.)

A few years ago, Mr. Lawrence extended to operations for aneurism the method of tying the artery with a small firm silk ligature, the whole of which is immediately afterwards cut off, with the exception of the noose and knot, and an endeavour then made to heal the wound by the first intention. In a case of popliteal aneurism, Mr. Carwardine, late of Thaxted, tied the femoral artery in this manner, and the wound united entirely by the first intention, not a particle of pus having been formed at any time; and the part continued perfectly sound at the distance of some months from the operation. On the 29th of March, 1817, I saw Mr. Lawrence try the practice in a similar case: with the exception of the integuments, the wound united by adhesion. However, it continued to discharge a small quantity of matter till the end of May, when the ligature came away, and it healed firmly. In an aneurism of the brachial artery, Mr. R. Watson, of Stourport, Worcestershire, tied that vessel and cut off the ends of the ligature, as proposed by Mr. Lawrence. The operation was done on the 2nd of March, and the wound was quite healed by the 10th of April. On the 3rd of May, a small tubercle which had been felt under the skin in the centre of the cicatrix, appeared above the skin, and proved to be the knot of the ligature. There was no inflammation, nor discharge; but the ring of the ligature was firmly impacted in the centre of the cicatrix. In about a week from this time, the whole of it was expelled. In another case, where Mr. Hodgson tied the ulnar artery, and cut off the ends of the small ligature, the skin healed over the vessel, but a firm almost cartilaginous knot gradually formed, from the centre of which the bit of ligature was extracted five or six months afterwards by a small puncture. (For additional observations, see *Med. Chir. Trans.* vol. viii. p. 490, &c.)

Although Mr. Carwardine's case is a strong one in favour of this method, I apprehend that, on the whole, the cures on record thus effected cannot be said to have been completed sooner thon others generally have been, in which one end of the small circular ligature was left for the removal of the noose. Thus, in two cases, where the practice was tried by Mr. Norman, of Bath, the results were by no means encouraging. In one of these instances, a part of the wound appeared to have united by the first intention, but *matter afterwards formed, and it was a considerable time before the ulcer healed.* The ligature was never seen to come away; but from the circumstance of the suppuration, Mr. Norman apprehends that it must have been voided. In a second example, the attempt to procure a permanent adhesion of the parts over the ligature did not succeed; a *long and troublesome suppuration ensued*, and the wound was not healed till the latter end of April, though the operation was done on the 7th of March. (*Norman, in Med. Chir. Trans.* vol. x. p. 120, 121.) As catgut, however, was employed for the ligatures in these two operations, I do not know that it is fair to consider the method exactly like that recommended by Mr. Lawrence, who particularly directs very small ligatures of dentist's silk to be used. But, besides the different material employed, we are left uninformed of the thickness of the catgut; and, in this respect, also, there would probably be no greater similarity between the ligatures of these gentlemen than there was in regard to the substances of which such ligatures were made. In favour of catgut as a ligature, when the ends of it are to be cut off, a case published by Sir Astley Cooper deserves particular notice. The wound was found completely united on the fourth day after the operation, notwithstanding the patient was eighty years of age. The catgut, previously to its application was softened in warm water. The recovery was complete; a fact, strongly proving the propriety of not rejecting an operation on account of age, if no other objection exists. (See *Surgical Essays*, part i. p. 126.) Sir Astley afterwards renounced both the use of catgut ligatures, and the plan of cutting off both ends of each ligature. With respect also to silk ligatures, it seems that little abscesses and hard knots occur even after their use in this manner, and these inconveniences have deterred surgeons generally from adopting the innovation. M. Manec tried the plan with ligatures composed of various animal substances, silk, catgut, filaments of nerves, tendons, &c.; and the result was, that the wound was never healed by adhesion over the extraneous substance, without abscesses afterwards forming for its discharge. Dupuytren observed the same thing. Lisfranc was a witness of two cases, in which the ligature was not absorbed, and severe consequences ensued. (*De l'Oblitération des Artères*, p. 55.) Some American surgeons, and especially Drs. Physic and Levert, tied the artery with lead, gold, silver, or platina wire, and then cut off the ends of such ligature. They were led to adopt this plan by the consideration of the little irritation sometimes resulting from the presence of a metallic substance in the textures of the body, as illustrated in gunshot wounds. In experiments on animals, the artery was obliterated by the metallic wire, the part of which, left in the wound, became included in a kind of little cyst, where it remained without inconvenience. It does not appear that the practice was ever tried on the human subject. However, I join Lisfranc in the belief, that if it were tried, it would be found liable to the objections urged against silk and catgut ligatures used in this way. (*De l'Oblitération des Artères*, p. 57.) Be it recollected, also, that a bullet, or other metallic body, only occasionally lies in parts without causing inconvenience: much more frequently it tends to make its way outward, and bring on suppuration and ulceration. I coincide, then, with M. Lisfranc, and the great body of English and French surgeons, that, as the plan of removing both ends of the ligature brings no advantage to counterbalance its inconveniences, it should be relinquished, and the preference given to the method of cutting off only one end, and leaving the other hanging out of the wound. (Op. cit. p. 58.)

In cases of aneurism, a single small ligature, composed of dentist's silk, common silk, thread, inkle or twine, is now usually preferred by the majority of surgeons in England; but, as the right qualities of ligatures are elsewhere considered (see HEMORRHAGE and LIGATURE), I need not here dwell upon the subject. It is not meant to assert, that the use of a single ligature is never followed by secondary hemorrhage; for this would be untrue. The accident, I believe, will sometimes happen after this or any other mode, under certain circumstances, and in unfavourable subjects. A fact of this kind we find recorded, which happened in the practice of a truly eminent and experienced surgeon (see *A. Burns*, *On Diseases of the Heart*, p. 230); but, it appears to me, that, *cæteris paribus*, a single small ligature, *applied with as little disturbance and detachment of the artery as possible*, will be more rarely followed by secondary hemorrhage, abscesses, sinuses, &c., than any other known method. Thus, in the several cases reported by Mr. Norman, the single ligature was never followed by any of those inconveniences which, he justly thinks, will be rarer after this practice than any other, "if the artery be not removed from its situation, or more detached, than the ligature separates it." (See *Med. Chir. Trans.* vol. x. p. 123.)

I have already insisted on the importance of tying a sound portion of the artery. Even a dilatation of it, unattended with calcareous or atheromatous depositions, is unfavourable to the success of the ligature. M. Lisfranc, in one instance of carotid aneurism, had only room for a ligature on a dilated portion of the common carotid, between the aneurism and the sternum: in a few days the artery gave way below the ligature, which had not quitted its place. (See *Lisfranc*, *De l'Oblitération des Artères*, p. 65.)

Before entering into the consideration of particular aneurisms, I wish to mention a few other circumstances, worthy the attention of every practical surgeon. The first is, the partial entrance of blood into the aneurismal sac, after the artery has been tied at some distance from the tumor. This fact was first particularly pointed out, and its reasons explained, by Sir E. Home, who published three examples of its occurrence. (See *Trans. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 173, and vol. ii. p. 239.) But I believe that it had never been considered with due attention, until Mr. Hodgson made it one of the subjects of his reflections in his valuable treatise.

"When an artery is tied close to an aneurismal sac, the ingress of blood into the latter is in most instances prevented; the coagulum which it contains is absorbed, and the membranes of which the sac is composed gradually contract, until its cavity is permanently obliterated. But when the artery is tied at a distance from the disease, the ingress of blood into the latter is not altogether prevented; for, the anastomosing branches, which open into the trunk below the seat of the ligature, convey a stream, which passes through the aneurism. The impulse of this current, however, is so trifling, that the enlargement of the sac not only ceases, but the deposition of coagulum in it increases, in consequence of the languid state of the circulation. The coagulum accumulates, until the cavity of the sac, and the mouth of the artery leading into it, are obliterated," &c. (See *Hodgson*, *On the Diseases of Arteries*, p. 266.)

This fact, which is of great importance, both in a practical and pathological point of view, is proved (says this gentleman), 1st, by the occasional recurrence of pulsation in the tumor after the operation; 2ndly, by cases in which the cavity of the sac has been exposed, and hemorrhage has been the consequence; and, 3rdly, by dissection, in which it has been found, that the cavity of the aneurism, as well as that of the artery from which it originated, was pervious, from the part which was obliterated by the direct operation of the ligature. For a detail of the facts relative to this interesting point, the reader is referred to Hodgson's valuable publication (p. 267, *et seq.*)

Some very uncommon instances are recorded, in which the return or continuance of pulsation in the tumor is said to have prevented the cure; the aneurismal sac having begun to enlarge again. The two cases of this kind, however, which happened in the practice of Pott and Guerin (*Trans. of a Soc. for the Impr. of Med. and Chir. Know.* vol. i. p. 172; and *Journ. de la Soc. de Santé* No. 3. p. 197), cannot be well depended upon, as it may be doubted whether the artery was really tied. Some better established facts, relating to this part of the subject, have been very recently published. One is a case by Dr. Monteath, jun., of Glasgow, which is very remarkable, as the disease, viz. a popliteal aneurism, occurred nine months after the femoral artery had been unequivocally tied in the upper third of the thigh. On the 27th of February, 1819, this gentleman performed the operation, using a single ligature; the pulsation of the tumor in the ham instantly ceased; and the wound healed by the first intention, except where the ligature was situated, which came away on the thirtieth dry. By this time the tumor was diminished to one half of its original size, and, in two months more, only a hard knot was perceptible, in which no pulsation whatever could be felt. After the considerable lapse of time above specified, the patient informed Dr. Monteath, that the tumor had reappeared, being rather larger than a plum. The pulsation in it was distinct, though not so strong as in ordinary aneurism. As the size of the swelling, and strength of the pulsation, increased gradually, a compress and bandage were applied, without confinement; but, as this treatment was ineffectual, the patient was afterwards kept in bed, bled, and put on a spare diet. A thick compress was placed over the tumor, and the limb was firmly bandaged from the toes to the groin. A trial of this plan for three days not having produced any benefit, a tight tourniquet was applied over the tumor; but the pain was such in half an hour, that the instrument was taken off, from which moment no pulsation was felt. Next day the tumor not only did not throb, but had a firm feel; and, the bandage being continued, the cure was gradually completed. Had the disease not yielded to these means, Dr. Monteath meant to have tied the inguinal or external iliac artery, with the view of cutting off the supply of blood to the sac, through the anastomosing branches. (*Scarpa*, *On Aneurism*, *by Wishart*, p. 510—512, ed. 2.)

The following cases were mentioned by Sir Astley Cooper:—A man underwent the operation for aneurism; the femoral artery was tied; the pulsation ceased; and the patient in a little while was supposed to be cured of the aneurism, and discharged. Upon his return to labour, however, a swelling arose in the ham, without pulsation. The swelling subsided in consequence of rest; but afterwards, while the man was at work, the swelling returned with great pain. At length, as Sir Astley conceived that there was no prospect of the limb becoming useful again, it was amputated. Upon an examination of the parts, he found that the femoral artery, below the place of the ligature, had been conveying blood. It does now and then happen (says he), that a blood-vessel will arise from the artery close above the ligature, and pass into the artery immediately below it, by which means the circulation is produced. Sir Astley then referred to a specimen in the hospital museum, where this fact is illustrated in the brachial artery. (See *Lancet*, vol. i. p. 298.) Mr. Jeffreys had a gardener under his care in St. George's Hospital, who had been operated upon by Mr. Gunning for a popliteal aneurism four years previously, and which appeared to have been cured; but the tumor returned a few weeks before the patient's re-admission. The limb was amputated, but the result was fatal. In the *post mortem* examination, the femoral artery was found obliterated for the space of half an inch, at the part where the ligature had been applied four years previously; and immediately below the impervious part, two branches, equal to half the diameter of the femoral artery, were observed to enter the continuation of that trunk. It was inferred, that the circulation through the aneurism had never been wholly suspended, and that the disease was a reproduction of the original tumor. (See *Guthrie*, *On Dis. of the Arteries*, p. 157.)

The external iliac artery was taken up by Mr. Norman of Bath, for the cure of an inguinal aneurism ; and when the collateral circulation was fully established a few days after the operation, the tumor was again supplied with blood in sufficient quantity to produce a distinct pulsation ; "a fact (says Mr. Norman) of practical importance, as it shows, that though the ligature on the iliac artery stops the direct influx of blood into the tumor, and is the means by which the disease is cured, yet that there exists a necessity for employing strict rest, the antiphlogistic regimen, and, in some cases, the abstraction of blood, to assist nature in her operation of obliterating the aneurism." And, in another instance, after the same gentleman had tied the femoral artery for the cure of popliteal aneurism, the pulsation, though stopped for a time in the tumor, afterwards recurred in such a degree, that much doubt was entertained whether the disease would have been cured by the ligature on the femoral artery, had not continued and rather powerful pressure been adopted. (*Med. Chir. Trans.* vol. x. p. 99, 118, &c.) Mr. Briggs also had a case exemplifying the recurrence of a popliteal aneurism some time after an apparent cure by the operation, and the successful employment of pressure on the artery in bringing about a permanent stoppage of the renewed pulsation, and the removal of the tumor. (See *Guthrie*, *On Dis. of the Arteries*, p. 157.) Another instance of the good effect of this practice, I shall presently notice: it was in a case under Mr. Liston.

[The continuance or return of pulsation in the sac after the ligature of an artery, is an interesting phenomenon. In most of the cases in which it has occurred, a thrill or pulsation has been felt in the artery within twenty-four hours after the application of the ligature. In other instances it has not occurred until a month or six weeks have elapsed; and in a few examples not until after some months have passed, when a *secondary* aneurism has formed. The aneurismal sac may slowly and gradually enlarge, without pulsation, after the application of the ligature, owing to the influx of regurgitant blood.

Recurrent pulsation usually ceases of itself. Should it not do so, the application of a compress or bandage will usually suffice to ensure the consolidation of the aneurism. If it recur at a late period, constituting a secondary aneurism, there would probably be no resource but amputation.

Suppurative sloughing of the aneurismal sac after the application of the ligature, is chiefly apt to occur when the disease is seated in the axilla, groin, or neck. It may prove fatal by the occurrence of secondary hemorrhage.

When an aneurism has suppurated or burst, the patient is in danger of dying from the immediate occurrence of hemorrhage from the sac. Should this not supervene at once, a tourniquet should be applied around the limb, and the sac being cleared of all coagula, and freely laid open, must be methodically plugged from the bottom, and a graduated compress firmly applied over it. In this way the bleeding may be checked and permanently arrested. Should it still recur, the actual cautery should be applied. The attempt to confine and to secure the bleeding vessel by a ligature has, I believe, ever been attended by successful results.

Gangrene of the limb may happen either from the large size of the aneurismal tumor compressing, and thus interfering with the circulation through the anastomosing vessels, or else by an obstruction being occasioned by the release of the venous blood in consequence of the incorporation of the contiguous vein on the wall of the sac. Sometimes it may occur from erysipelas, or from the tendons of an inflamed sac. Under such circumstances, incision of the sac, and letting out the contents, has saved the limb. But when gangrene has once fairly set in, there is no resource but amputation high up.]

With respect to the circumstance of hemorrhage being more likely to follow, when the ligature is placed close below, than at some distance from a great collateral artery, there cannot be a doubt of the fact. M. Roux, when in London, saw an occurrence of this kind himself, and has published it in his book. It was a case in which Sir Astley Cooper tied the external iliac artery ; but the patient died of hemorrhage a fortnight afterwards, and, on opening the body, it was ascertained that the obturator artery, which usually arises either from the trunk of the internal iliac, or from the epigastric, proceeded from the external iliac, and arose immediately above the point to which the ligature was applied. (See *Parallèle de la Chir. Angloise avec la Chir. Françoise, &c.* p. 278, 279.)

From a preparation, spoken of by Mr. Travers, from others in different museums, especially in that of the University College, and from some experiments which were made, it would appear that the presence of a collateral branch hinders the formation of the internal coagulum, but will not always prevent the closure of the vessel by the adhesive inflammation. In the preparation referred to by Mr. Travers, a ligature was applied to the external iliac, between the epigastric and circumflex iliac arteries, "and having been in contact with the former at the angle which it makes at its origin from the iliac, ulceration had taken place, and the bleeding had proved fatal. *There was no coagulum formed in the iliac trunk*, though the operation had been performed several days, the circulation through the epigastric having continued. *But the lymph-plug at the seat of the ligature on the iliac artery was complete.*" (*Med. Chir. Trans.* vol. vi. p. 656.) Indeed, it must be admitted that the fluidity of the blood does not prevent the adhesive process, a fact which, as Mr. Travers observes, is also proved by the indirect obstruction of a vessel, by means of a temporary ligature, or compressor. When, therefore, the vicinity of a large branch to the ligature is spoken of as a circumstance conducive to secondary hemorrhage, I mean that it is so, inasmuch as the internal coagulum is useful in promoting the closure of the vessel, and its formation is prevented.

It was either Brasdor or Desault, who first conceived, that, when an aneurism was so situated, that a ligature could not be applied to the artery leading to the swelling, a cure might possibly arise from tying the vessel on that side of the tumor, which was most remote from the heart. Desault conjectured that, by this means, the circulation through the sac would be stopped, the blood in it would coagulate, that the circulation would go on by the collateral arteries, and that the tumor would be finally absorbed. Deschamps tied the femoral artery below an inguinal aneurism; but the progress of the disease, instead of being checked, seemed to be accelerated by the experiment. The operator was obliged, as a last resource, to open the tumor, and try to take up the vessel. In this attempt the patient lost a large quantity of blood, and died eight hours afterwards. (See *Œuvres Chir. de Desault par Bichat*, t. ii. p. 563; and *Recueil Périodique de la Société de Médecine de Paris*, t. v. No. 17.)

The operation of tying the artery below the tumor was repeated by Sir A. Cooper, not for an aneurism of the femoral artery in the groin, but for an aneurism of the external iliac, where tying the artery above the swelling was impracticable. The femoral artery was therefore tied immediately below Poupart's ligament, between the origins of the epigastric and the profunda. The pulsations of the tumor continued; but the progress of the disease was checked. After a time, indeed, the swelling decreased, and this in so considerable a manner, that hopes began to be entertained that perhaps the external iliac artery might soon admit of being tied above the disease. The ligatures came away without any unfavourable occurrence; and when the wound was healed, the patient was sent into the country for the benefit of the change of air. Afterwards, however, the tumor gave way; an extravasation of blood took place in the cellular membrane of the pelvis, and the patient died. Sir A. Cooper had no opportunity of seeing the case; and as the body could not be opened, further particulars were not obtained.

I believe no additional trials of this practice were made in any part of the world, and that, in fact, the general feeling of the profession was decidedly against it until my friend Mr. Wardrop directed his particular attention to the subject, and both by reasoning and facts exemplified, that Brasdor's method of operating ought to be adopted in certain aneurisms, the circumstances of which forbid the application of a ligature on the cardiac side of the tumor. The pulsation, which is sometimes felt for the first few days, at length subsides, in consequence of the circulation being stopped by the increased quantity of coagula, and the tumor begins to diminish. It is from facts of this kind that Mr. Wardrop deduces what he calls "a new principle for operating in aneurisms, so situated as hitherto to have been considered beyond the reach of art, and to which the Hunterian principle of operating is totally inapplicable." (*On Aneurism*, p. 15, 8vo. Lond. 1828.) Mr. Wardrop observes, that the changes produced by Brasdor's method, both in the artery and the sac, are precisely those which Nature employs when she cures the disease by a spontaneous process. No sooner is the ligature applied on the distal side of the aneurismal tumor, than, as after the Hunterian plan, the anastomosing vessels dilate, and perform the function of the obliterated or obstructed trunk. The cases in which the operation has been done, prove also what would not have been expected, that the tumor, directly after the application of the ligature, diminishes, instead of undergoing enlargement. "If the circulation be turned into a new channel, and if that channel completely fulfil the purpose, the sac, with its contents, as well as the portion of artery extending between the aneurism and the ligature, and also the blood contained in it, will now be in a passive state; and though the blood will continue, for a certain time, to be influenced by the impulse of the circulation, carried on in that part of the vessel which passes into the tumor, still its motion mus become not only languid, but its current irregular, a state which, we know, admits of its speedy coagulation. Whenever the coagulation of the blood does take place, then the cure of the aneurism may be said to be accomplished; the sac will contract; the coagulum will be absorbed; some portions in contiguity with the sac will become organised, and consolidate; others, if the quantity be very large, will escape by a process of ulceration through the skin; and ultimately a gradual coalescence of the tumor will thus take place." (*Wardrop*, p. 20.) In the summer of 1825, this gentleman first tried Brasdor's method. The case was a carotid aneurism, in a female seventy-five years of age. The disease was so close to the clavicle, that it was quite impracticable to tie the vessel on the cardiac side of the tumor. Immediately the artery was tied, the swelling underwent a diminution. On the fourth day, it had lessened by one third. Afterwards the throbbing continued strong for a few days, at the expiration of which it became obscure, and at the same time the tumor began to diminish again. Previously to the complete cure, ulceration occurred, and several large masses of coagulated blood were discharged, along with some healthy pus. Three years after the operation, the patient continued to enjoy good health.

December 10, 1826, Mr. Wardrop attempted a similar operation for the cure of a carotid aneurism in another woman aged fifty-seven. Some reduction of the throbbing, and other relief, are stated to have ensued; but the patient died of a complication of complaints on the 23rd of the following March, 1827. "Up to the day of her death, a tumor remained in her neck, of about the bulk of an almond, which pulsated strongly, felt very thin in its coats, and its contents could be readily squeezed out of it, but returned rapidly when the pressure was removed." (P. 33.) In the dissection it deserves notice, that *the carotid was found completely pervious*, and that *no cicatrix, nor other appearance, enabled Mr. Bennett to ascertain the precise point to which the ligature had been applied.* (P. 35.) These circumstances might raise a doubt about the artery having been tied at all; but, supposing the ligature to have been duly applied, they prove to my mind the failure of the operation, inasmuch as the tumor and carotid artery were probably in almost the same state as if nothing had been attempted. The blood passed freely through them, and was not compelled to circulate through new channels. Without wishing however, to enter into the question whether the artery were tied or not, I shall dismiss this example with two plain inferences: first, that, if the artery were tied, the operation failed to bring about the desired obliteration of the vessel, and coagulation of the blood in the swelling; secondly, that if it were not tied, what was done is neither favourable, nor unfavourable, to the practice of which we are now considering the merits. A third example of the operation is reported in vol. xii. of the *Lancet*. The carotid was tied above the aneurism by Mr. Lambert, March 1st, 1827, in the presence of Mr. Wardrop, Mr. B. Cooper, and Mr. Calloway. On the third day the tumor seemed much consolidated and reduced in size. On the tenth day, there was some bleeding from the wound; but it was suppressed by the application of a compress wet with cold water; and in a few days the swelling had entirely disappeared, and all that could be felt of it, on pressing the finger deeply down, was a small hard tumor, having a very faint undulatory thrill. Unfortunately, this patient, also a female, fell a victim to hemorrhage on the 1st of May, in consequence of ulceration extending from the cicatrix through the platisma myoides to the artery. Without detailing other appearances noticed in dissection, suffice it to mention, that "at the root of the right common carotid artery was a consolidated tumor, of a pyramidal shape. A probe could not be passed upwards from the arteria innominata, and water forcibly injected at this part would not pass, so completely and effectually closed was the lower part of the carotid artery. On making a longitudinal section of the tumor, we observed at its lower part a firm coagulum of blood, of about the size of a French olive. It accurately closed the opening at the base of the carotid, and it was this which afforded the resistance to the probe and injection of water passing upward from the arteria innominata. The coats of the artery surrounding the coagulum were thickened to about four times their natural size, and lined by a thin layer of fibrine. Above the coagulum, the coats of the artery were thickened to the extent of at least six times their natural size, and, in addition to a layer of fibrine closely adherent to the inner surface of the artery, and continuous with that surrounding the coagulum at the lower part of the tumor, there were three other layers of coagulated lymph.—At the upper part of the thickened portion of the artery, and just above the omo-hyoideus, where the ligature had been applied, was an ulcerated opening on the anterior and tracheal surface of the carotid artery, a quarter of an inch in length, and rather less in breadth, covered by a coagulum of dark-coloured lymph, communicating with the opening in the integuments." This case, according to my judgment, must be received as another proof that Brasdor's method is capable of producing those changes in the tumor, artery, and circulation, which, if not succeeded by some accidental untoward occurrence, like the ulceration, leading in this case to fatal hemorrhage, may bring about the perfect cure of the disease.

If any doubt remained of this fact after the cases already cited, it would be dispelled by the results of some other trials of the practice, and more particularly by the history of the case of Mary Covis, aged thirty-six, on whom Dr. Bush operated, under very trying and difficult circumstances, with complete success. (*Lancet*, vol. i. 1828.) The tumor extended from the clavicle, on the right side, upwards nearly to the os-hyoides, pressing the trachea towards the opposite side, and passing under the sterno-mastoid muscle, to nearly an inch beyond its outer border. For nine days previously to the operation, the patient had not been able to swallow anything; her respiration was alarmingly obstructed, and her voice nearly lost. In the operation, the artery immediately above the aneurism was found dilated, not more than half an inch of its extremity being sound, and on this a single silk ligature was placed. As soon as the artery was tied, the tumor became softer and less prominent; and though she had not swallowed any thing for nine days, she took, before the wound was dressed, about ten ounces of wine and water. The operation was performed September 11th, 1827. April 19th, 1828, the woman was in perfect health. There was then scarcely a remnant of the tumor; the inordinate action of the heart had ceased; and respiration and deglutition were natural. The facts recorded seem to Mr. Wardrop to prove, that the future growth of an aneurismal tumor may be arrested, and the disease cured, by placing a ligature on the distal side of the sac, especially if no branch of the artery intervene between the sac and the ligature; for, if a considerable branch, and one that afterwards enlarged sufficiently, were to be in this situation, the operation would have little or no effect in producing any diminution of the impetus of the blood in the aneurism, from the cavity of which the blood would pass as freely into the enlarged branch, as it previously did along the trunk itself. Hence we see why Brasdor's operation will probably be attended with greater success on carotid than other aneurisms, the common carotid artery giving off in its course no branches which would interfere with the principles of the practice. Of five operations of this description, which had been performed on the carotid artery at the period when M. Lisfranc published on aneurism, three were completely successful; and of the other two, one performed by Mr. Wardrop in December, 1826, and the other by Mr. Montgomery, at the Mauritius, in 1829, the particulars leave doubts whether in one instance, the carotid artery had been tied, and whether the case was a carotid aneurism; and whether, in the other, the disease had not been an aneurism of the arch of the aorta. (See *De l'Oblitération des Artères*, p. 100, 150; and *Dupuytren, Clin. Chir.* t. iv. p. 593.)

Mr. Wardrop himself regards Brasdor's operation as not merely applicable to examples, in which it is impracticable to place a ligature on the cardiac side of the sac, but as likely to merit the preference when the tumor is large, and likely to inflame after the circulation through the sac is interrupted. This inference he makes from the fact of the immediate diminution of the swelling, which has usually followed the application of the ligature on the distal side of the aneurism. He also deems it probable that, in this method, there is less risk of hemorrhage from the part of the vessel on which the ligature is applied, than in the Hunterian operation. On the principle that it is sufficient for the cure of an aneurism, that the impetus of the blood through it be diminished, as the deposit of lamellated coagula within the sac will then increase, Mr. Wardrop urges the propriety of extending Brasdor's method to aneurisms of the arteria innominata; but the very interesting and valuable cases which are adduced in confirmation of his views of these particular aneurisms, will be more conveniently noticed in the sequel, where reference also will be made to some instances in which Brasdor's operation was practised for the cure of inguinal and subclavian aneurisms. As an admirer of the improvement of surgery, I must not quit this part of the subject, without expressing the conviction that I entertain of the service which Mr. Wardrop has rendered the profession and the public by his able and enlightened view of a valuable operation, which, without his exertions and example, might long have remained quite neglected, or briefly mentioned in the history of surgery as a dangerous proceeding, unworthy of further trials.

That Brasdor's operation must sometimes fail, and particularly that it should have failed in the trials made of it by Deschamps, Sir A. Cooper, and Mr. Anthony White (see *Guthrie*, *On Dis. of Arteries*, p. 90) is not surprising. All these cases were inguinal aneurisms; and it does not follow because the method will answer in carotid aneurisms that it will answer in aneurisms in every other situation. I should say, indeed, that unless it retard *in a certain degree*, the circulation through the sac, or bring on considerable and deep inflammation of the parts, it will never answer in any case; and how much the first of these occurrences must depend upon the existence, or not, of one or more branches between the sac and the ligature, is completely obvious. It is no trivial consideration in favour of this method, that it had the approbation of the celebrated Dupuytren, who observes, that it is the only resource when an aneurism, situated too near the centre of the circulation, continues to increase, notwithstanding debilitating treatment and cold applications. As for the operations performed by Deschamps and Sir Astley Cooper, he expresses his conviction that their failure was owing to the origin of some important branch between the ligature and the aneurismal sac. When, however, no branch, capable of maintaining the circulation in the sac, is situated between this and the ligature, Dupuytren joins Wardrop, and others, in representing the probabilities of a cure as very great. The result, he adds, may also be favourable, although a few small branches may originate near the aneurism, because the coagulum, which is formed in the sac and internal trunk, will be likely to extend into them. But, says he, the presence of considerable branches, such as are capable of impeding the blood in the tumor from assuming a solid consistence, must evidently render the operation useless. Nay, what is worse, it may accelerate the fatal progress of the disease; because, when the blood has only a narrow outlet on the distal side of the aneurism, nature will make a perpetual effort to enlarge it, and in this progress the sac will be more and more distended. (*Dupuytren*, *Clin. Chir.* t. iv. p. 592.) The example in which this eminent surgeon tried this practice on the axillary artery will be presently noticed. The fact of the general failure of Brasdor's operation when any considerable vessels arise from the sac, or artery, on the cardiac side of the ligature, and the greater success that has attended such operations when performed for carotid aneurism than any other form of this disease, seem to me to justify the view of the principles on which this operation sometimes brings about a cure, entertained by Hodgson, Wardrop, and Dupuytren. I make this remark, fully aware of the suggestion of Mr. Guthrie, that the cure, so far as it goes, is affected by inflammation of the artery and sac, and not by the mere coagulation of the blood in them. (See *Guthrie*, *On Dis. of the Arteries*, p. 179.) He also enters into an inquiry how far the communicating of inflammation to an aneurism so near the heart as an aneurism of the innominata or lower part of the carotid, is an advisable proceeding. He argues, that too much inflammation kills the patient, while too little is insufficient to effect a cure. In support of his reasoning, Mr. Guthrie takes a different view of Mr. Montgomery's case from what that gentleman himself does; and on the following grounds: — "An aneurismal sac, of the size described in the first part of the case, never could disappear in four months by any of the processes of nature, or after any operation performed for its cure, with which we are at present acquainted; more particularly as the remains of the artery and vein were discoverable, although obliterated, by which I understand them to have become impervious. *There never was then an aneurism of the carotid;* but the aneurism, which was found to exist between the origin of the left carotid and the innominata, had formerly extended up the neck, so as to resemble an aneurism of the carotid. The operation on the carotid gave rise to inflammation, which extended first to the arch of the aorta, and to the aneurismal sac, and afterwards along the aorta to the heart and pericardium, which, in the end, destroyed the patient." (See *Guthrie*, *On Dis. of Arteries*, p. 198.) Whatever may have really happened in this instance, it will not form an adequate ground for the rejection of Brasdor's operation in examples where the aneurism is truly one of the carotid, and a ligature cannot be applied below the tumor. Indeed, M. Lisfranc argues, that Mr. Guthrie's objection of the inflammation being likely to be propagated to the heart, has no weight at all; for, says he, "If this consequence is so greatly dreaded after the ligature is placed on the distal side of the sac, how much more so must it be, when Anel's method is pursued! Besides, is the fear of such inflammation, which is after all very uncertain, a sufficient reason for renouncing the only hope of saving the patient?" (*Lisfranc*, *De l'Oblitération des Artères*, p. 97.)

In this article I have not yet mentioned the proposal made by Dr. Jameson, of Baltimore, to substitute for the ligature a seton composed of thread, or of a piece of doe-skin. The carotid of a sheep was transfixed with a needle, armed with a slip of doe-skin of a conical shape, three lines broad at its greatest extremity. The two ends of it were cut off three lines from the vessel. There was no hemorrhage during the operation. The animal was killed on the twenty-second day; and the coats of the artery were found considerably thickened for an inch above and below the seton. On one side of the vessel there was no trace of the wound; but, on the other, there was a slight depression, containing a yellowish substance, which proved to be a small particle of doe-skin. The parietes of the artery were in contact, and every where united, excepting a flattened aperture, capable of admitting a small probe. The same experiment was repeated on the carotids of dogs by Dr. Jameson, and also by M. Worms, at the Val de Grace, in Paris, with similar results. M. Amussat varied the process by puncturing the artery with a curved needle, armed with a common thread, which was conveyed up within the tube of the vessel about an inch, and then brought out through the side of the vessel, by means of the needle. Then the ligature was drawn further up, till its lower end was entirely within the artery. A knot was next made near the vessel, and the rest of the ligature cut off. In small arteries, a clot was produced round the thread, and the artery became obliterated. In vessels above a certain size, no clot was found.

With respect to setons, as substitutes for the ligature in the treatment of aneurism, I am of opinion that they promise no advantage whatsoever, and as being less likely to produce the desired obliteration of the artery, should never be employed on the human subject. I entertain the same opinion of acupuncture, which has been tried by M. Velpeau, M. Amussat, and Mr. Benjamin Phillips, on the arteries of animals. In some of these experiments, one or more needles or pins were thrust through the arteries without any preliminary exposure of these vessels; while, in others, the arteries were first laid bare. The accounts given of these experiments prove, that the obliteration of the vessel by the plan is a matter of great uncertainty; and that in several instances, where the attempt was made to transfix the artery through the undivided coverings, either it was not hit at all, or only pierced very near one of its sides. (*Lisfranc, De l'Oblitération des Artères*, p. 77; also *Mr. B. Phillips, On the Cure of Aneurismal Tumors without the Knife or Ligature.*) Besides, it is doubtful whether the arteries of the human body can be so easily rendered impervious, or the process of reparation be so favourably carried on in them, as in the arteries of animals. As Mr. Guthrie observes, it is probable that a simple puncture with a needle would sometimes heal; but he has seen two instances, "in which the femoral artery was wounded with a tenaculum, and ulceration followed by hemorrhage, took place in both, requiring application of a ligature." (See *Guthrie, On Dis. of Arteries*, p. 212.)

I shall finish these general observations on the treatment of external aneurisms, or such as admit more particularly of surgical treatment, with observing, that, in England, surgeons now lose few patients either from gangrene of the limb or secondary hemorrhage; and this, notwithstanding they may sometimes prefer applying a ligature above the profunda to cutting open the aneurismal tumor. I firmly believe, that such matchless success is to be ascribed to the perfection in their mode of operating; the choice of a proper kind of ligature; the right plan of applying it; the rejection of the employment of several ligatures at a time; the great care taken to promote the healing of the wound as quickly as possible; the avoidance of all unnecessary and hurtful extraneous substances in the wound; and, above all, the relinquishment of the formidable proceeding of cutting open the tumor.

In the consideration of particular aneurisms, I shall begin with those which may be cured by a surgical operation; and here we shall be fully satisfied that "*l'art de guérir ne triomphe jamais plus heureusement que lorsqu'il peut employer la médecine efficace, c'est à dire, les moyens chirurgicaux ou opératoires.*" (*Pelletan, Clinique Chir.* t. i. p. 110.)

Of Popliteal Aneurism, and Operation for its Cure.

Notwithstanding the solitary example in which M. A. Severinus, early in the 17th century, tied the femoral artery near Poupart's ligament in a case of aneurism (*De Efficac. Méd.* lib. i. p. 2, c. 51), the practice of tying arteries wounded either by accident or in the performance of surgical operations, and even the plan of tying the brachial artery for the cure of aneurism at the bend of the the arm, were known long before the operation for the relief of popliteal aneurism was attempted. The considerable size of the femoral artery, its deep situation, the urgent symptoms of the disease, and ignorance of the resources of nature for transmitting blood into the limb after the ligature of the vessel, are the circumstances which appear to have deterred former surgeons from this operation.

Valsalva treated popliteal aneurisms on the debilitating method, and published one or two equivocal proofs of its success. In Pelletan's first memoir on aneurism, and in the 3rd vol. of Sabatier's *Médecine Opératoire*, as I shall hereafter notice again, are two cases of axillary aneurisms, which were cured by Valsalva's treatment. But encouraging as such examples may be, experience is not yet sufficiently favourable to this practice to allow it to bear a comparison, in point of efficacy, with the surgical operation, or to justify the general rejection of this last more certain means of cure. As Pelletan admits, Valsalva's treatment is extremely severe; the event of it doubtful; and were the plan to fail, the patient might not be left in a condition to bear an operation, for the success of which it seems necessary that a certain strength of vascular action should exist, in order that the blood may be freely transmitted through such arterial branches as are to supply the places of the main trunk after it has been tied. The time, therefore, has not yet arrived when surgical operations for the relief of aneurisms can be relinquished. (*Clinque Chir.* t. i. p. 114.)

[Femoral and popliteal aneurisms may usually be successfully treated by the compression of the artery in the groin, by means of Carte's compressor, or some similar instrument applied in accordance with the principles already laid down. In no cases of aneurism is compression so serviceable as in these, and it should, as a general rule, be had recourse to in the first instance. In the event of its failing from some untoward accident, the ligature of the femoral artery may then be undertaken.]

Aneurisms in general, and, among them, the popliteal case, are all attended with some little chance of a spontaneous cure; yet this desirable event is too uncommon to be a judicious reason for postponing the operation, especially as it is the usual course of the disease to continue to increase; while, in the early stage, the cure may be more speedily accomplished. In fact, when the patient is not too much debilitated, the experience of modern operators leaves no ground for apprehending that the anastomoses will not suffice for the due nourishment of the leg, and consequently proves, that waiting beyond a certain time for the enlargement of the collateral vessels to take place is altogether an unnecessary and a disadvantageous method. Popliteal aneurisms, as well as other external tumors of the same nature, stand some chance of a spontaneous cure, when any cause induces a general, violent, and deep inflammation all over the swelling; for, then the communication between the sac and the artery is likely to become closed with coagulating lymph, and the pulsation of the tumor to be suddenly and permanently stopped. If, in this state, the disease sloughs, and the patient's constitution holds out, the coagulated blood in the sac and the sloughs are gradually detached, leaving a deep ulcer, which ultimately heals. An example, in which a popliteal aneurism was cured by such a process, is related in the *Trans. for the Improvement of Med. and Chir. Knowledge*, vol. ii. p. 268.

In former times, when all hopes of curing a popliteal aneurism by Valsalva's method, by compression, or a natural process, were at an end, amputation of the limb was considered as the sole and necessary means of saving the patient's life. But, about seventy years ago, the confidence of surgeons in the sufficiency of the anastomosing vessels for the continuance of the circulation began to increase; and, in opposition to the tenets of J. L. Petit and Pott, experience soon proved, that, in general, not only might the patient's life be saved, but his limb also, and this without any operation that could be compared with amputation, in regard to severity. On looking back to the history of amputation, we shall find that A. N. Guenault was one of the earliest writers who disapproved of amputation as not truly necessary in cases of popliteal aneurism.

It is alleged that Teislere, Molinelli, Guattani, Mazotti, and some other celebrated Italian surgeons, were the first who ventured to tie the popliteal artery for the cure of aneurism. The path, as Pelletan remarks, had been pointed out to them by Winslow and Haller, whose valuable descriptions and plates of the arterial anastomoses about the knee-joint, showed by what means the lower part of the limb would be nourished, after a ligature had been placed on the principal arterial trunk. For almost thirty years, however, the practice of tying the popliteal artery was confined to the Italian surgeons. Pelletan believes that he was the first who attempted such an operation at Paris, nearly thirty years ago (alluding to about the year 1780, the *Clinique Chirurgicale* being dated 1810).

However, this operation of opening the tumor and tying the popliteal artery itself, was a severe and often a fatal proceeding, and does not admit of being compared with the Hunterian operation, in point either of simplicity, safety, or success, as I shall explain, after the detail of a few particulars relating to the popliteal aneurism.

On whatsoever side of the artery the tumor is produced, it can be plainly felt in the hollow between the hamstrings, and in general its nature is as easily ascertained by the pulsation in every part of it. In the early stage of spontaneous aneurism, the swelling is soft, not usually accompanied by pain, and capable of being lessened by pressure, and more particularly by compression of the artery above the tumour, whereby the flow of blood into it is stopped, or materially diminished. The pulsation then ceases, but is restored on the compression being removed; and with the return of the pulsation, and that of the swelling to its original size, a peculiar thrilling feel is experienced, arising from the passage of the blood into the aneurism again from the artery, and termed by the French *bruissement*, because attended with a confused rattling sound. After the swelling has existed a little while, the *bruit de soufflet*, or bellows sound, is likewise more audible, especially when the stethoscope is employed. At length the tumor becomes firmer, and the blood cannot be entirely pressed out of it, because the interior of the sac is now more or less covered by solid lamellated blood. The patient, in order to avoid bearing much on the affected limb, limps in the early stage of the case; but, "as the aneurism increases, he does so from two causes—the pressure which takes place on the nerves passing to the toes, and which gives rise to pain, not in the part affected, but in that to which the terminations of the nerves are distributed; and, from the same cause, giving rise to contraction of the muscles and rigidity of the tendons passing behind the joint, the leg is permanently bent; the toes and leg are extremely painful; and the foot and leg, incapable of bearing the weight of the body, become swelled and œdematous." (See *Guthrie, On Dis. of the Arteries*, t. i. p. 109.) Sometimes, however, the patient, even in the spontaneous form of the disease, does complain of great pain in the ham, and of numbness in the leg and foot, instead of pain in those parts. (See *Case by Collis, in Dublin Journ. of Med. Sci.*, vol. v. p. 33.) The symptoms of a popliteal aneurism, as they present themselves, when the sac gives way under the integuments and fascia, or under the heads of the gastrocnemius, I need not repeat as they have been noticed in the general observations on aneurism. The progress of a popliteal aneurism differs in different examples; being sometimes slow, in other instances rapid. Mr. Collis had a patient with an aneurism in each ham, and the disease continued almost stationary from 1818 to 1833, during all which time so little inconvenience was experienced by the patient, that he was able to discharge the fatiguing duties of an infantry soldier. (See *Dublin Journ. of Med. Science*, vol. v. p. 32.) I had a patient with popliteal aneurism, who, in his business of an organ-builder, used to ascend ladders, and lead a very active life for a considerable length of time; indeed, until the sac gave way, and the disease changed into the diffused form. (See *Med. Chir. Trans.* vol. xvi.) Though the disease may not occur in the popliteal artery so often as in the aorta itself, it certainly is seen more frequently in the former vessel than any other branch derived from the aorta. As Sir E.

Home has observed, this circumstance has never been satisfactorily explained; and, what is rather curious, in many instances of this disease, the patients have been coachmen and postillions. Morgagni found aneurisms of the aorta most frequent in guides, post-boys, and other persons who sit almost continually on horseback; a fact, which he imputes to the concussion and agitation to which such persons are exposed. Some allusion to this subject has already been made in the foregoing pages. Whether an explanation of the frequency of popliteal aneurisms can be correctly referred to the force with which the blood must be impelled against the bend of the artery when the knee is in a state of flexion, seems questionable, though it is on a similar principle that the great frequency of aneurisms of the curvature of the aorta is attempted to be solved. (*Home, in Trans. for the Improvement of Med. and Chir. Knowledge*, vol. i. &c.; and *Monro, in Ed. Med. Essays*, vol. v.) Were this the only, or even the principal cause, surely one would have reason to expect aneurisms to be at least as frequent in the axilla, and in the bend of the elbow, as in the ham.

Popliteal aneurism was once supposed to arise from a weakness in the coats of the artery, independently of disease. If this were true, we might reasonably conclude, that, except, at the dilated part, the vessel would be sound. Then the old practice of opening the sac, tying the artery above and below it, and leaving the bag to suppurate and heal up, would naturally present itself. As the arterial coats were found to be altered in structure higher up than the tumor and the artery immediately above the sac, seldom united when tied, but, when the ligature came away, the patient was destroyed by hemorrhage, Mr. Hunter concluded, that some disease affected the coats of the vessel, before the actual occurrence of aneurism. Dissatisfied with Haller's experiments on frogs, showing that weakness alone could give rise to aneurism, he tried what would happen in a quadruped, whose vessels were very similar in structure to the human. Having denuded above an inch of the carotid artery of a dog, and removed its external coat, he dissected off the other coats, layer after layer, till what remained was so thin, that the blood could be seen through it. In about three weeks the dog was killed, when the wound was found closed over the artery, which was neither increased, nor diminished in size.

It being conjectured that the prevention of aneurism, perhaps, arose from the parts being immediately laid down on the weakened portion of the artery, Sir E. Home stripped off the outer layers of the femoral artery of a dog, placed lint over the exposed part of the vessel to keep it from uniting to the sides of the wound, and in six weeks killed the animal, and injected the artery, which was neither enlarged nor diminished, its coats having regained their natural thickness and appearance.

These experiments strengthened Mr. Hunter's belief, that aneurismal arteries are diseased; that the morbid affection frequently extends a good way from the sac along the vessel; and that the cause of failure, in the old operation, arose from tying a diseased artery, which was incapable of uniting before the ligature separated. These reflections led him to propose taking up the artery in the anterior part of the thigh, at some distance from the diseased portion, so as to diminish the risk of hemorrhage, and be enabled to get at the vessel again, in case it should bleed. The stream of blood into the sac being stopped, he concluded that the sac and its contents would be absorbed, and the tumor gradually disappear, so as to render any opening of it unnecessary.

The first operation of this kind ever done was performed on a coachman, by Mr. Hunter, in St. George's Hospital, December, 1785. An incision was made on the anterior and inner part of the thigh, rather below its middle, which wound was continued obliquely across the inner edge of the sartorius muscle, and made large, in order to facilitate the performance of whatever might be necessary. The fascia covering the artery was then laid bare, for about three inches, after which the vessel itself could be felt. A cut, about an inch long, was then made through the fascia, along the side of the artery, and the fascia dissected off. Thus the vessel was exposed. Having disengaged it from its connections by means of the knife and a thin spatula, Mr. Hunter put a double ligature under it with an eye-probe. The double ligature was then cut, so as to make two separate ones. The artery was now tied with both these ligatures, but *so slightly as only to compress the sides together.* Two additional ligatures were similarly applied a little lower, with a view of compressing some length of artery so as to make amends for the want of tightness, as it was wished to avoid great pressure on any one part of the vessel. The ligatures were left hanging out of the wound, which was closed with sticking-plaster. On the second day the aneurism had lost one third of its size, and, on the fourth, the wound was every where healed, except where the ligatures were situated. On the ninth, there was a considerable discharge of blood from the apertures of the ligatures, but it ceased on applying a tourniquet, and did not recur. On the fifteenth day after the operation, some of the ligatures came away, followed by a small quantity of matter; and about the latter end of January, 1786, the man went out of the hospital, the tumor having become still less. In the course of the spring, abscesses in the vicinity of the cicatrix followed, and some pieces of ligature were occasionally discharged. In the beginning of July, a piece of ligature, about one inch long, came away, after which the swelling went off entirely, and the man left the hospital again on the 8th perfectly well, there being no appearance of swelling in the ham. This subject died of a fever in March, 1787, and on dissection, the fermoral artery was found impervious from the giving off of the arteria profunda down to the place of the ligature, and an ossification had taken place for an inch and a half along the course of this part of the vessel. Below this portion the vessel was pervious, till just before it came to the aneurismal sac, where it was again closed. What remained of the sac was somewhat larger than a hen's egg, and its communication with the popliteal artery was obliterated. The rest of the particulars of the dissection are very interesting. (See *Trans. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 153.)

This celebrated case completely established the important fact, that simply taking off the force of the circulation is sufficient to cure an aneurism, the tumor being afterwards diminished and removed by the action of the absorbent vessels. In order to confirm the same fact, Sir E. Home related a case of femoral aneurism, which got well without an operation, but on a similar principle to what occurs when the artery is tied. A trial of pressure had been made without avail. The tumor became very large, and such inflammation took place in the sac and integuments, that mortification was impending ; no pulsation could now be felt in the tumor, or the artery above it. The correct inference of Sir E. Home was, that a coagulum, which we know always occurs in an artery previously to mortification, seemingly to prevent bleeding, had formed in this instance, and, in conjunction with the effusion of coagulable lymph about the root of the aneurism, had kept the blood from entering the sac.

Mr. Hunter's second operation was on a trooper. Instead of using several ligatures, which were found hurtful, he tied the artery and vein with a single strong one ; but, unluckily, the experiment was made of dressing the wound from the bottom, instead of attempting to unite it at once, and the result was, that the man died of hemorrhage.

After this case, Mr. Hunter's practice was to tie the artery alone with one strong ligature, and unite the wound as speedily as possible.

Having recorded Mr. Hunter's cases, which first established the present method of operating for the cure of popliteal aneurisms, I shall not repeat the strong reasons which exist against the employment of reserve-ligatures ; metallic compressors ; two ligatures, with the division of the vessel between them ; the interposition of pieces of linen, wood, cork, agaric, &c. between the knot and the vessel ; the use of large ligatures ; and other contrivances, the merits, or rather demerits, of which have been already fully considered in the preceding section. My next duty is to explain the method of performing the Hunterian operation, as brought to its modern state of improvement, and adapted to the wise principles which first emanated from the valuable experiments and investigations of Dr. Jones. (See HEMORRHAGE.)

In the arrangement of the assistants, one of them should be so placed, that, if required, in consequence of any accidental wound of that vessel in the operation, he can compress the femoral artery as it passes over the brim of the pelvis ; but, as Scarpa justly observes, no pressure of this kind is to be made, unless the accident referred to should happen, because the pulsations of the artery, inasmuch as they indicate the track of the vessel, must tend materially to facilitate the operation. The surgeon is to explore with his forefinger the course of the artery from the crural arch downwards ; and when he comes to the place where the vibration of this vessel begins to be less distinctly felt, this *point is to be fixed upon for the lower end of the external incision.* This angle of the wound will fall nearly on the inner edge of the sartorius, just where this muscle crosses the track of the femoral artery, and at the very apex of the triangle formed by the convergence of the triceps and vastus internus. A little more than three inches above the place here fixed upon, the surgeon is to begin, with a convex-edged bistoury, the incision through the integuments and cellular substance, and carry the wound down the thigh, in a slightly oblique line, from without inwards, so as to make it follow the course of the artery, as far as the apex of the above-mentioned triangular space, or the point where the vessel passes under the inner edge of the sartorius muscle. In order to make this first external incision with correctness, I consider it a good rule always to take particular notice of the line described by the sartorius on the thigh, the inner margin of which muscle, at the place where it meets the artery, as we have seen, forms at once the lower boundary of the incision, and an important guide to the vessel itself. By observing the track of the sartorius attentively, we shall likewise avoid all chance of making the wound too low down, so as to have this muscle intervening between the incision and the artery ; a greater source of embarrassment in the operation, and of troublesome consequences afterwards, than, perhaps, any other error ; for when this has happened, and the surgeon has not room enough afforded by the higher part of the wound to get at the artery above the sartorius, he is compelled to dissect and raise up this muscle from its natural connections, ere he can plainly discover the vessel. This inconvenience made a deep impression on me in the first case where I tied the femoral artery ; for the intervention of the sartorius in a stout soldier, upon whom the operation was done, threw me into the dilemma of either dissecting at the outer edge of this muscle, and drawing it inwards, or of enlarging the wound upwards. The latter proceeding was that to which I gave the preference, because it seemed to me an excellent maxim in this operation, to avoid making any further detachment of parts from their natural connections than is absolutely necessary ; and I knew, that when the wound was extended a little higher up, the artery would present itself more superficially, quite unconcealed by any muscle whatever. In fact, in the superior third of the thigh, the anterior surface of the artery is covered only by the common integuments, the superficial fascia, the inguinal glands, the fascia lata, a little cellular tissue, and the arterial sheath. But in the middle third of the limb the vessel is more deeply seated, as, in addition to the skin, superficial fascia, fascia lata, cellular tissue, and arterial sheath, it is covered by the sartorius muscle, beneath which is a fascia composed of oblique fibres, passing from the tendon of the adductor longus and magnus muscle to the vastus internus. (See *Dr. Quain's Elements*, p. 506, ed. 2.) This last facia begins superiorly at the point where the sartorius first passes in front of the artery, and is here thin ; but, about the middle of the thigh, it is very dense. It terminates at the upper part of the inferior third of the thigh, in a well-defined edge, beneath which passes the nervus saphænus major. If this fascia be divided the femoral artery and vein will be exposed. (See *Harrison's Surgical Anatomy of the Arteries*, vol. ii. p. 136, ed. 2.) Anatomy teaches us, then, that the femoral artery may be more readily taken up in the superior third of the thigh than in the middle. Strongly, therefore, as my principles lead me to condemn Scarpa's modification of the ligature, his use of from four to six threads, and his interposition of a roll of linen between the knot and the vessel, I feel pleasure in expressing my conviction of one excellence in his mode of operating ; an improvement which is now obtaining, if it has not already obtained, the universal approbation of the surgical profession. This amendment consists in making the incision in the upper third of the thigh, or a little higher than the place where Mr. Hunter used to make the wound. Scarpa's reason for this practice is to avoid the necessity of removing the sartorius muscle too much from its position, or of turning it back, to bring the artery into view, so as to be tied. I have seen the best operators, even professors of anatomy, embarrassed, by having the sartorius muscle immediately in their way after the first incision; and as the vessel is more superficial a little higher up, not being covered there by the sartorius, or the dense fascia extended from the adductor muscle to the vastus internus lower down the thigh, while the place is further from the diseased part of the artery, and there is no hazard of the anastomoses failing to keep up the circulation, this part of Scarpa's practice is highly deserving of imitation.

"The part of the limb (observes Mr. Hodgson) in which the femoral artery can be tied with the greatest facility, is between four and five inches below Poupart's ligament. The profunda generally arises from the femoral artery an inch and a half, or an inch and three quarters, below Poupart's ligament: it very rarely arises so low as two inches. If, therefore, the ligature be applied to the femoral artery at the distance of four or five inches below Poupart's ligament, the surgeon will not be embarrassed by meeting with the profunda during the operation, and the chance of causing secondary hemorrhage, by tying the artery close to the origin of this vessel, will be obviated." (*On the Dis. of Arteries, &c.* p. 434.)

With the view of preventing injury of the femoral vein, Mr. Carmichael recommended a plan, which is now always followed, namely, that of introducing the needle on the pubic side of the artery, where the vein presents itself to view, and can be most easily avoided. He remarks, that the only part of the thigh, from Poupart's ligament to the tendon of the adductor magnus, in which the femoral vein is not completely covered by the artery, lies within the space which extends from Poupart's ligament to the point where the artery meets the sartorious muscle. At the part of this space most distant from Poupart's ligament, the vein begins to disclose itself at the pubic side of the artery, from beneath which it emerges more and more as it ascends. (See *Trans. &c. of the Fellows, &c. of the King's and Queen's College of Physicians, Ireland,* vol. ii. p. 357.)

[Wound of the femoral vein is without doubt the most serious accident that can happen in the operation for ligature of the superficial femoral artery, and is one of which there is especial risk when this operation is had recourse to for aneurism, as in this disease the fine cellular tissue which naturally connects the two vessels often becomes thickened and indurated, in consequence of inflammatory action having extended upwards from the sac to the sheath of the vessels. It is best avoided by passing the needle in the way that has been already recommended, unarmed, and without the employment of force. This accident is almost invariably fatal, there being but very few instances on record in which patients have survived it; death usually resulting from diffuse phlebitis, or the supervention of gangrene. The true cause of the fatal result in these cases was first pointed out by Mr. Hadwen, who showed that when the vein is wounded by the aneurismal needle, it is transfixed at two points, between which the thread is drawn across; and when this is tied, a segment of the vein is necessarily included with the artery in the noose. It is this inclusion of the ligature within a portion of the vein, where it acts like a seton, and keeps up constant irritation, that prevents the occurrence of adhesive phlebitis, and occasions diffuse inflammation in the interior of the vessel; and it is consequently this circumstance, and not the mere wound of the vein, that determines the great fatality of this peculiar accident. Guided by this view of the mechanism of the injury, the indications in its treatment become obvious. They consist in removing the ligature at once, and thus, by taking away the main source of irritation, converting the wound into a simple puncture of the vessel, which readily assumes adhesive action. The surgeon should therefore, as soon as the accident is perceived, withdraw the ligature, and opening the sheath about half an inch higher up, reapply it to the artery there. The hemorrhage from the punctured vein readily ceases on the application of a compress.]

The femoral vein, in a few rare instances, has been found double. Thus, in the case recorded by Mr. Macready, the popliteal vein, in the lower part of the popliteal space, "consisted of but one trunk, as usual, and held its natural situation, with respect to the surrounding parts; but in the upper third of the popliteal space, it divided into two branches, which passed off at an acute angle, having one of the muscular branches supplied by the popliteal artery in the apex of the angle. The veins then ascended; one, the internal and posterior, holding its usual position, with respect to the artery, namely, posterior to it at first, but getting internal as it ascended; the other branch crossed the artery, and ascended anteriorly, and a little externally to it, which relation it held until it arrived at the upper third of Scarpa's space, where it crossed the artery again, and then, uniting with the internal, formed the femoral, which appeared dilated into a sinus. The vein then had the usual relation to the artery, but was somewhat larger." (*Macready, in Dublin Journ. of Med. Science,* vol. ix. p. 318.) In the same volume, p. 325, Mr. Goodall has recorded another example of double femoral vein. In the latter, the external branch crossed the artery twice. This occasional variety in the femoral vein is important, in relation to the operation for popliteal aneurism.

The skin and superficial fascia are to be divided, in the situation and to the extent above specified, down to the femoral fascia, under which the artery lies, and may be felt beating. The next object, therefore, is to divide the fascia, which is here much thinner than at the outer side of the limb, and may be cut with another stroke of the bistoury; or, (what is safer, with the view of abstaining from all chance of wounding the artery,) a slight cut may first be made in the fascia, the division of which may then be made to the requisite extent by introducing under it a grooved director, on which the further incision may be made with perfect security. The fascia is to be divided in the direction of the external wound, but, to what extent, is a point on which surgical writers differ, and, indeed, they must here differ, so long as they are not unanimous about the me-hod of applying the ligature round the artery; because, if it be intended to use a broad ligature, with a cylindrical piece of linen interposed between it and the artery, or especially if it be designed to apply two ligatures and divide the vessel in the interspace, more of the artery must be exposed, and of course more of the fascia must be cut, than when it is simply meant to surround the vessel with a single small ligature. Such operators also as have contracted the pernicious habit of insulating the artery all round sufficiently far to let them thrust their fingers under it, will likewise require an extensive opening in the fascia. This detachment of the vessel for an inch or more, for the purpose of placing the finger under it, is a measure which deserves to be condemned in the strongest terms, as it is the very thing which produces some risk of injuring the saphena vein, and has a tendency to bring on secondary hemorrhage, inasmuch as it occasions unnecessary handling, stretching, and disturbance of the artery and surrounding parts, and an inevitable division of the vessels, by which the arterial coats are supplied with blood.

I shall suppose the fascia has now been divided, under which the surgeon distinctly feels the pulsations of the femoral artery, which is still invested by the cellular sheath. The femoral vein lies directly under this vessel, the nervus saphænus major, runs for some way upon the sheath of the vessels, and then penetrates it so as to get into contact with the anterior and external side of the vessel in the middle third of the thigh, care should be taken not to include it in the ligature. The next object, therefore, is to pass a single ligature round the artery, without including, or in any manner meddling with, the subjacent femoral vein, or detaching and disturbing the artery. For this purpose, the best direction is that given by my friend Mr. Lawrence, especially when combined with Mr. Carmichael's plan of letting the needle be introduced on the pubic side of the artery. "After dissecting down to the artery, a slight scratch or incision may be made through the sheath close to the side of the vessel. Then, with a narrow aneurism needle, nearly pointed at the end, and made as thin at its edge as it can be without cutting, a single silk ligature is to be conveyed round it, the point of the needle being kept in contact with the artery. A needle of this form makes its way easily through the cellular substance, and the vessel is detached only in the track of the instrument." (See *Med. Chir. Trans.* vol. iv.)

Dupuyrent and several other eminent French surgeons first pass a bent director under the artery, and then, by means of an eye-probe, which is pushed along the groove, convey the ligature under the vessel. This is an eligible method, when it is particularly desirable to see, before the ligature is passed, that nothing is raised but the artery itself.

Of the kind of ligature to be employed, I need only say here, that it should be a single one, composed of firm materials, in order to avoid the necessity for increasing its diameter more than would be desirable for reasons elsewhere considered. (See HEMORRHAGE and LIGATURE.) The ligature having been put under the artery, one end of it is to be drawn completely through the track made for it by the needle, which instrument is then to be taken away, leaving the ligature under the vessel. The ligature is now to be tied in a steady firm manner, but without any immoderate force, which can never be necessary even for the division of the inner coats of the vessel. In this part of the operation, a few practitioners give the preference to what is termed the *surgeon's knot*, and commend this plan of fastening the ligature; a plan, which consists in putting the end of the cord twice through the noose, before the constriction is made. The only good of the surgeon's knot is, that it does not so readily slip and loosen as a common one; but Scarpa thinks a simple knot best, as it does not, like the other, prevent the surgeon from calculating the force with which the artery is constricted. (*On Aneurism*, p. 281, ed. 2.) A better reason against the surgeon's knot, is the irregularity with which a ligature in this form will lie round the vessel. A simple noose should therefore be first made and tightened, and then a second one, so as to form a common knot; and now, as a matter of precaution against the possibility of the ligatures slipping and becoming loose, the surgeon, if he pleases, can tie the knot once again. One end of the ligature is next to be cut off near the knot; and the sides of the wound are to be brought together with strips of adhesive plaster, or by the interrupted suture. The remaining end of the ligature should always be brought out at the nearest point of the external wound to the knot on the artery.

If by any accident the artery be pricked in the operation, a double ligature should be passed under the vessel, and one part of it tied above, the other below the puncture. Thus, Mr. Collis, in endeavouring to separate the artery from the vein, "made a small opening, about the size of a pin's point, into the artery, from which a rapid jet of blood took place. The artery was immediately compressed against the os pubis, and a double ligature applied, one part of which was tied upon the highest exposed portion of the vessel, and the other upon the lowest, leaving between both about a quarter of an inch of the artery." (See *Dublin Journ. of Med. Science*, vol. v. p. 31.) The case ended favourably, and illustrates what should be done under similar circumstances in other operations for aneurisms. The manner of taking up the femoral artery in the middle third of the thigh, and in the groin, will be described under the head of ARTERIES.

The effects which, in general immediately follow the operation are a total cessation of the pulsation of the aneurismal tumor; a manifest sinking and flaccidity of the swelling; a diminution of pain in the seat of the disease; and a strong vibration of the articular arteries round the knee. As Mr. Hodgson has remarked, the unusual influx of blood into the minute ramifications, when a main artery is suddenly rendered impervious, is generally attended with a remarkable increase in the temperature of the limb. After tying the femoral artery for the cure of popliteal aneurism, the same phenomenon occurs, at least after a short time, during which the temperature of the leg and foot frequently continues lower than that of the sound limb. But, in a few hours, it generally rises, and is sometimes several degrees higher than that of the opposite member. This state lasts several days, at the end of which time, the heat of the limb which had been operated upon will be found to be about the same as that of other parts of the body. (*Hodgson, On Diseases of Arteries, &c.* p. 356.) It is only while the limb is colder than natural, that it ought ever to be fomented, or covered with flannel. In particular examples, there is no increase of temperature in the limb at any period after the operation; a fact, which Mr. Hodgson refers to the probability of a collateral circulation having already been established, in consequence of the obstruction to the passage of the blood through the main artery by the accumulation of the coagulum in the aneurismal sac. Of course, unless a collateral circulation be established, the operation cannot succeed, as the limb will mortify: it behoves us, therefore, to be aware of the circumstances which may prevent the due transmission of the blood to the inferior part of the limb. These are ably explained and commented upon in Mr. Hodgson's work: 1st, An extensive transverse wound, by which the principal anastomosing branches are divided. 2ndly, Tigh, bandages and pressure operating so as to obstruct the same vessels. 3rdly, The immense bulk of the tumor, and the pressure upon the principal collateral arteries. 4thly, Calculous depositions in the coats of the arteries of the limb. 5thly, Advanced age. 6thly, A languid state of the circulation; a fact, indicating the wrongness of venesection, as a general practice after the operation, though it may yet be right to adopt this treatment, where the pulsations return in the tumor with unusual strength, and appear to stop the diminution of the swelling. 7thly, The abstraction of heat from the limb by cold evaporating lotions; a plan which can only be right when there is a great increase of heat in the limb, a tendency to inflammation, or a return of strong pulsation in the tumor.

Sir Astley Cooper saw a case, in which the application of white-wash occasioned mortification and the patient's death. In cold weather, he always covers the limb with flannel, or a stocking, and sometimes puts jars filled with hot water to the feet. (See *Lancet*, vol. ii. p. 42.)

If secondary hemorrhage were to occur, ought we to take up the artery higher up, or have recourse to direct pressure on the bleeding point? In one case under Mr. Colles, he applied a compress, pressed down with a screw affixed to an iron hoop about half an inch in breadth, and sufficiently long to encompass the thigh. With this instrument, any degree of pressure could be made on the artery, whilst little or none was made on other parts, and the collateral circulation remained free. The bleeding returned once, but was at length permanently stopped. "My chief object (says Mr. Colles) in recording this case, is to show the advantage to be derived from pressure properly made, in arresting secondary hemorrhage from such a vessel as the femoral artery, and the greater benefit likely to arise from such a mode of proceeding than from tying the artery higher up, which, in the majority of cases in which it has been tried, has failed of saving the life of the patient. (See *Dublin Journ. of Med. Science*, vol. v. p. 36.) Sometimes pressure will answer, and then the ligature of the artery higher up becomes unnecessary; but pressure may not succeed. In an interesting case under Professor Regnoli, the femoral artery was tied in the upper third of the thigh, and secondary hemorrhage took place about a week after the operation. The bleeding was suppressed for a time by pressure on the bleeding point, and the application of a bladder filled with ice to the wound. The hemorrhage returned, however, and Regnoli decided to take up the external iliac artery. This measure permanently stopped the bleeding; and, *though the artery was so completely ossified*, where it was tied, *that, on tightening the ligature, a remarkable crepitation was distinctly heard, and it was even apprehended that the ligature had broken the vessel completely through*, the ligature came away on the eighteenth day, without any bleeding. The artery, in fact, had become obliterated. In the end, however, the patient died of gangrene in the leg. (*Istoria, &c. intorno un Aneurisma Popliteo*, Pisa, 1833, p. 26, &c.)

When the operation is done according to the principles laid down in this article, the patient is not too old nor enfeebled, and the after-treatment is properly conducted, mortification cannot be said to be a frequent event. In one case, operated upon by Sir Astley Cooper in 1823, the whole of the foot and part of the leg mortified; but it should be noticed, that in this instance, the whole limb was extremely swollen previously to the artery being taken up. (See *Lancet*, vol. i. p. 436.) In all his extensive practice, he has seen but three or four instances of a failure of the operation from gangrene. (*Lectures, &c.* vol. ii. p. 60.) Mr. Liston has related one example, which he ascribed to the improper use of fomentations with hot salt water. (See *Edinb. Med. Journ.* No. 90, p. 3.) As, however, the patient seems to have been of a very phlogistic diathesis, and to have been attacked with inflammation of other parts, the reality of the alleged cause appears questionable. I have seen but one example of gangrene, and in that only one toe, and a portion of the skin of the instep, sloughed in a very debilitated subject. This partial gangrene of the foot was particularly noticed by Deschamps and Scarpa, the latter of whom regards it as an unusual thing, only likely to happen in old, weak, or unhealthy subjects; and "at any rate (says he), if this should happen in any of these enervated individuals, the patients may console themselves for the loss of one or two of their toes, with the cure of a popliteal aneurism, and the avoidance of a painful and dangerous incision in the ham, and of the tedious suppuration which would have followed it."

Sir Astley Cooper has known retention of urine brought on by the operation in one or two examples, and the use of the catheter indispensable. (*Lectures, &c.* vol. ii. p. 58.) Sir Charles Bell met with a case in which the femoral artery divided below the profunda into two equal branches, the most superficial of which was alone noticed and tied in the operation. The patient died of constitutional disturbance, arising from inflammation in the whole course of the sartorius. After two or three days, the pulsation of the tumor, which had been very strong, ceased in consequence of the coagulation of the blood within the sac; another fact exemplifying that this desirable change will not be prevented by a current of blood being still propelled through the aneurismal cavity. (See *Quarterly Journ.* vol. iii. p. 607.)

Mr. Liston has recorded a case, in which the pulsation and tumor returned several months after the operation. "On consulting with Dr. Thomson, it was agreed to try the effect of methodical bandaging, from the points of the toes upwards, and a compress over the tumor, with rest, cold applications, and moderate diet." These means had the desired effect; and the patient did not complain much of those pains which so frequently remain after the operation for aneurism.

According to Mr. Liston, these pains are in general distinctly referrible to the sacro-ischiatic nerve and its branches, and are explained by the state of the vessels in the substance of the nerve. In the natural state, the neurilemal vessels, when injected, are not larger than sewing threads; but, when the enlargement of the collateral branches is requisite, owing to the obstruction of the trunk, they also are called on to contribute their share in the new circulation; and they become enormously distended. In one remarkable specimen, in which the limb was injected and examined fifteen years after the superficial femoral artery had been secured for aneurism in the ham, the vessels in the sacro-ischiatic nerve had attained the size of crow-quills, and were convoluted in an extraordinary manner. The pains in the limb, noticed by Mr. Liston as occurring after the operation, he acknowledges, however, are by no means so severe as those experienced previously, and which are produced by the compression and stretching of the nerves by the sac. (*Edinb. Med. Journ.* No. 90, p. 2.)

[The ligature of the femoral artery for popliteal aneurism is, on the whole, a very successful operation. Of 110 cases recorded by Dr. Crisp, only 12 proved fatal; of these 4 died of secondary hemorrhage, and 3 of gangrene of the limb.]

When the operation succeeds, a considerable portion of the artery above the aneurismal tumor is rendered impervious, the vessel indeed being sometimes converted into a solid cord from the origin of the profunda to that of the tibial arteries. (*A. Cooper*, *Med. Chir. Trans.* vol. ii. p. 254.) In general, however, the obliteration of the artery is less extensive; a fact, particularly noticed in one of Mr. Hunter's cases (*Trans. of a Soc. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 153), and vainly urged by Deschamps, as a proof of the insufficiency of the new method. (See *Obs. et Réflexions sur la Ligature des principales Artères blessées, et particulièrement sur l'Aneurisme de l'Artère poplitée*, p. 76. Paris, 1797.) It appears from the observations of Mr. Hodgson, that the artery generally becomes impervious, for the space of three or four finger-breadths, at the place where the ligature is applied; below which part its tube is free, and continues so for some distance, when the obliteration again commences, and descends along a considerable extent of the popliteal artery to the origin of the inferior articular or tibial arteries. Thus, says this author, an insulated portion of the femoral artery preserves its cavity, from each extremity of which considerable anastomosing branches arise; the upper branches convey blood into the vessel, and the lower transmit it into anastomosing channels, that originate below the knee. (*On Diseases of Arteries*, *&c.* p. 278. (Now, as Mr. Hodgson is unacquainted with any case, except that recorded by Sir Astley Cooper, where, after the modern operation, the artery was obliterated from the seat of disease in the ham to the part at which the ligature was applied, he thinks it probable that, in most instances, a double collateral circulation exists in the limb, after this method of cure.

A preparation in the Museum of St. Mary's Hospital, admirably bears out the view here taken by Mr. Hodgson. It was obtained from a patient aged twenty-five, who died of an internal aneurism six months after the ligature had been applied to the femoral artery for the cure of a popliteal aneurism.

In consequence of the motion of the blood being more or less impeded in the aneurismal sac by the application of the ligature to the femoral artery, the aneurismal cavity soon becomes completely filled with coagula, which even block up the adjoining portion of the arterial tube. The coagulated blood in the sac is afterwards absorbed; and a gradual diminution, and final disappearance of the aneurism in the ham ensue; with the exception of a slight induration, which sometimes remains, composed of a remnant of the sac itself, or of the fibrous parts of the blood. This slight hardness in the cavity of the ham occasions no inconvenience, and does not hinder the patient from performing the motions of the knee and leg with quickness and safety. (*Scarpa*, p. 257, edit. 2.)

After the operation, the circulation is carried on principally by the arteria profunda, whose branches communicate with the articular arteries of the popliteal, and with arteries sent to the knee by the anterior and posterior tibial. Large branches in the sciatic nerve, sent off by the arteria profunda, communicate very freely with the popliteal artery, the articular, and branches of the posterior tibial. As Sir Astley Cooper has further explained, the freedom of anastomosis sometimes leads to a reproduction of an aneurism. The femoral artery was tied by Mr. Key, and the patient, after being discharged cured, returned with a painful tumor in the ham, attended with an obscure pulsation. The limb was amputated, and a large artery, passing to the tumor, and situated nearly in the usual place of the femoral, required a ligature. (*Lectures*, *&c.* vol. ii. p, 60.)

I shall now advert to a few facts in the history of surgery, which eventually led to the bold and successful operations performed at the present day, for the cure of aneurisms of the femoral and popliteal arteries. The earliest case, of which the particulars are recorded, amounting to a satisfactory proof that the lower extremity might be duly supplied with blood, notwithstanding the femoral artery had been tied high up in the thigh, is the example, related by M. A. Severinus, of a false aneurism of the thigh, about eight finger-breadths below the groin, caused by a musket-ball wound. In this instance, Severinus tied the femoral artery above and below the aperture in it, and not only was the patient's life saved, but the use of the limb also preserved. (*Chirurgiæ Efficacis*, p. 2, *Enarratoria.*) The next authentic case of the ligature of the femoral artery, is that reported by Saviard, where Bottentuit, in 1688, tied this artery on account of a false aneurism, the result of a sword wound, at the inner and upper part of the thigh. The surgeons, called into consultation, were immediately convinced that the only thing to be done was to take up the femoral artery; but they were fearful lest the patient should perish of bleeding ere the opening in the vessel could be found; and, in case the artery were secured, they apprehended that the obstruction of the circulation would be followed by mortification of the limb. The patient was therefore first prepared for his fate by the administration of the sacrament. A band was then applied round the upper part of the limb, and tightened by means of a stick, with which it was twisted, a piece of pasteboard being put under the knot, in order to render the constriction less painful. The tumor was then opened, the clotted blood extracted, and the opening in the artery detected by slackening the tourniquet. A curved needle, armed with a double ligature, was then introduced under the femoral artery, and one of the cords was tied above, and the other below, the wound in the vessel. Then follows a curious passage, showing the operator's judgment at that time, respecting the impropriety of interposing any cylinder of linen between the knot of the ligature and the artery, as some of the old surgeons at that time used to do, as well as a few of the moderns. "*On ne mit point de petites compresses sur le corps de l'artère au-dessus du nœud, comme font quelques-uns, parce que l'on jugea qu'il étoit d'une grande conséquence de lier très-étroitement une artère si considérable, ce que l'on n'auroit pas été sûr de faire en interposant la petite compresse,*" &c. For greater security, assistants, who relieved each other in turn, kept up constant pressure on the tied part of the vessel for twenty-four hours. In six weeks the patient recovered, and afterwards enjoyed such good health that he went through several campaigns. (*Saviard, Nouveau Recueil d'Observations Chir. Obs.* 63. 12mo. Paris, 1702.)

Now, with respect to these two cases, it merits attention, that, though Heister, Morgagni, and others, endeavoured to explain the success, by supposing that each of the patients in question must have had a double superficial femoral artery in the limb operated upon, both Severinus and Saviard were wise enough to avoid making any such erroneous inference themselves. At a later period, Guattani laid bare the femoral artery, as it passed under Poupart's ligament; compressed it against the ramus of the pubes, by means of graduated compresses, retained with a firm roller; and thus obtained the speedy obliteration of the vessel, and cured an aneurism which had been first injudiciously opened. (*De Externis Aneurysmatibus Hist.* 15, 4to. Romæ, 1772.) In the same book is given the case of an inguinal aneurism, which, when it had continued three months, and become equal in size to a large fist, was attacked with gangrene, whereby the aneurismal sac was quickly destroyed, and the femoral artery obliterated for a considerable extent from the crural arch downwards. The sloughs were thrown off, however, and the ulcer had in a great measure healed when the patient fell a victim to debility. (*Hist.* 17.) Here it is to be remarked, that, during the five weeks this man lived after the obliteration of the femoral artery, above the origin of the profunda, not only the circulation and life of the whole limb were preserved, but the auxiliary arteries, coming from within the pelvis, proved capable of limiting the progress of the mortification of the parts round the aneurism, and of commencing the healing process in a manner which raised great hopes of a cure. A similar fact is also recorded by Dr. Clarke. (*Duncan's Med. Comment.* vol. iii.)

These, and other cases which might be quoted, furnished ample proof of the efficiency of the anastomosing vessels to support the limb, though the femoral artery had been tied, or obliterated in a very high situation.

Besides these facts, surgeons derived every encouragement to attempt the cure of popliteal aneurism, by the ligature of the artery above the tumor, from the elucidations given by Winslow and Haller, concerning the numberless inosculations which exist between the upper and lower articular arteries. Haller even drew the conclusion, that, if the course of the blood were intercepted in the popliteal artery, between the origins of the two orders of articular branches, such anastomoses would suffice for carrying on the circulation in the leg. And at length Heister, weighing the anatomical observations of Winslow and Haller and the facts recorded by Severinus and Saviard, first proposed applying to popliteal aneurisms an operation, which, with the exception of those two cases, had until his time been restricted chiefly to aneurisms of the brachial artery. (*Dis. de Genuum Structurâ eorumque Morbis. Dis. Chir. Halleri.* t. iv.)

It was in Italy that the earliest operations were undertaken for the cure of popliteal aneurisms, by Guattani, or rather by a German surgeon, named Keysler, as would appear from a letter written by Testa to Cotunni. (See *Pelletan, Clinique Chir.* t. i.) The practice of tying arteries for the cure of aneurism was also adopted in Italy by Molinelli and Mazotti, at a period, when, in other countries, amputation was the measure to which the patient was always subjected. The success obtained by these surgeons, soon led others to imitate them, and by degrees the practice of tying the femoral artery became common both in cases of aneurism and wounds; and from the observations of Heister (*Haller, Disp. Chir.* t. v.), Acrell (*Murray, de Aneurysm. Femoris*), Leslie (*Edin. Med. Comment.*), Hamilton (*B. Bell's Surgery*, vol. i.), Burschall (*Med. Obs. and Inq.* vol. iii.), Leber (*Dehaen, Ratio Medendi*, t. vii.), and Jussy (*Ancien Journ. de Méd.* t. xliii.), it was proved, beyond the shadow of a doubt, that the circulation might continue in the limb after the obliteration of the femoral artery, whether such obliteration were effected by direct pressure or the ligature.

The exact period when the first operation of laying open the tumor and tying the popliteal artery was performed in England, is not, as far as I know, particularly specified. However, judging from the observations made on this practice in the writings of Pott (*Remarks on Palsy, &c.* 8vo. Lond. 1779), of Wilmer (*Cases and Remarks in Surgery*, 8vo. Lond. 1779), of Kirkland (*Thoughts on Amputation*, 8vo. Lond. 1780), and of others, it is clear that this method of treatment had been often done in this country earlier than the dates of those works, and, as would appear, with little or no success. The earliest attempt of this kind in France was made by Chopart in 1781 (*Roux Nouveaux Elémens de Méd. Opératoire*, t. i. p. 556), about five and twenty years after the examples set by Guattani in Italy; but Chopart failed in his endeavours to repress the bleeding from the exposed cavity of the tumor, and was therefore obliged to amputate the limb. Subsequently to this attempt, the operation was undertaken by Pelletan in two instances, the terminations of which were successful: consequently, this surgeon may be regarded as entitled to the honour of having proved to his countrymen the possibility of curing the popliteal aneurism by laying open the tumor, and securing the artery in the ham.

The severity and frequent ill success of this method of operating I have already noticed, nor shall I repeat the objections to it. With respect to the Hunterian practice, the great peculiarities of which were tying the artery at some distance above the disease, and not opening the swelling at all, Richerand seems offended that Hunter's name should be affixed to an operation, which he conceives was in reality the invention of Guillemeau. Here we observe Ætius again puts in a prior claim, and with much more effect, because the method of which he speaks, truly resembled Mr. Hunter's, inasmuch as the vessel is directed to be tied at some distance above the swelling, while Guillemeau only tied the artery close above the disease, and *opened the swelling, a serious deviation from the Hunterian practice.*

Guillemeau, a disciple of Ambrose Paré, having to treat an aneurism at the bend of the arm, the consequence of bleeding, exposed the artery above the tumor, tied this vessel, then opened the sac, took out the coagulated blood, and dressed the wound, which healed by suppuration. After more than a century, Anel, on being consulted about a similar case, tied the artery above the swelling, which was left to itself. The pulsation ceased, the tumor became smaller, and hard, and after some months no traces of the disease were perceptible.

In 1785, Desault operated in the same manner for a popliteal aneurism: the swelling diminished by one half, and the throbbings ceased; on the twentieth day it burst; coagulated blood and pus were discharged in large quantities; and the wound, after continuing a long time fistulous, at length healed. Towards the end of the same year, Hunter applied the ligature somewhat differently; instead of placing it close to the swelling, or directly above it, he put it on the inferior part of the femoral artery. (See *Richerand, Nosogr. Chir.* t. iv. p. 98, 99, edit. 2.) Unquestionably Anel did, in one solitary instance, tie the brachial artery immediately above an aneurism at the bend of the arm, and effected a cure without opening the swelling (*Suite de la Nouvelle Méthode de guérir les Fistules lachrymales*, p. 251, Turin, 1714); but he did not think of applying the plan to the femoral artery, or draw the attention of French surgeons sufficiently to the matter, to make them imitate his operation; on the contrary, the method fell into oblivion, and was never repeated. With regard to Desault's operation, said to have been done in an earlier part of 1785 than Mr. Hunter's first operation, it is only necessary to say, that Desault tied the popliteal artery itself, while the grand object in Mr. Hunter's method was to take up the femoral artery, at a distance from the disease, and that it is this last mode alone which has gained such approbation, and been attended with unparalleled success.

The French surgeons have not practised the Hunterian operation with the same degree of success with which it has been performed in England, and, consequently, they have often returned to the old method of opening the sac, &c. Even Boyer averred, a few years ago, his relinquishment of what he calls Anel's plan. (*Traité des Mal. Chir.* t. ii. p. 148.) But we shall not be surprised at this ill success, when we hear that some of them neglected, for a long while, the right principles on which ligatures ought to be applied to arteries, as explained by Dr. Jones in his work on hemorrhage. Even Baron Dupuytren, until a late date, adhered to the use of ligatures of reserve; while Boyer applied not less than four loose ligatures round the artery, besides two tight ones; and consequently a large portion of the vessel lay separated from its natural connexions, and irritated by these extraneous substances. Hunter's first operation nearly failed also on account of so many ligatures, none of which were tightened so as to cut through the inner coats of the artery, and thus promote its closure. (See Hemorrhage.) At length, however, Dupuytren, and several other distinguished surgeons in France, convinced of the inutility and danger of ligatures of reserve, totally discontinued their employment. (See *Leçons Orales de Clin. Chir.* t. iv. p. 531.) The following passage also shows the valuable reforms which have taken place in France in the mode of tying arteries and the treatment of aneurism. "The process generally employed at the present day," says Baron Dupuytren, "is that of Anel or Hunter. When an artery is tied in this plan, it is exposed, if possible, at a point far enough from the aneurism for the vessel to be perfectly healthy, and in a situation where it is superficial; so that the neighbouring veins and nerves may be more easily separated from it, and the ligature more conveniently tightened, in a proper degree. Another, not less important precept, is to preserve above the wound, a sufficiency of collateral branches to keep up the circulation in the lower part of the limb after the operation, and to make the incision so that the ligatures may not be applied too near any large collateral vessels, particularly the superior ones, because their immediate proximity to the ligatures is one of the causes most to be apprehended of secondary hemorrhage. The incision should be extensive enough to let what is requisite be easily done to the artery, and *the fascia should be even more freely divided than the integuments.*" (Op. et vol. cit. p. 516.) With reference to the operation for popliteal aneurism, *Rosenmuller's Chir. Anat. Plates*, part iii. tab. 8 and 9; Scarpa's and Tiedemann's matchless engravings; *Haller's Icones; Manec, de la Ligature des Artères*, pl. 9 and 10; and *Elias Bujalsky, Tabulæ Anat. Chir.* Petropol. 1828; deserve to be consulted.

ANEURISMS OF THE LEG, FOOT, FOREARM, AND HAND.

It is not long since doubts were entertained of the possibility of curing an aneurism at the upper part of the calf of the leg by tying the femoral artery in the middle of the thigh. (*Instituto Ital. di Scienze ed Arti*, vol. i. parte ii. p. 266.) The author here referred to was led by this uncertainty to have recourse in one instance to the severe method of laying open the tumor, in order to get at the vessel lower down. On this case, Scarpa makes some correct reflections: The operator (says he) assured himself, that, *on compressing the femoral artery at the upper part of the thigh, the tumor at the top of the calf ceased to pulsate; and that, when the compression was continued for some time, the swelling partly disappeared, and became softer.* It ought to have been evident, therefore, that the aneurism might have been cured by tying the trunk of the femoral artery, as described in the foregoing section. In Scarpa's work is a case in which an aneurism at the bifurcation of the popliteal artery was cured by the ligature of the femoral artery. (See p. 541, ed. 2.) Mr. Hodgson has seen three aneurisms, situated at the commencement of the tibial arteries, cured by the same operation. (*On Diseases of Arteries, &c.* p. 437.) But, as Scarpa remarks, though the Hunterian operation answers in the cure of aneurism in the bend of the arm, and at the upper part of the calf of the leg, it is not so effectual for aneurisms situated on the back or palm of the hand, or the dorsum, or sole of the foot. The free communication, which the ulnar and radial arteries keep up with each other in the hand, and the tibial arteries have with each other in the foot, prevent the operation from succeeding, whether the brachial or femoral artery, or one of the two large arteries of the forearm, or leg, be tied. In proof of this statement, Scarpa cites two cases of aneurism seen by himself; one on the instep, the kind of case seen also by Guattani; the other in the sole of the foot; and a third case of the same disease in the latter situation; all of which were found to be incurable by the ligature of the anterior tibial artery. (P. 311.) Scarpa thinks, however, that the operation of tying this vessel where it passes over the dorsum of the foot might succeed, if aided by compression, applied so as to stop the current through the other main channel; and he seems to approve of this practice, because the plan of tying the artery above and below the disease (which is the most certain means of cure) could not be done without extensive incisions in the sole of the foot. In an aneurism at the lower part of the leg, Mr. Hodgson judiciously insists upon the prudence of tying the artery as near as possible to the tumor, because the recurrent circulation, through the large inosculations in the foot, might still cause the swelling to enlarge, in consequence of the blood sent into the sac from the lower extremity of the vessel passing through the aneurismal cavity into branches arising from the artery between the aneurism and the ligature. (P. 438.) However, in one case of aneurism of the anterior tibial artery, Mr. H. Cline applied a ligature just above the tumor without success, and Sir Astley Cooper expressly recommends making an incision in the sac, and applying a ligature both above and below the swelling. (*Lectures, &c.* vol. ii. p. 63.) When an aneurism arises from the radial, ulnar, or interosseous arteries near the elbow, tying the brachial will suffice; but if the disease be lower down, the vessel from which it proceeds must be taken up near the swelling. (*Hodgson*, p. 393.) A case, strikingly illustrative of this truth, is recorded by Mr. Liston:—J. M. P., aged nineteen, applied to him on the 28th of July, on account of an aneurism of the left radial artery, about the middle of the forearm, occasioned by a wound. The tumor was as large as a walnut, and so compressible that it could easily be made to disappear. Pressure was tried at first, with apparent benefit; but, as it did not succeed, the humeral artery was tied on the 8th of August, and with the effect of completely removing the tumor. On the eighteenth day afterwards, however, a small slough was detached from the cicatrix, and about three o'clock next morning a violent hemorrhage took place. Mr. Liston then deemed it necessary to lay open the sac, and tie the artery above and below the wound in it. (See *Edin. Med. Journ.* No. 90, p. 4.)

Scarpa mentions a case, where the dorsal artery of the thumb was wounded; but as the hemorrhage returned several times, and pressure failed in suppressing it, the surgeon took up the radial artery at the wrist. After cutting off this direct current of blood towards the injured vessel, pressure on the wound proved effectual. Three months afterwards, the patient having died, the radial artery was found impervious for three finger-breadths below where the ligature had been applied, and the dorsal artery was likewise obliterated from the root of the thumb to the beginning of the palmar arch.

Mr. Todd has published a case, in which he cured a large aneurismal swelling of the posterior side of the forearm by tying the brachial artery. From the description, I conclude that the disease was an aneurism by anastomosis, as it is termed; but the particulars given by the author leave some doubt on this point. (See *Dublin Hospital Reports*, vol. iii. p. 135.)

The manner of exposing and tying the principal arteries of the leg and forearm will be described under the term ARTERIES.

OF ANEURISMS HIGH UP THE FEMORAL ARTERY.

Several facts, already specified in the preceding columns as having occurred many years before the operation of tying the external iliac artery was attempted, amounted to a full proof, that the circulation might go on in the lower extremity, notwithstanding the artery in the groin were tied, or obliterated. On this point, some of Guattani's cases were most decisive.

The ligature of the external iliac artery, for aneurisms of the femoral artery in the bend of the groin, has now been practised so frequently, and the instances of success are so numerous, that all doubt concerning the propriety and utility of the attempt has entirely ceased. The French, who evinced great backwardness in espousing the Hunterian method of operating for aneurisms, though it is decidedly one of the greatest improvements in modern surgery, at one period showed great reluctance to practise the operation of tying the external iliac artery. M. Roux, however, who was in London about twenty years ago, saw the thing done, and his testimony, no doubt, had considerable influence in quickening the adoption of this bold, but, on the whole, very successful measure, by his brethren in the capital of France. Still, as M. Roux remarks, "We cannot but blame the indifference with which the operation is mentioned in some of the latest French surgical publications. At this moment (1815) we can reckon twenty-three facts relative to tying the external iliac artery, and on fifteen of the patients it has perfectly succeeded. In these twenty-three operations, I comprehend the two which were done in France; one at Brest, by Delaporte, and the other at Lyons, by Bouchet; cases, the authenticity of which cannot be doubted. In the number of successful cases, is to be comprised Bouchet's operation, since the patient lived more than a year afterwards, and then died of the consequences of an inguinal aneurism of the opposite side.

"Sir A. Cooper alone had tied the external iliac artery six times before my journey to London, and during my stay there I saw him perform the operation once. Four of his patients were entirely well; one of the three others died, the thirteenth week after the operation, of the bursting of an aneurism of the aorta. At this period, the circulation in the limb had been re-established. I saw the limb after it had been injected, amongst Sir A. Cooper's anatomical preparations. Large and beautiful anastomoses existed round the pelvis, between the dilated branches of the internal iliac and femoral arteries. With respect to the sixth patient, the leg mortified, and the thigh was amputated without success. The seventh died of hemorrhage, which took place on the fourteenth or fifteenth day after the operation." (*Paralèlle de la Chir. Angloise avec la Chir. Françoise*, p. 275, 276.) Sir Astley Cooper had tied the external iliac artery in nine cases (see *Lancet*, vol. ii. p. 44); and the operation is now so common, that scarcely a week passes without some record of its performance in one part of the world or another.

The many facts exemplifying the propriety of this operation must have been highly gratifying to Mr. Abernethy, by whose judgment it was first suggested, and by whose enterprising hand it was first performed.

Mr. Abernethy was called upon on several occasions to take up the external iliac artery, and every one of these cases proved that the anastomosing vessels were fully capable of conveying blood enough into the limb below, and that a vessel even of this size could become permanently closed after being tied. Three of the operations in which Mr. Abernethy took up the external iliac artery, the very first examples of this practice, I was an eye-witness of, the cases having occurred at St. Bartholomew's Hospital, at the time when I was an articled student there. (See *Abernethy's Surg. and Physiol. Essays, and Surgical Obs.* 1804; *Edin. Med. and Surg. Journal for January*, 1807.)

In Mr. Abernethy's first operation, performed in 1796, an incision about three inches in length, was made through the integuments of the abdomen, in the direction of the artery, and thus the aponeurosis of the external oblique muscle was laid bare. This was next divided from its connection with Poupart's ligament, in the direction of the external wound, for the extent of about two inches. The margins of the internal oblique and transverse muscles being thus exposed, Mr. Abernethy introduced his fingers beneath them to protect the peritoneum, and then divided them. Next he pushed this membrane, with its contents, upwards and inwards, and took hold of the external iliac artery with his finger and thumb. It now only remained to pass a ligature round the artery and tie it; but this required caution, on account of the contiguity of the vein to the artery. These Mr. A. separated with his finger, and introducing a ligature under the artery with a common surgical needle, tied it about an inch and a half above Poupart's ligament.

The following was the method which Mr. Abernethy adopted in the second instance of tying the external iliac artery.

An incision, three inches in length, was made through the integuments of the abdomen, beginning a little above Poupart's ligament, and extending upwards; it was more than half an inch on the outside of the upper part of the abdominal ring, to avoid the epigastric artery. Here I may remark, that as the epigastric artery ascends obliquely inwards between the fascia transversalis and the peritoneum, near the internal border of the inner ring, the usual distance between which and the abdominal ring is an inch and a half, the place chosen by Mr. Abernethy for the incision did not in reality leave the epigastric artery unexposed to danger. The aponeurosis of the external oblique muscle was next divided in the direction of the external wound. The lower part of the internal oblique muscle was thus uncovered; and the finger being introduced below the inferior margin of it and of the transversalis muscle, they were divided with the crooked bistoury for about one inch and a half. Mr. Abernethy now introduced his finger beneath the bag of the peritoneum, and carried it upwards by the side of the psoas muscle, so as to touch the artery about two inches above Poupart's ligament. He took care to disturb the peritoneum as little as possible, detaching it to no greater extent than was requisite to admit his two fingers to touch the vessel. The pulsations of the artery made it clearly distinguishable, but Mr. Abernethy could not put his finger round it with facility. In order to be able to do so, he was obliged to make a slight incision on each side of it. Mr. A. now drew the artery gently down, so as to see it behind the peritoneum. By means of an eye-probe, two ligatures were conveyed under the vessel; one of these was carried upwards as far as the artery had been detached, and the other downwards; they were firmly tied, and the vessel was divided in the interspace between them. (*Surg. Observ.* 1804.)

Mr. Freer, of Birmingham, who may claim the honour of having seconded Mr. Abernethy in this new practice, made an incision about one inch and a half from the spine of the ilium, beginning about an inch above it, and extending it downwards about three inches and a half, so as to form altogether an incision four inches and a half long, extending to the base of the tumor. The tendon of the external oblique being exposed, was carefully opened, and also the external oblique, when the finger, being introduced between the peritoneum and transversalis, served as a director for the crooked bistoury, which divided the muscle. Avoiding all unnecessary disturbance, Mr. Freer separated the peritoneum with his finger, till he could feel the artery beating, which was so firmly bound down that he could not get his finger under it without dividing its fascia. The vessel having been separated from the surrounding parts, a curved blunt needle, armed with a strong ligature, was put under it, and tied very tight, with the intention of dividing the internal coats of the vessel. The operation led to a perfect cure. (*Freer, On Aneurism*, p. 83, 4to. 1807.) Mr. Tomlinson, of the same town, was also an early performer of the operation: he applied only one ligature, and, of course, left the artery undivided; the event was completely successful.

The following is Sir Astley Cooper's mode of operating: A semilunar incision is made "through the integuments, in the direction of the fibres of the aponeurosis of the external oblique muscle. One extremity of this incision will be situated near the spine of the ilium, the other will terminate a little above the inner margin of the abdominal ring. The aponeurosis of the external oblique muscle will be exposed, and is to be divided throughout the extent and in the direction of the external wound. The flap, which is thus formed, being raised, the spermatic cord will be seen passing under the margin of the internal oblique and transverse muscles.

The opening in the fascia, which lines the transverse muscle, through which the spermatic cord passes, is situated in the midspace between the anterior superior spine of the ilium and the symphisis pubis. The epigastric artery runs precisely along the inner margin of this opening, beneath which the external iliac artery is situated. If the finger, therefore, be passed under the spermatic cord, through this opening in the fascia, it will come into immediate contact with the artery, which lies on the outside of the external iliac vein. The artery and vein are connected together by dense cellular membrane, which must be separated to enable the operator to pass a ligature, by means of an aneurism needle, round the former." (See *Hodgson, On Diseases of Arteries*, p. 421, 422.)

The foregoing incision, the convexity of which is turned outward and downward, I think, should extend from within and a little above the anterior superior spinous process of the ilium to above and a little within the middle part of Poupart's ligament, the exact point under which lies the internal ring, behind which the external iliac artery is to be found. As soon as the tendon of the external oblique muscle has been divided, the internal oblique and transverse muscles may be cautiously cut with the aid of a director; and then the fascia transversalis either divided in the same way, or torn through with the end of the scalpel or director. Care must be taken to avoid the epigastric artery, which runs from the pubic side of the external iliac to the inner side of the incision. Baron Dupuytren, in performing the operation at the Hôtel-Dieu, in 1821, wounded the epigastric artery. (See *Averill's Operative Surgery*, p. 37.) The hemorrhage was so copious, that two ligatures were required. The patient afterwards died of peritonitis, which, in all probability, was brought on by the disturbance of the parts in the proceedings requisite for securing the ends of the wounded vessel. Hence, in operating according to Sir A. Cooper's plan, after pushing upwards the lower border of the internal oblique and transversalis, together with the spermatic cord, if the fascia transversalis is to be cut, and not torn, or if the inner ring, the opening in that fascia, is to be dilated, the requisite incision should be made with a probe-pointed bistoury in the direction towards the anterior superior spinous process of the ilium, and away from the epigastric artery. Mr. Guthrie has seen the epigastric artery divided in this operation, and two ligatures placed upon it without any inconvenience occurring. When such practice is adopted, he rates the importance of the accident much lower than I am inclined to do; for he observes, "I have reason to know that this artery is made a greater bugbear of than there is any occasion for in all operations on these parts. If the surgeon has unluckily divided it, either in this or any other operation, all that he has to do is to enlarge the incision, and tie both the divided ends; and I have no hesitation in saying, it will not be of any consequence, either in this operation, or one for hernia. If a man has been so unfortunate as to have a wound in his peritoneum, of a quarter or half an inch in extent, two ligatures on the epigastric artery, and a slight increase in the extent of the external incisions, add little or nothing to the danger, which only takes place in reality when the wound is closed up, and the artery is allowed to bleed internally." (*Guthrie, On Dis. of Arteries*, p. 376.) While I approve of the practice of securing the two ends of the epigastric artery in a case of this description, the accomplishment of it would not be so easy as the delivery of the proper advice; and where the peritoneum is cut, as in examples of hernia, blood would be likely to be effused in the cavity of the peritoneum before the ends of the vessel could be secured. In taking them up also a considerable disturbance and irritation of the parts would necessarily be produced. For such reasons, and on account of the generally fatal termination of a wound of the epigastric artery, I cannot but view this accident as a truly perilous one. The external iliac vein must never be included in the ligature, as such a proceeding would cause a dangerous interruption of the return of the blood.

Mr. Norman, of Bath, who has tried both modes of operating, found that proposed by Sir A. Cooper a more easy way of finding the external iliac artery than the longitudinal incision practised by Mr. Abernethy. "The objection (says Mr. Norman) to Sir A. Cooper's mode of operating in cases where the tumor extends high up, is by no means well founded; for the lower part of the bag of the peritoneum, lying on the edge of Poupart's ligament, must in every case be exposed and detached, in order to get at the artery, which lies behind the posterior part of that membrane, and this is most easily effected by an incision in the direction of Poupart's ligament; whilst two thirds of the longitudinal incision are made on a part of the peritoneum, which lines the abdominal muscles, and the lower portion only of the incision reaches that part of the membrane which is to be separated. The consequences of this are, that the peritoneum is in much greater danger of being wounded, and that the probability of a hernia forming after the cure is much increased by the extensive division of the oblique muscles." (See *Med. Chir. Trans.* vol. x. p. 101.) These remarks are well founded, and they coincide with some observations made many years ago by M. Roux, who, while he inclined to Mr. Abernethy's method, saw the disadvantage of letting the direction of the wound in this instance correspond to the course of the artery. Hence, after many trials on the dead subject, he laid down the rule, that the beginning of the wound should never be further than half an inch from, and a very little higher than, the anterior superior spine of the ilium, and that it should be carried very obliquely downwards, to the middle of Poupart's ligament. (See *Nouveaux Elémens de Méd. Op.* t. i. p. 747, &c.)

Mr. Todd also, after repeated trials of Mr. Abernethy's and Sir Astley Cooper's methods on the dead subject, concluded that the plan, recommended by the latter afforded the greatest facility of applying the ligature to the artery, because more room was obtained by it, and with less disturbance of the peritoneum, than in the other way. Where, however, it becomes necessary to apply a ligature to a higher part of the artery, in consequence of secondary hemorrhage, Mr. Todd conceives that Mr. Abernethy's method should be adopted. (See *Dublin Hospital Reports*, vol. iii. p. 92.)

In a case operated upon by Mr. Kirby, a hernia followed, in the situation where the abdominal muscles had been divided. (See *Cases with Obs.* p. 109, 8vo. Lond. 1819.)

In one case, Dr. Post found the peritoneum so thickened and diseased, that he could not raise it from the subjacent parts, and he was obliged to make an opening in it. The protruding viscera were then pushed back, and, with a needle, a ligature was introduced under the artery, the peritoneum being also included in the ligature. Notwithstanding the disadvantageous method of operating, and the return of pulsation in the swelling, the patient had so far recovered in three months, that he had regained the use of the limb. (See *American Med. and Phil. Reg.* vol. iv. p. 443.) Both the external iliac arteries of the same individual were tied in succession by Mr. Tait; one on the 8th of May, 1825, and the other on the 16th of April, 1826; and this with entire success, notwithstanding the peritoneum was wounded in one of these operations. M. Arendt also took up both the external iliac arteries in one patient, and, though there was only an interval of a week between the operations, the case had a very favourable termination. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 175.)

In one remarkable case, Mr. Newbiggin, by tying the external iliac artery, cured both an inguinal and a popliteal aneurism together. (See *Edin. Med. and Surg. Journal for Jan.* 1816, p. 71, &c.)

The many operations, which have now been done on the external iliac artery, impress me with a conviction that, in subjects under a certain age, there is no reason to fear that the anastomoses will not generally suffice for the supply of the lower extremity. Out of twenty-five cases the particulars of which I formerly collected, there were only three in which the limb was attacked by gangrene. These three were patients of Sir A. Cooper, M. Bouchet of Lyons, and Mr. Collier. The proportion is not so much as one in eight. The three instances of gangrene were not all in the circumstances which permitted the event to be imputed to the anastomoses not having had sufficient time to enlarge, though perhaps Mr. Collier's case was such. On the other hand, we are to notice that Dr. Cole's patient was operated upon a few days after the wound, and yet the limb was duly supplied with blood, and did not become gangrenous. The same important facts were likewise exemplified in the remarkable case, where M. Velpeau was suddenly called upon to tie the external iliac artery, which had been accidentally wounded with a knife. Here, although there had been no preliminary dilatation of the collateral vessels, either by a trial of pressure, or by the presence of an aneurism, a ligature was at once put on the external iliac artery, with a perfectly successful result. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 175.) It appears therefore to me, that the occasional occurrence of gangrene cannot be admitted as a just reason for delay, until the collateral vessels have had time to enlarge. I believe, that in all aneurismal diseases, early operating is the best and most judicious practice. This was one principal cause, as Kirkland observes, which occasioned the bad success of the old surgeons in the treatment of popliteal aneurisms, and he foretold, many years ago, that operations for the cure of aneurisms would answer better, if not deferred so long as formerly. (See *Thoughts on Amputation, &c.* 8vo. Lond. 1780.) I join Kirkland in this sentiment, not without recollecting that all aneurisms are attended with a chance of getting well spontaneously in the course of time. I saw the inguinal aneurism which did so, under Dr. Albert, in the York Hospital; but as this is a rare incident, I do not believe that it ought to influence us against having speedy recourse to an operation. Besides, the cure by inflammation and sloughing appears to me to be attended in reality with more peril than a well executed operation, and, consequently, has less recommendations than many may imagine. Had not Dr. Albert's patient been a very strong man, he would certainly have fallen a victim to the extensive disease which the bursting and sloughing of the tumor created. Thus, Delaporte's patient died of the mass of disease which the tumor itself made; for it had been suffered to attain too large a size, so that, when it inflamed, the effects were fatal. (See *Richerand, Nosogr. Chir.* t. iv. p. 113, edit. 4.)

I believe Dr. Wilmot's observation is perfectly correct, that if a comparison were made between the operation of tying the external iliac artery and that of tying the artery in the thigh, we should find the recoveries after the first more frequent, in proportion to the number of times it has been done, than after common operations lower down. (See *Dublin Hospital Rep. &c.* vol. ii. p. 214.)

[The results of the ligature of the external iliac artery are very favourable. According to Norris, of one hundred cases in which the vessel has been tied for aneurism, seventy-three have recovered, and twenty-seven died. The most frequent cause of death was gangrene of the limb, and next to that secondary hemorrhage.

Pulsation recurred in six cases, but one of these proved fatal; and suppuration of the sac happened in thirteen instances, of which three had a fatal result.]

The greatest artery that conveys blood into the lower extremity, after the external iliac has been tied, is the gluteal: but besides it, the ischiatic, the obturator, and the external pudic, which anastomoses freely with the internal pudic, are important vessels in keeping up the circulation.

In one case, operated upon by Mr. J. C. Warren, the epigastric artery arose from the anterior and inner part of the sac, and gave origin to the obturator, while the circumflexa ilii originated from the outer part of the sac. All these vessels were greatly enlarged, and the epigastric rendered the necessary detachment of the external iliac very difficult. (See *New England Journ.*)

Some particulars of inguinal aneurisms, in which Sir A. Cooper, Mr. James, and Mr. Murray tied the aorta, will be hereafter noticed. (See Aorta.)

Rosenmüller's Chir. Anat.; Tiedemann's Tabulæ Arteriarum, Carlsruhæ, 1822; the plates in Scarpa's great work, *Sull Aneurisma Reflessioni, &c.* Par. 1804; *J. P. Manec, De la Ligature des Artères*, pl. ix.; and *Elias Bujalsky's Tabulæ Anat. Chir.* Petropol, 1828, tab. x. et xi., in illustration of the operation of tying the external iliac artery, all merit notice. Under the head of Arteries, additional instructions will be offered on the mode of taking up the external iliac artery.

Cases of Gluteal Aneurism cured by tying the Internal Iliac Artery.

The gluteal artery is large; from its situation, liable to wounds; from its size, subject to aneurism. Dr. Jeffray, of Glasgow, was consulted in a case where the gluteal artery had been wounded, and an aneurism resulted. He urged the propriety of tying the vessel where it had been injured. This sensible advice was at first rejected; and when the friends at last consented, the operation was too late, as, while preparation was making for it, the tumor burst, and the patient expired in a few moments. Theden also mentions an instance, in which the gluteal artery was wounded in the dilatation of a gunshot wound, and the patient lost his life. (See *Scarpa, On Aneurism,* p. 407, ed. 2.) Mr. John Bell, however, tied the gluteal artery in a case where it was wounded, and the patient was saved.

Mr. Stevens, surgeon in Santa Cruz, the gentleman who has proved the practicableness of putting a ligature round the internal iliac artery, informs us, that one of the first surgeons in London had a patient with gluteal aneurism. The tumor was large; allowed to burst; and the person bled to death. "I sincerely trust," says he, "that the following case may be the means of preventing such an occurrence in future. Maila, a negro woman, from the Bambara country in Africa, was imported as a slave into the West Indies in the year 1790. She was purchased for the estate Enfield Green, now the property of the heirs of P. Ferrall, Esq. I saw her first in the beginning of December, 1812. She had a tumor on the left hip, over the sciatic notch. It was nearly as large as a child's head, and pulsated very strongly. She could assign no cause for the disease. It had commenced about nine months before, with slight pain in the part; and had gradually increased to its present size. She was now much reduced, in great misery, and ready to submit to any operation." (See *Medico-Chir. Trans.* vol. v. p. 425.) Mr. Stevens had tied the internal iliac on the dead body, and believed that it might be done with safety on the living. The following is the account of the operation: "On the 27th of December, 1812 (says Mr. Stevens), I tied the artery, in the presence of Dr. Lang, Dr. Van Brackle, Mr. Nelthropp, and Mr. Ford, the manager of the estate. An incision, about five inches in length, was made on the left side, in the lower and lateral part of the abdomen, parallel with the epigastric artery, and nearly half an inch on the outer side of it. The skin, the superficial fascia, and the three thin abdominal muscles, were successively divided; the peritoneum was separated from its loose connection with the iliacus internus and psoas magnus; it was then turned almost directly inwards, in a direction from the anterior superior spinous process of the ilium, to the division of the common iliac artery. In the cavity, which I had now made, I felt for the internal iliac, insinuated the point of my forefinger behind it, and then pressed the artery betwixt my finger and thumb. Dr. Lang now felt the aneurism behind; the pulsation had entirely ceased, and the tumor was disappearing. I examined the vessel in the pelvis; it was healthy, and free from its neighbouring connections. I then passed a ligature behind the artery, and tied it about half an inch from its origin. The tumor disappeared almost immediately after the operation, and the wound healed kindly. About the end of the third week, the ligature came away, and in six weeks the woman was perfectly well."

This is the first example, in which the internal iliac was tied. The operation was not attended with much difficulty or pain, and not an ounce of blood was lost. Mr. Stevens had no difficulty in avoiding the ureter, which, when the peritoneum was turned inwards, followed it. Had it remained over the artery, he could easily have turned it aside with his finger. (See *Med. Chir. Trans.* vol. v. p. 422, &c.)

The woman enjoyed good health for ten years, and then died of an affection of the chest. The body was opened, and the internal iliac artery found impervious at the point where the ligature had been applied. The ischiatic artery had the appearance of a ligamentous cord, but the gluteal artery was pervious. The pelvis was then removed, brought from Santa Cruz, and deposited in the Museum of the Royal College of Surgeons in London. In the further examination of the parts, the ileo-lumbar artery was found to have arisen just above the part where the ligature had been applied, and consequently the internal iliac was pervious from its origin to this point. The particulars of the dissection, as given by Mr. Richard Owen, are remarkably interesting. I shall only notice those circumstances which strike me as peculiarly deserving of record. An incision being made into the common iliac, and continued down to the part where the internal iliac became contracted, it was found there to have become completely obliterated. In the state of a ligamentous cord, the internal iliac descended towards the ischiatic notch for the space of an inch, and then suddenly resuming its natural diameter, it again became pervious, and so continued for the extent of half an inch; the gluteal artery arising from the lower part of this space, a sacro-lateral vessel from about the middle, and the obturator artery from the upper part of it. The latter vessel was entirely obliterated; but the sacro-lateral was pervious, of the size of a crow-quill, and passed inwards to the second sacral foramen; whilst the gluteal artery received, close to its origin, two vessels, as large as the preceding, given off from the sacro-lateral artery. The ischiatic was impervious. The gluteal artery was of its natural size. An oblong tumor of the sciatic artery was detected, three inches and a half in length, between the tuberosity of the ischium and the great trochanter, doubtless the remains of the original disease. It was filled with dark-coloured, granular, not lamellated blood. From the ischiatic notch to the tumor, the artery was completely obliterated, its texture altered, and the remains of its cavity filled with indurated and partly calcareous matter. From the lower part of the swelling, the sciatic artery proceeded down the posterior part of the thigh, and was nearly as large as the femoral. Its calibre did not, however, correspond to its apparent magnitude, its coats being vastly thickened. It was obliterated for about the space of an inch below the sac, but became pervious again after receiving an anastomosing vessel from the profunda. Mr. Owen infers from several circumstances, which he specifies, that the aneurism was of the true kind. Amongst the things highly deserving notice in this case was the open space maintained by the collateral circulation in the trunk of the artery, between the ligature and the aneurism. (See *Med. Chir. Trans,* vol. xvi. p. 221. &c.)

A second instance, in which the internal iliac artery was tied, was some time ago communicated to the public. The operation was performed by Mr. Atkinson, of York, on account of a gluteal aneurism. The following are a few of the particulars: —

Thomas Cost, aged twenty-nine, presented himself at the York County Hospital, April 29th, 1817. He was a tall, strong, active bargeman, not corpulent, but very muscular. He was enduring great pain from a large, elastic, pulsating tumor, situated under the glutæus of the right side; an obvious aneurism. It had existed about nine months, and was the consequence of a blow from a stone. In a consultation with Dr. Lanson and Dr. Wake, the necessity of the operation was determined upon, and it was performed on the 12th of May, without any material difficulty or interruption, except such as was the consequence of the division of, and bleeding from, the small muscular arteries. Having got command of the internal iliac artery within the pelvis, which, says, Mr. Atkinson, required the complete length of the fingers to accomplish, it was tied. Sufficient proof of its being the identical artery was repeatedly obtained, by the pressure upon it stopping the pulsation, and causing a subsidence of the tumor. Dr. Wake, Mr. Ward, and all the pupils were quite assured of the circumstance. The artery being then tied, the pulsation of the swelling entirely ceased. Some delay in placing the ligature arose from the needle not being sufficiently pliable; but, for future operations of this kind, Mr. Atkinson very properly recommends the ligature to be put round the artery by means of an instrument, resembling a catheter, the wire of which has a little ring at its extremity, and can be pushed out some way beyond the end of the tube.

The patient went on tolerably well for some time after the operation; the pulse never exceeded 130, and after a time sunk to 85 or 90. He became exhausted, however, partly by the discharge, and partly by hemorrhage, and died on the 31st of May, about nineteen days after the operation. In the dissection, the cavity, on the external part of the peritoneum, in the situation of the incision, was completely filled with coagulated blood. "The ligature, on moving a part of this (blood) with a sponge, readily followed it, and, without doubt, had been disengaged for some days." The internal iliac, which appeared to have been tied, had separated about an inch and a half from the bifurcation with the external iliac. By "separated," I conclude Mr. Atkinson means, that the upper part of the internal iliac was separated from the continuation of the same vessel. (See *Medical and Phys. Journ.* vol. xxxviii. p. 267, &c.) Although this gentleman has not given a very clear account of some part of the dissection, and he has also omitted to describe the place of his external incision, or the exact parts which he divided in the operation, yet I think that all the circumstances of the case, taken together, leave not the smallest doubt of the internal iliac artery having been actually tied. The complete stoppage of the pulsation as soon as the ligature was applied, and the testimony of several respectable practitioners who were present, remove, indeed, all ambiguity. The profession is much indebted to Mr. Atkinson for this important communication, which was in some measure required, in order to confirm Mr. Stevens's similar case, as it is well known that some distinguished anatomists and surgeons in this metropolis formerly expressed strong doubts of the practicable nature of the operation.

The internal iliac artery has since been tied with success by an army surgeon in Russia, upon whom the late Emperor Alexander settled a pension, as a reward for the skill displayed in the treatment of the case. (See *Averill's Operative Surgery*, p. 39.)

The operation of tying the internal iliac was also performed by Mr. Thomas, of Barbadoes, who sent the preparation of the parts to Sir Astley Cooper, and it is in the Museum of Guy's Hospital. (*Med. Chir. Trans.* vol. xvi. p. 230.) A fifth instance of the application of a ligature to the internal iliac artery took place in the practice of Mr. Hudson, of New York. (See *American Journ. of Med. Sciences* of Feb. 1828, art. v. p. 304.) A semilunar incision, seven inches in length, was made with its convexity towards the ilium, from the vicinity of the umbilicus to that of the abdominal ring. After dividing the parietes of the abdomen, and tying some arteries which bled, the peritoneum was pushed upwards and inwards, and the handle of a scalpel passed under the trunk of the internal iliac artery, which was tied an inch below its origin. The patient recovered.

[Since Stevens's case, the internal iliac has been ligatured six times; of these seven cases, four recovered, and three died; a very considerable amount of success when we take into consideration the depth at which the vessel is situated, the size of the trunk, and its proximity to the centre of the circulation.]

It is very justly observed by M. Velpeau, that the ligature of the internal iliac artery, with regard to its influence on the circulation, is in reality less serious than that of the external iliac, or even the femoral. In fact, it leaves undisturbed all the vessels appertaining to the corresponding limb, while the great pelvic arteries anastomose with one another so freely, that, when one is obliterated, an abundance of blood is promptly conveyed by the others to the organs which the obliterated one is designed to nourish. But the ligature of the internal iliac artery is dangerous in another point of view: first, on account of the difficulties in its performance; and secondly, on account of the unavoidable detachment of parts from one another which are connected together by a large quantity of loose cellular tissue, a texture in which inflammation and suppuration are disposed to spread to a great extent. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 185.)

In a modern publication are given a few particulars of a case, which was supposed to be an aneurism of the gluteal artery, and cured by means of pressure, a light vegetable diet, gentle laxatives, and digitalis. (See *Trans. of the Fellows, &c. of the King's and Queen's College of Physicians in Ireland*, vol. i. p. 41. 8vo. Dub. 1817.) From the very imperfect account here given of the tumor, it is impossible to form any conclusion respecting its nature. Mr. Mayo also briefly mentions a case which was believed to be a false aneurism of the gluteal artery, and which got well without an operation. (*Outlines of Pathology.*)

Sandifort has recorded an instance of an aneurism of the internal iliac artery itself. (See *Tabulæ Anatomicæ, &c. Præcedit Obs. de Aneurysmate Arteriæ Iliacæ internæ rariore ischiadis Nervosæ causa.* Fol. Lugd. 1804.)

ANEURISM REQUIRING LIGATURE OF THE COMMON ILIAC ARTERY.

Professor Gibson had occasion to put a ligature round the common iliac artery, in an example of gunshot wound. "The patient lived fifteen days after the operation, and then died from peritoneal inflammation, and from ulceration of the artery. The circulation in the limb of the injured side was re-established about the seventh day after the artery had been tied." (See *American Med. Recorder*, vol. iii. p. 185 ; and *Gibson's Institutes of Surgery*, vol. ii. p. 145. Philadelphia, 1825.)

In March, 1827, Dr. Mott took up the common iliac artery in a case of aneurismal tumor protruding considerably in the iliac region, and causing excruciating pain. Dr. Mott's incision, about eight inches in length, extended from the external abdominal ring, to one or two inches above the anterior superior spine of the ilium. The tendon of the external oblique muscle was divided, and also a part of the insertion of the internal oblique and transverse muscles. The operator then cautiously raised the peritoneum with his fingers, and detached it from the tumor and vessels, without doing it the slightest injury. The aneurismal dilatation was found to terminate about half way between the bifurcation of the aorta and the origin of the internal iliac trunk. The ligature was passed from the outside of the vessel, with the aid of an instrument invented by Drs. Parish and Hewson. The protrusion of the intestines rendered this part of the operation most difficult. The exact situation of the ligature was just below the bifurcation of the aorta, and at the side of the sacro-vertebral promontory. As soon as the ligature was tightened, the pulsation of the tumor ceased, its size was lessened, and the agonising pain previously felt subsided. The limb having become cold, was wrapped in cotton and well covered, and, in little more than half an hour, its circulation and temperature were entirely restored. The operation was completely successful. In 1828, the operation of tying the common iliac artery was performed by Mr. Crampton, of Dublin ; but the patient died of hemorrhage on the fourth day. In this case, the circulation, heat, and sensibility, which had been seriously interrupted in the limb for a time, were perfectly re-established, and every thing seemed to promise a favourable result, when, on a sudden, the ligature became displaced, and the patient died of internal hemorrhage. In the year, 1833, the common iliac artery was taken up by Mr. Guthrie, for a tumor, supposed by him and some other surgeons to be aneurismal, but which proved to be of a medullary malignant character. The temperature of the limb after the operation diminished, but not much. It was constantly rubbed, day and night, and a hot brick and bottles of hot water applied to the feet. The tumor subsided directly.

After the ligature of the common iliac, the lower extremity is supplied with blood through the anastomoses of the internal mammary with the epigastric, of the uppermost lumbar arteries with the circumflexa ilii, or even the ilio-lumbalis ; and, lastly, of the branches of the internal iliac of the sound side with those of the diseased one.

[The results of the ligature of the common iliac are sufficiently encouraging. Of seventeen cases in which this artery was tied, nine recovered. In eleven of the cases the ligature was for aneurism, and of these seven recovered. The remaining four rather died from the magnitude of the disease, or from wound of the peritoneum, than from the operation itself ; and in no instance did gangrene occur.]

ANEURISMS OF THE BRACHIAL ARTERY.

Surgical writings contain many histories of aneurisms in the bend of the arm, produced by the puncture of the brachial artery in venesection, or caused by a deep wound inflicted at the bend of the arm, along the inner side of the humerus, or in the axilla. Such cases must indisputably be followed by effusion ; but the blood extravasated may spread widely in the cellular tissue, so as to constitute a diffused false aneurism ; or it may be confined in one mass, and be bounded by the adhesive inflammation, so as to form a circumscribed false aneurism. Morand and others found, that, along with aneurisms, caused by a wound of the brachial artery, the diameter of the vessel was sometimes enlarged through its whole length, above the seat of the tumor.

The proximate cause of these cases may invariably be traced to the solution of continuity in the proper coats of the artery, and the consequent effusion of blood into the cellular substance. The effect is the same, whether from an internal morbid affection, capable of ulcerating the internal and fibrous coats of the artery, the blood be effused into the neighbouring cellular sheath surrounding the artery, which it raises after the manner of an aneurismal sac ; or, the wound of the integuments having closed, the blood issue from the artery, and be diffused in the surrounding parts. The cellular substance on the outside of the wounded vessel, is first injected, as in ecchymosis ; the blood then distends it, and elevates it in the form of a tumor, and the intercellular spaces being destroyed, converts it at last into a firm capsule, or aneurismal sac. (*Scarpa*, p. 167.)

The circumscribed or the diffused nature of the aneurism, and the rapidity or slowness of its formation, depend on the greater or less resistance to the impetus of the blood, during the time of its effusion, by the interstices of the cellular substance surrounding the artery, and by the ligamentous fasciæ and aponeuroses, lying over the sac.

While aneurisms, from an internal cause, are not unfrequent in the aorta, thigh, and ham, they are exceedingly rare in the brachial artery ; though a few such instances are recorded. (*Scarpa*, 174 ; *Pelletan, Clinique Chir.* t. ii. p. 4.) Dupuytren, in noticing the great rarity of true aneurisms of the brachial artery, expresses his belief that Pelletan's is the only well authenticated instance of it. The cases quoted by Scarpa from Paletta and Flajani do not appear to him precise enough, and he takes the same view of those reported by Saviard and Hodgson. (See *Clinique Chir.* t. i. p. 265.)

The mode of distinguishing a wound of the brachial artery, in attempting to bleed, and the method of trying to effect a cure by pressure (direct pressure is here meant) are described in the article HEMORRHAGE. From the cases published by Mr. Cusack, it appears that the brachial form of aneurism to which pressure (*direct* pressure is here meant) is most applicable, and in which it is most likely to effect a cure, is that of circumscribed false aneurism, unattended by inflammation either of the sac or of the surrounding parts. The pressure should be applied to the tumor alone, and not to the artery above ; and it should be but slight, until the diminished pulsation and solidity of the swelling indicate that coagula fill the sac; for otherwise the aneurism will become diffused, as happened in one of Mr. Cusack's cases.

(See *Dublin Journ. of Med. Science*, vol. i. p. 124.)

[Compression of the brachial artery above the aneurismal sac is not usually attended by very successful results. This may be partly owing to the aneurism being usually of the traumatic kind, to which compression is not very applicable, but is in a great measure due to the pain inflicted by the pressure on the neighbouring nerves rendering this method of treatment unbearable to the patient.]

Anel was the first who tied the brachial artery, for the cure of aneurism at the bend of the arm, in the same way that Hunter did the femoral, for the cure of aneurisms in the ham; viz. with one ligature above the tumor, without making any incision upon, or into, the sac itself.

The operation is performed as follows: — The surgeon having traced the course of the brachial artery, and felt its pulsations above the aneurism, may either cut down to the vessel immediately above the tumor, or much higher in the long space between the origins of the superior and inferior collateral arteries. The integuments are to be divided in the course of the artery, and also the fascia for the space of about two inches and a half. The surgeon, now introducing his left forefinger to the bottom of the wound, will feel for the hard cord formed by the median nerve, and closely under, or at the side of which, is the artery within its sheath, which is to be opened. The surgeon should cut chiefly on the side next to the internal margin of the biceps, to avoid dividing any of the numerous muscular branches which go off from the opposite side of the artery. He is then to separate the artery from the median nerve and the brachial veins, and with an eye-probe is to pass a ligature under the artery, and then tie it with a simple knot.

In the operation, it should always be recollected, that the median nerve lies in the lower third of the arm, on the inner side of the artery; and, therefore, that the instrument used for putting the ligature under the vessel, should be passed from within outwards, by which means the inclusion of the nerve will be avoided. (See *Boyer, Traité des Maladies Chir. &c.* t. ii. p. 193.)

In the upper third of the arm, the median nerve will be found on the outer side of the artery; in the middle third it crosses superficially over the artery as it gradually changes its position from the outside to the inside of that vessel; occasionally, however, the nerve crosses underneath the artery.

Sometimes the surgeon has a difficulty in discriminating the artery from the median nerve. When there is no pulsation perceptible in the artery, the firmer feel of the nerve is one of the best criterions. Indeed, after dividing the integuments, the hard cord felt under the fascia may be regarded, without any risk of mistake, as the median nerve. However, the best operators are sometimes perplexed. Thus, Dupuytren was operating on a patient who fainted, and, for more than a quarter of an hour, he remained doubtful which was the nerve, and which the artery, and he did not venture to tighten the ligature till the circulation had revived. (*Dupuytren, Clin. Chir.* t. i. p. 282.) And, in another instance, after making an incision, two inches and a half long, in the course of the artery, above the bend of the elbow, he found the subcutaneous cellular tissue gorged with blood, and the cellular sheath, inclosing the median nerve and brachial artery, thickened and easily torn. A large vein lying across the artery was cut through. The fasciculus, composed of the artery and nerve, were next exposed, and an eye-probe passed under the guidance of a director beneath the artery, as Dupuytren supposed; but, on raising up the probe to ascertain what lay over it, severe pain was felt, followed by numbness in the track of the nerve. Dupuytren, then, by very careful dissection, detached the nerve from the artery, to which he next applied a ligature. (Op. et vol. cit. p. 288.)

The importance of avoiding the inclusion of the median nerve in the ligature is great, not only with reference to paralysis, but to gangrene, which Dupuytren never knew follow the ligature of the brachial artery, except when that nerve had been tied together with it. (See *Clin. Chir.* t. i. p. 286.)

Whoever, says Scarpa, shall have the treatment of a *circumscribed* aneurism in the bend of the arm, will no longer, it is to be hoped, follow the method of those, who supposing the tumor to be formed by the dilatation of the artery, used first to divide the integuments over the tumor, insulated the sac, and sought the vessel above and below the aneurism, in order to tie it in two places; and then endeavour to make the sac slough away. The operation is now reduced to the greatest simplicity, viz. tying the artery merely above the tumor. (See *Scarpa*, p. 358, 359.)

The ligature should be placed as near the aneurism as possible, the principal reason for doing it at a distance from the swelling in some other cases not being here applicable. (See *Harrison on the Arteries*, vol. i. p. 167; *Guthrie, On Dis. of Arteries*, p. 333, &c.) The correctness of Scarpa's recommendation of tying the artery only in one place above a circumscribed brachial aneurism is confirmed by the experience of Dr. Colles, who observes, "I have operated repeatedly, and with success, for the cure of brachial aneurism, in consequence of injury to the arteries in performing venesection. I have also frequently assisted others in operating for the same case, and with the same result; and I never yet found it necessary to open the aneurismal sac, or to apply more than one ligature round the artery, and which, I think, ought always to be tied as near as possible to the seat of the disease." (See *Harrison's Surgical Anatomy of the Arteries*, vol. i. p. 170, ed. 2.)

When the aneurism is *diffused*, and accompanied with violent inflammation and swelling of the whole arm, from the excessive distension of the clots of effused blood, Scarpa recommends the old operation of opening the tumor, and tying the artery at the bottom of the sac, above and below the wound made by the lancet. In this method, a tourniquet must be applied to the upper part of the arm, near the axilla; or if the limb be very painful and swelled, it is better to let an assistant compress the artery above the clavicle, against the first rib. The incision having been made into the tumor, and the blood discharged, a probe is to be introduced into the puncture in the vessel, from below upwards, so as to raise the artery. This, being separated from the parts beneath, and the median nerve, for a small extent, is to have two ligatures put under it; one of which is to be tied above, the other below, the wound in the vessel. Then the tourniquet, or pressure, is to be taken off; and if there be no bleeding, the wound is to be brought together. (See *Scarpa*,

p. 359.) With reference to this operation, Rosenmüller's Chir. Anat. Plates, part ii. tab. 11.; Scarpa's plates; Tiedmann's beautiful engravings of the arteries; *Manec, De la Ligature des Artères*, pl. vi.; and *Camper's Demonstr. Anat. Pathol.* lib. i. are worth consulting.

From observations made by Mr. Harrison, a doubt may be entertained, whether, even in these circumstances, the adoption of the foregoing plan is always necessary. Indeed, he distinctly declares, that "in no case of *diffused* or circumscribed aneurism at the bend of the elbow have I seen it necessary to open the sac, or the artery below the tumor." "Brachial aneurism," says he, "which commences at the bend of the elbow, in consequence of a wound, is not always circumscribed. Sometimes the tumor extends up the arm between the biceps and triceps muscles, the fascia of the arm preventing its increase in a lateral direction. In one instance I saw the disease extend from the elbow nearly to the axilla. In this diffused aneurism, the surgeon must tie the brachial artery in the upper part of its course, and apply moderate compression along the aneurismal sac. This plan succeeded in the case to which I have alluded, and in which the operation was performed by Mr. Wilmot, in Jervis Street Infirmary; and a perseverance in moderate compression for some weeks, caused the total disappearance of the disease." (See *Harrison's Surgical Anat. of the Arteries*, vol. i. p. 169, ed. 2.) Still, exceptions to the preceding advice may present themselves. Thus the brachial artery has been wounded in venesection precisely at its bifurcation into the radial and ulnar branches. The brachial artery was tied close to the wounded part; but as the bleeding returned, it was secured a little higher up. Amputation was performed, and the patient lost his life. Here it was ascertained that a ligature could scarcely have been applied below the opening in the vessel, so near was this to the bifurcation; and perhaps the radial and ulnar arteries should have been secured. (See *Guthrie, On Dis. of Arteries*, vol. i. p. 332.) While Baron Dupuytren expresses himself in favour of the preference which should generally be given to a single ligature above the tumor in aneurism at the bend of the arm, he admits the possibility of this method failing, the pulsations being only temporarily suspended by it. In simple aneurism it will answer; in what he terms the arterioso-venous aneurism, or varicous aneurism, it will not stop the throbbings. (See *Clinique Chir.* t. i. p. 274.)

A high division of the brachial artery is well known to be a frequent occurrence. If, in consequence of this, two arteries should be exposed in the operation (see *J. G. Crosse in Prov. Med. and Surg. Trans.* vol. v.), the surgeon should endeavour to ascertain by pressure, which vessel communicates with the wound, or sac, and apply the ligature accordingly; but, if the pulsation, or bleeding, cease only when both vessels are compressed, he will be justified in tying both. (See *Harrison's Surgical Anat. of the Arteries*, vol. i. p. 166, ed. 2.)

[*Spontaneous aneurisms of the arteries of the fore-arm* are of extremely rare occurrence. When met with they require to be diagnosed from pulsating encephaloid tumors, which are not very unfrequently met with in this situation. Their treatment consists in the application of a ligature to the brachial.]

Axillary Aneurisms.

Aneurisms occasionally take place in the axilla, and make it necessary to tie the subclavian artery. A question, here naturally presenting itself, is, whether the surgeon should attempt the operation in the early period of the disease, or wait till circumstances are urgent—the aneurism large and far advanced; the arm œdematous and insupportably painful, from the stretching of the axillary plexus of vessels; the patient worn out by suffering and loss of rest; and the tumor in danger of bursting? In all cases of aneurism, unquestionably, there is a certain chance of the disease getting well spontaneously; and one axillary aneurism, in a man in St. Bartholomew's Hospital a few years ago, had certainly disappeared of itself, as was proved by the account which the patient while living gave of his case, and by the obliteration of the artery, found on inspection after death. We may also find a few instances of subclavian aneurism being cured by Valsalva's treatment. (See *Pelletan, Clin. Chir.* t. i. p. 77; *Cloquet in Archives*, 1834, t. vi. p. 511.)

I believe, however, we ought not to suffer our conduct to be too much influenced by the hope of events which are so unfrequent; and, from the observations which I have made on this subject, it is my decided opinion that the operation should never be delayed so as to allow the tumor to acquire an immoderate size. The operation is always difficult; but the difficulty is seriously increased when the swelling has extended far towards the breast, and has become so large as to push the clavicle considerably upwards. The several examples in which the subclavian artery has now been successfully tied furnish abundant proof that the anastomoses are fully competent to the supply of the limb with blood. The plan, therefore, of delaying the operation long, with the view of allowing the inosculating arteries to enlarge, must be as questionable here as in some other cases of aneurism, and at all events the maxim may be safely advanced, that, previously to the operation, the tumor should never be suffered to acquire an enormous size.

That the limb would receive an adequate supply of blood was well proved, even without the performance of the operation, by cases in which the axillary and subclavian arteries had been rendered impervious by disease; as, for instance, by the pressure of an aneurism of the aorta. (For an account of such facts, the reader is particularly referred to *Hodgson's Treatise on the Diseases of Arteries*, p. 111; *Journ. de Médecine, by Corvisart, Leroux, and Boyer*, t. ii. p. 29; *Corvisart, Essai sur les Maladies du Cœur*, p. 215.)

"In these cases," says Mr. Hodgson, "the only unusual circumstance which was observed during the life of the patients, was the deficiency of the pulse at the wrist. The limbs were well nourished, although a considerable extent of the main artery (the subclavian) was obliterated even before it had given off any branches." (P. 47.)

This vessel was tied by Mr. Hall, in Cheshire, when it had been wounded with a scythe, and its ends exposed; the arm was preserved, though it remained somewhat weakened, which might be owing to the division of some large nerve. (See *J. Bell, On Wounds*, p. 60, ed. 3; and *Scarpa*, p. 372.) Mr. White, of Manchester, relates another instance of this vessel being tied in the case of a wound; but mortification of the limb and death followed. Three of the nerves were found included in the ligature. (*Lond. Med. Journ.* v. 4.) In cases of wounds of the axillary, or any other large arteries of the extremities, the surgeon, before proceeding to apply a ligature, should first ascertain the precise place of the wound in the artery; and, for this purpose, it may sometimes be proper, in certain wounds of the shoulder, to make an incision in the axilla, so as to expose the injured part of the vessel; or, if circumstances do not forbid it, the external wound may be dilated, until the exact part where the artery has been wounded is discovered. In proof of the propriety of acting in this manner, and applying a ligature above and below the wound in the vessel, Scarpa quotes a case in which such practice was successful on a patient under M. Maunoir, of Geneva: the artery had been injured with a sabre near the head of the humerus; but, after the wounded part of the vessel had been traced, and secured in the way above suggested, the patient, a boy fourteen years of age, was saved from the dangers of hemorrhage, and recovered the use of his arm, as fast as this was possible, with the loss of the first phalanges of the three last fingers from gangrene. (See *Scarpa, On Aneurism*, p. 412, ed. 2; and *Journ. de Méd.* t. xl. Mars, 1811.)

There are two modes for operating for axillary aneurisms: one, by cutting below the clavicle, in order to take up the axillary artery itself; the other, by making the wound above the bone, for the purpose of securing the subclavian artery at the point where it emerges from behind the anterior scalenus muscle.

The first of these methods has been attempted by Desault, Pelletan, the late Mr. Thomas Keate, Mr. Chamberlaine, &c. In a case of wound of the axillary artery, Desault made an incision, six inches long, below the external third of the clavicle; two thoracic arteries cut were immediately tied; the two lower thirds of the great pectoral muscle were next divided with a bistoury guided on a director: a large quantity of coagulated blood was now discharged; and the artery was directly taken hold of and tied, together with the brachial plexus of the nerves. The arm mortified, and the patient died. This case, we must agree with Scarpa, was not a fair trial of the operation, inasmuch as the inclusion of the plexus of nerves in the ligature was an improper measure, and must have promoted the occurrence of sphacelus. It seems also probable, from the account, that the vein was likewise tied; another serious and objectionable proceeding. Besides, it is worthy of notice, that the case was a wound of the axillary artery, attended with a copious effusion of blood in the cellular membrane. In all examples of this kind, gangrene is more readily induced, than when the case is merely a circumscribed aneurismal tumor. (See *Œuvres Chir. de Desault, par Bichat*, t. ii. p. 553.) As for Pelletan's example, it hardly deserves recital, because the operation in fact was not achieved. His colleagues objected to dividing the pectoral muscle; a random thrust was made with a needle and ligature; and the artery was not included. (See *Clinique Chir.* t. ii. Obs. 7, p. 49.)

In a case of axillary aneurism, which had actually burst, and the hemorrhage from which could only be stopped by pressing the artery against the first rib, the late Mr. Thomas Keate, surgeon-general, practised the following operation, which was attended with complete success. His plan was to take up the artery, above the diseased and ruptured part, in its passage over the first rib. Accordingly he made an incision obliquely downwards; divided the fibres of the pectoral muscle that were in his way; and, when he came to the artery, passed a curved, blunt-pointed silver needle, armed double, as he conceived, under the artery, and tied two of the ends. After a careful examination, finding that the artery pulsated below the ligature, he determined on passing another ligature higher up, and nearer to the clavicle: he therefore passed the needle more deeply, so as evidently to include the artery. In a few days the swelling of the arm began to subside, the wound suppurated, and the ligatures came away with the dressings. The arm afterwards recovered its feeling, and the patient regained, in a great measure, the entire motion of the shoulder, &c. (See *Med. Review and Magazine for* 1801.) This method is objectionable, inasmuch as it was a dive made with a needle, and attended with great danger of wounding and tying parts which should be left undisturbed.

Mr. R. Chamberlaine, of Kingston, Jamaica, took up the axillary artery below the clavicle, in a patient who had an aneurism in the left axilla, occasioned by a wound with a cutlass on the 5th of October, 1814. On the 10th of January, the tumor had considerably increased, and was less compressible than it had been when first seen by Mr. Chamberlaine. The operation was done on the 17th of January, 1815. "A transverse incision, of three inches in length, was made through the skin and platisma myoides, along and upon the lower edge of the clavicle, three finger-breadths from the sternal end of that bone, and terminating about an inch from the acromion scapulæ. This incision divided a small artery, which was immediately secured. A second incision, of three inches in length, was also made obliquely through the integuments over the deltoid and pectoral muscles, meeting the first nearly in the centre. The cellular membrane and fat, lying between them at the upper part, were now removed. The next step consisted in detaching the clavicular portion of the pectoralis major, and taking away the fat and cellular membrane lying over the subclavian vessels. The artery was now brought into view, and its pulsations made it clearly distinguishable from the contiguous parts." After several ineffectual efforts, Mr. Chamberlaine succeeded in conveying a ligature under it, by means of an eye-probe, curved for the purpose, and the point of which was brought up with the aid of a pair of forceps. On the 22nd of February, the wound was completely healed; the aneurismal tumor reduced to the size of a turkey's egg, and very solid; the arm smaller than its fellow, but its muscular power improving. (See *Medico-Chir. Trans.* vol. vi. p. 128, &c.) Mr. Chamberlaine expresses his conviction, that the operation would have been much facilitated had he been furnished with the instruments described in Mr. Ramsden's work for passing the ligature under the artery: a still better invention, however, for passing a ligature under a deep artery, is the needle constructed by Mr. Weiss, surgeons' instrument-maker in the Strand. An engraving and description of this valuable instrument may be found in the *Edin. Med. and Surgical Journal*, No. 76.

Mr. Hodgson's directions for the performance of this operation are very clear: A semilunar incision through the integuments, which is to have its convexity downwards, and to begin about an inch from the sternal end of the clavicle, being continued towards the acromion for the extent of three or four inches, so as to end near the anterior margin of the deltoid muscle, without reaching into the space between the deltoid and pectoral muscle, in order to avoid wounding the cephalic vein. This incision will expose the fibres of the pectoral muscle, which are now to be divided in the direction and extent of the external wound. The flap is then to be raised, by dividing the loose cellular tissue which connects the pectoral muscle to the parts underneath it. The pectoralis minor will now be seen crossing the inferior part of the wound; and, by introducing his finger between the upper edge of this muscle and the clavicle, the surgeon may feel the pulsations of the axillary artery. Here one of the cervical nerves lies above, but in contact with, the artery; the other nerves are behind it. In the dead subject, the axillary vein is situated below it: but in the living the vein is distended, and conceals the artery. The cellular tissue, connecting these parts, is to be separated by careful dissection, or by lacerating it with a blunt instrument. A ligature having been drawn under the artery with an aneurism needle, the ends of the cord are to be raised, and a finger passed down, so as to compress the part surrounded by the ligature. If the artery be included, the pulsation in the aneurism will immediately cease. This precaution is highly necessary, lest one of the cervical nerves should be tied instead of the artery. (See *Hodgson, On Dis. of Arteries, &c.* p. 362.)

When an aneurism extends a certain way inwards, or towards the trachea, the operation below the clavicle becomes impracticable; and it is now requisite to make the incision above that bone, and take up the subclavian artery at the point where it comes out from between the scaleni muscles, and lies on the flat surface of the first rib.

In the dead subject, without any tumor under the clavicle, this operation is easy enough; but in a living patient, and particularly in one whose neck is short, the difficulty is much increased by a large axillary aneurism, for then the clavicle is sometimes so much elevated, and the artery lies so deeply, that a ligature can hardly be carried under it without a particular needle for the purpose. This was the case in an attempt which I once saw made by Mr. Ramsden to tie the artery, and in which one of the cervical nerves, affected by the pulsation of the artery, was mistaken for it, and tied, so that the aneurism soon afterwards burst, and a fatal hemorrhage arose. Hence, the advice given by my friend Mr. Hodgson, always to operate in this case while the tumor is small, cannot be too well remembered. The direction given by Mr. Liston is also important; indeed, it is given by Mr. Hodgson in relation to the operation below the clavicle, and may be said to apply to all operations for the cure of aneurism. It is one which Dupuytren always particularly insisted upon; namely, "before tightening the ligature, try the effect of compression with the fingers on the pulsation, as by taking this precaution (says Mr. Liston) I saved myself and my patient the pain of tying the nerve, which I got hold of in my first operation, in place of the artery." (*Lancet*, No. 195, p. 234.) The chief difficulty in the operation is that of passing the ligature round the artery; but, it may be done either with an ingenious needle, which Mr. Ramsden has described, and which is exactly similar in principle to Desault's *aiguille à ressort*, or with the still preferable instrument constructed by Weiss. Another very ingenious contrivance for tying deep arteries has also been recently proposed by Dr. Prevost, of Geneva. (See *Edin. Med. and Surgical Journ.* No. 79.) The instruments used by Dr. Mott, when he took up the arteria innominata, will be presently noticed.

In order to avoid the inconveniences of the needles ordinarily used for conveying ligatures under deep arteries, Desault (says Bichat) invented "une aiguille à ressort," composed of a silver tube, or sheath, which was straight at one end, and bent at the other in a semicircular form. This sheath enclosed an elastic wire, the projecting extremity of which was accurately fitted to the end of the sheath, and perforated with a transverse eye. The instrument was passed under the artery, and, as soon as it had reached the other side of the vessel, the sheath was kept fixed, while an assistant pushed the elastic wire, which, rising from the bottom of the wound, presented the aperture or eye to the surgeon, who now passed the ligature through this opening. The wire was next drawn back into its sheath again, and the whole instrument brought from beneath the artery, by which means the ligature was conveyed under the vessel. (See *Œuvres Chir. de Desault, par Bichat*, t. ii. p. 560.) Another very ingenious method of passing the ligature under the artery, is that practised by Mr. Key; but, as the comprehension of it is difficult without the plate, I shall here merely refer to that gentleman's description of it. (See *Med. Chir. Trans.* vol. xiii. p. 10.)

The invention of the foregoing instruments effects a material diminution in the difficulty of taking up the subclavian artery from above the clavicle; nor can it be wondered, that without such assistance, the operation should have baffled even so skilful a surgeon as Sir A. Cooper. (See *Lond. Med. Review*, vol. ii. p. 200.)

The following example is the first in which the operation of applying a ligature to the subclavian artery above the clavicle was ever accomplished.

John Townly, a tailor, aged thirty-two, addicted to excessive intoxication, of an unhealthy and peculiarly anxious countenance, was admitted into St. Bartholomew's Hospital on Tuesday, the 2nd of November, 1809, on account of an aneurism in the right axilla. The prominent part of the tumor in the axilla was about half as big as a large orange, and there was also much enlargement and distention underneath the pectoral muscle, so that the elbow could not be brought near the side of the body.

"The temperature of both arms," says Mr. Ramsden, "was alike, and the pulse in the radial artery of each of them was correspondent. After the patient had been put to bed, some blood taken from the left arm, and his bowels emptied, his pulse, which, on his admission, had been at 130, became less frequent; his countenance appeared more tranquil; and he experienced some remission of the distressing sensations in the affected arm: this relief, however, was of short duration."

The pulsation of the radial artery of the affected arm gradually became more obscure, and soon after either ceased, or was lost in the œdema of the forearm and hand. On the evening of the twelfth day, a dark spot appeared on the centre of the tumor, surrounded by inflammation, which threatened a more extensive destruction of the skin. A further postponement of the operation being deemed inadmissible, Mr. Ramsden performed it the next day in the following manner: a transverse incision was made through the skin and platysma myoides, along and upon the upper edge of the clavicle, about two inches and a half in length, beginning towards the outer border of the trapezius, and terminating about half an inch within the outward edge of the sterno-cleido-mastoideus muscle. "This incision divided a small superficial artery, which was directly secured. The skin, above the clavicle, being then pinched up between my own thumb and finger and those of an assistant, I divided it from within, outwards and upwards, in the line of the outward edge of the sterno-cleido-mastoideus muscle, to the extent of two inches.

"My object, in pinching up the skin for the second incision, was to expose at once the superficial veins, and, by dissecting them carefully from the cellular membrane, to place them out of my way, without wounding them. This provision proved to be useful, for it rendered the flow of blood during the operation very trifling comparatively with what might otherwise have been expected; and thereby enabled me with the greatest facility to bring into view those parts which were to direct me to the artery.

"My assistant having now lowered the shoulder, for the purpose of placing the first incision above the clavicle (which I had designedly made along and upon that bone), I continued the dissection with my scalpel, until I had distinctly brought into sight the edge of the anterior scalenus muscle, immediately below the angle, which is formed by the traversing belly of the omo-hyoideus, and the edge of the sterno-cleido-mastoideus; and having placed my finger on the artery, at the point where it presents itself between the scaleni, I found no difficulty in tracing it without touching any of the nerves to the lower edge of the upper rib, at which part I detached it with my finger nail for the purpose of applying the ligature.

"Here, however, arose an embarrassment, which (although I was not unprepared for it) greatly exceeded my expectation. I had learned, from repeatedly performing this operation, many years since, on the dead subject, that to pass the ligature under the subclavian artery, with the needle commonly used in aneurisms, would be impracticable; I had, therefore, provided myself with instruments of various forms and curvatures to meet the difficulty, each of which most readily conveyed the ligature underneath the artery, but would serve me no further; for, being made of solid materials, and fixed into handles, they would not allow of their points being brought up again at the very short curvature which the narrowness of the space between the rib and the clavicle afforded, and which, in this particular case, was rendered of unusual depth, by the previous elevation of the shoulder by the tumor.

"After trying various means to overcome this difficulty, a probe of ductile metal was at length handed me, which I passed under the artery; and bringing up its point with a pair of small forceps, I succeeded in passing the ligature, and then tied the subclavian artery at the part where I had previously detached it for that purpose. The drawing of the knot was unattended with pain, the wound was closed by the dry suture, and the patient was then returned to his bed." (See *Practical Obs. on the Sclerocele, &c. to which are added four Cases of Operation for Aneurisms*, p. 276, &c.)

Immediately the artery was tied, the pulsation of the swelling ceased; the arm of the same side continued to be freely supplied with blood, and was even rather warmer than the opposite arm; the operation, which was severe from the length of time it took up, was followed by considerable indisposition; the patient died about five days after its performance; after the artery had been tied, the œdema of the arm and the aneurismal tumor partly subsided; and on examination after death, nothing but the vessel was found included in the ligature.

In Mr. Ramsden's publication are descriptions of instruments which will be of great service to any future performer of this operation. The chief one is a needle, resembling that which was invented and used by Desault, and of which I have already endeavoured to give an idea. By means of this or other instruments already specified, I conceive, that the main difficulty of the operation will in future be avoided. Had Mr. Ramsden had its assistance, his patient would have been detained a very little time in the operating theatre, and the event of the case might have been completely successful. Having witnessed all the circumstances of the case, the inference that I drew from them was, that, if the operation could have been done in a moderate time, which now seems practicable with the aid of some kind of aiguille à ressort, or even without it in most examples, the case in all probability would have ended well. The preceding case is particularly memorable, as being the first instance in which the subclavian artery was scientifically tied, without any random thrust of a needle, and without the inclusion of any part besides the artery in the ligature. It furnished encouragement to repeat the experiment; held out the hope, that axillary aneurisms might be cured as well as inguinal ones; and confirmed the competency of the anastomosing arteries to nourish the whole upper extremity, when the subclavian is tied where it emerges from behind the anterior scalenus muscle.

In the year 1811, the subclavian artery was tied in the London Hospital, in a case of axillary aneurism, by Sir W. Blizard, who found no difficulty in getting the ligature under the artery with a common aneurism-needle. A single ligature was applied. At first, hopes of recovery were entertained; but the patient, who was old and debilitated, afterwards sunk, and died on the fourth day. (See *Hodgson's Treatise*, p. 375.)

In the year 1815, Mr. Thomas Blizard tied the subclavian artery in the same Hospital. The case was an aneurism in the left axilla, and, like all the other examples of this kind upon record, was attended with great pain in the tumor and limb. There was no pulse in the left radial artery, though there was scarcely any difference in the temperature of both arms. "An incision, about three inches in length, was made through the integuments at the root of the neck, on the acromial side, and parallel with the external jugular vein. The platysma myoides being divided, the cellular membrane was separated with the finger, until the pulsation of the subclavian artery was felt where the vessel passes over the first rib. The finger being pressed upon this part of the artery, the cellular sheath investing it was carefully opened with the point of a knife. A ligature was then conveyed underneath the artery, by means of a common aneurism-needle, with the greatest facility." As soon as the ligature was tied, the pulsation in the tumor ceased. On the second day after the operation, the left arm began to have more feeling, and was as warm as the right. However, difficulty of breathing, twitchings, delirium, &c., afterwards ensued, and the patient died on the evening of the eighth day, previously to which event the ring and middle fingers turned black. On opening the body, the pericardium exhibited the effects of a high degree of inflammation, and the heart was covered with flakes of lymph, its posterior surface being of a deep red colour. The inner membrane of the ascending aorta was of a bright scarlet hue, much diseased, and studded with white patches. A reddish appearance was also noticed in the lining of the right carotid, left subclavian, and even the abdominal aorta. The boundaries of the aneurismal tumor were in a state of sphacelation. These are all the circumstances which I wish here to notice; but more particulars may be perused in Mr. Hodgson's work, p. 602.

In some cases upon record, no difficulty was experienced in passing the ligature under the artery with a common aneurism-needle, a circumstance which must have depended upon the space between the clavicle and the first rib having been less deep in these instances than the two which fell under my own observation, or in others which occurred in the practice of Dr. Colles, Sir Astley Cooper, and Mr. Liston. (See *Lond. Med. Review*, vol. ii. p. 200; and *Edin. Med. and Surg. Journal, January*, 1815, No. 64.) In Mr. Key's case, "the depth of the angle in which the artery was enclosed, rendering it impossible to pass a ligature under it, about three quarters of an inch of the clavicular portion of the sterno-mastoid was divided, which afforded sufficient room, and rendered the concluding part of the operation easy; the artery became readily exposed to view, and an armed aneurismal needle was passed with facility under it." (*Med. Chir. Trans.* vol. xiii. p. 5.) It is an observation made by Dupuytren, that in persons who have long necks, the subclavian artery is more superficial than in others whose necks are short. The size and situation of the tumor will also make a considerable difference; for if it be large, and placed a certain way towards the shoulder, it may raise the clavicle a good way from the first rib, and increase the difficulty of the operation.

In Dr. Colles's first case, the artery was tied before it reached the scaleni muscles, as the tumor, which was in the right subclavian artery, extended from the sternal origin of the sterno-mastoid muscle along the clavicle, a little beyond the arch of that bone, and rose nearly two inches above it, in a conical form, the apex of the cone being situated at the outer edge of the foregoing muscle. After a tedious dissection, it was found, that only a quarter of an inch of the artery was sound, and on this portion the ligature was placed. Great difficulty was encountered in passing it round the artery, and the pleura was supposed to have been slightly wounded. Before tightening the ligature, the breathing became laborious, and the patient complained of oppression about the heart. These symptoms, indeed, were so violent, that it was judged prudent not immediately to tighten the ligature. On the fourth day, however, the artery was constricted, when the pulse at the wrist ceased, the patient not seeming to suffer much from what had been done. The patient then went on pretty well till the ninth day, when he was seized with a sense of strangling, and pain about his heart; and becoming delirious, died in nine hours after the beginning of this attack. On dissection, the aorta was found diseased, and the disease extended into the subclavian artery.

In another instance, Dr. Colles tied this vessel at the point where it emerges from between the scaleni muscles, without any particular difficulty. The operation, however, was soon followed by a train of severe symptoms, delirium, and mortification; the patient dying on the fifth day. (See *Edin. Med. and Surg. Journ. January*, 1815.)

The first case in which complete success attended the operation of tying the subclavian artery, where it first comes from behind the anterior scalenus muscle, was that under the care of Dr. Post, of New York. The patient was a gentleman, with an aneurism in the left axilla. Dr. Post performed the operation on the 8th of September, 1817, in the following manner:—"An incision, commencing at the outer edge of the tendon of the mastoid muscle, was carried through the integuments about three inches in length, in a direction deviating a little from a parallel line with the clavicle. This divided the external jugular vein, the bleeding from which required a ligature for its suppression; and, in proceeding with the operation, three or four arterial branches were cut, which it was also necessary to secure. The subclavian artery was then sought immediately on the outside of the scaleni muscles, and was easily laid bare. Passing over the artery at this place, in contact with it, were three considerable branches of nerves, running downwards towards the chest, from the plexus above. These were separated, and a ligature passed under the artery, with great facility, by the instrument, well adapted to this purpose, invented by Drs. Parish, Hartshorn, and Hewson, of Philadelphia. On tying the ligature all pulsation ceased in the limb." In the afternoon, the temperature of the limb was observed to be rather higher than that of the other arm. On the 17th of September, the aneurismal tumor burst, and about three ounces of dark coagulated blood were discharged. On the 26th, the ligature came away from the subclavian artery. Oct. 11. the wound was entirely healed; and on the 16th of the same month the patient required no further attendance, his only complaints being now a little occasional pain in the fingers, and a superficial sinus at the part where the tumor burst. (See *Med. Chir. Trans.* vol. ix. p. 185, &c.)

In Europe, the first axillary aneurism cured by taking up the subclavian artery from above the clavicle, was that in which Mr. Liston was the operator, on the 3rd of April, 1820. The particulars of the case prove the risk there always is of tying one of the axillary nerves, instead of the artery, unless great caution be employed; and, in fact, Mr. Liston himself first passed the ligature under a nerve, and would have tied it, had he not wisely tried what effect constricting the included part would have upon the pulsation of the tumor; a criterion that was never neglected by Dupuytren in operations for aneurism. As the subclavian artery seemed diseased at the point where it emerged from behind the anterior scalenus, Mr. Liston cautiously divided this muscle to about its middle, so as not to injure the phrenic nerve. At length, with the aid of an aneurism-needle, he passed a strong round silk ligature under the artery, and, laying hold of the loop with a small hook, withdrew the needle. In consequence of the great depth of the artery, the knot could not be made with the fingers; but, with the assistance of a kind of forceps, each extremity of which had a little notch in it, the business was accomplished. (See *Edin. Med. and Surgical Journ.* No. 64.)

When the subclavian artery has emerged from behind the anterior scalenus muscle, it passes obliquely over the flat surface of the first rib, with which it is in immediate contact. The cervical nerves are situated above and a little behind the artery: the subclavian vein passes before it, and underneath the clavicle. If the finger be passed down the acromial margin of the anterior scalenus muscle the artery will be found in the angle, formed by the origin of that muscle from the first rib. The shoulder being drawn down as much as possible, the skin is to be divided, immediately above the clavicle, from the external margin of the clavicular portion of the mastoid muscle to the margin of the clavicular insertion of the trapezius. I think, with Mr. Hodgson, that no advantage whatever can be gained by cutting the clavicular attachment of the sterno-cleido-mastoideus. The exposed fibres of the platysma myoides are now to be carefully divided, without wounding the external jugular vein, which lies immediately under them, near the middle of the incision, and should be detached, and drawn towards the shoulder with a blunt hook. The cellular membrane, in the middle of the incision, is then to be cut, or separated with the finger, until the surgeon arrives at the acromial edge of the anterior scalenus. He passes his finger down the margin of this muscle, until he reaches the part where it arises from the first rib, and in the angle formed by the origin of the muscle from the rib he will feel the artery. The ligature is now to be conveyed under the vessel with an aneurism-needle, or that recommended by Desault. (*Hodgson, On Diseases of Arteries, &c.* p. 376, &c.)

[The result of the ligature of the subclavian artery in the third part of its course, for spontaneous axillary aneurism, is as follows:—of 45 cases, there were 23 cures, and 22 deaths. This result was so unfavourable, that I have analysed the causes of death, and find them as follows:—

Inflammation within the chest . .	9
Suppuration of sac	6
Hemorrhage	2
Gangrene of arm	1
General gangrene	1
Not stated	3
	22]

In 1819, Baron Dupuytren took up the left subclavian artery in the second part of its course, for the cure of an axillary aneurism, following a stab. This eminent surgeon used to consider this vessel as having three different portions; the first, extending from its origin from the aorta to the point where it passes between the scaleni; the second, from its entrance between the scaleni to the point of its quitting the interspace between them; the third, from the latter point to the upper surface of the first rib. This third portion of the course of the subclavian artery, which in individuals whose necks are long and slender, and whose shoulders are low and thin, is not far beneath its skin, is, on the other hand, very deeply placed in persons whose necks are thick and short, and whose shoulders are covered with a good deal of flesh. In particular, this portion of the vessel is also deeply seated, when the clavicle is pushed up by a tumor in the axilla. Dupuytren's patient was in these latter circumstances; and besides the difficulty which they created to the ligature of this portion of the artery, Dupuytren reckoned that he should have had a good deal of trouble in separating the artery from the brachial plexus of nerves, which, however, in this situation, in reality lie above the vessel, the lowermost one alone lying close above it. Now, Dupuytren conceived that the second part of the course of the artery presented the advantage of the vessel passing alone between the scaleni, entirely separated from the subclavian vein, which ran in front of the anterior scalenus muscle, and also from the brachial plexus, the nerves of which lay backwards and outwards; consequently, by taking the anterior scalenus muscle as a guide he judged that the artery might be tied, without risk of including any nerve in the ligature.

Governed by these reflections, Dupuytren made an incision on the left side, and at the lower part of the neck, from above downwards, and from within outwards. By this the skin, platysma, and subcutaneous cellular tissue were divided, together with three small vessels, which were immediately secured. In the continuation of the operation, the cellular tissue and absorbent glands contiguous to the artery and brachial plexus were arrived at. The external border of the anterior scalenus was sought for, and this muscle completely cut through near its insertion, with the aid of a probe-bistoury. The artery was now exposed, and its pulsation readily stopped by the pressure of a finger passed to the bottom of the wound. A silver director, bent in the form of a quarter of a circle, was passed under the artery; and an eye-probe, armed with a ligature composed of three silk threads, conducted along the groove of the director, and withdrawn from the opposite side. Care was now taken to ascertain that the ligature was really under the artery by pulling at each end of it, and at the same time placing the forefinger on the vessel above it. In this manner it was found that the pulsation of the artery was completely stopped. This proceeding, repeated several times, was observed not to give the least pain; a proof that no nerve was included in the ligature. The artery was now tied; the wound brought together; and the limb placed on a pillow, and covered with bags filled with warm sand. This case proved successful. By the sixty-eighth day the tumor was reduced to one-fifth of its original size. The heat, sensibility, and muscular powers of the limb were entirely re-established. In it, as in all limbs whose principal artery has been tied, the arteries did not pulsate, though blood circulated freely through them. This fluid in passing through numerous and minute anastomoses, from the upper to the lower portion of the limb, seemed to Dupuytren to be no longer within reach of the power of the heart. Between two and three years after the operation, an abscess formed in the axilla and burst. Dupuytren enlarged its opening, and a great deal of pus, blended with old coagula, was discharged. This was soon followed by a perfect cure. (See *Leçons Orales de Cliniq. Chir.* t. iv. p. 524—535.) The reasons assigned by Dupuytren for choosing this method of operating, appear to me not so good as one which, I believe, is the only valid ground for taking up the subclavian in the second part of its course, viz. the extension of the tumor too far inwards to admit of the ligature being applied at the point where the artery emerges from behind the anterior scalenus, close behind the tubercle of the first rib. This point can always be reached with facility, by tracing the outer edge of that muscle downwards, whatever may be the conformation of the neck or the height of the shoulder. The phrenic nerve, be it remembered, would also be considerably exposed to injury in Dupuytren's method, which therefore seems to me eligible only under the circumstances already specified.

With respect to tying the subclavian artery on the tracheal side of the scalenus, I have stated that it was performed by Dr. Colles, and the event fatal. Descriptions of the operation may be found in Mr. Hodgson's work, p. 382. When I consider the manner in which the subclavian artery, before it passes behind the anterior scalenus, is surrounded by parts of great importance, I can scarcely bring my mind to think that the measures requisite for taking up the vessel in this situation will ever leave the patient much chance of recovery. "Between the aorta and scaleni muscles (says Mr. A. Burns), the subclavian arteries are connected with several important vessels and nerves. They are in the vicinity of the nervus vagus, of the recurrent laryngeal nerve, of the sympathetic nerve, of the phrenic nerve, and the subclavian vein; and, on the left side, the subclavian artery is intimately connected with the termination of the thoracic duct. These parts are all grouped together in a very narrow space, and the perplexity of their dissection is further increased by the interlacement of the different nerves with one another. The natural connections of these parts are best shown by merely raising the external extremity of the sterno-mastoid muscle. If this be done, the nervus vagus will be brought into view, lying on the forepart of the subclavian artery, almost directly behind the sternal end of the clavicle; and exactly opposite to the nervus vagus, but behind the artery, the lower cervical ganglion of the sympathetic nerve will be brought into view. The recurrent nerve, on the right side, hooks round the subclavian artery, and, in its course towards the larynx, ascends along the tracheal side of the sympathetic nerve. On the left side, it twines round the arch of the aorta, and, in mounting upward, is interposed between the subclavian artery and œsophagus. The subclavian vein lies anterior to the artery, and, in the collapsed state, sinks nearer to the thorax;" but, when distended in the living body, it overlaps the artery. The thoracic duct enters the subclavian vein about the eighth of an inch nearer to the acromion than the point where the internal jugular vein empties itself into the subclavian vein. The termination of the thoracic duct is situated between the sternal and clavicular portions of the sterno-mastoid muscle. (*A. Burns*, *On the Surgical Anatomy of the Head and Neck*, p. 28.)

[The subclavian has been ligatured on the tracheal side of the scalenus in seven cases, and all have proved fatal. In six from hemorrhage, and in one from diffuse inflammation within the chest. The accompanying table includes all the cases in which this operation has been performed.

SURGEON.	SEX.	AGE.	DATE OF DEATH.	CAUSE OF DEATH.
COLLES.	m.	33	4th day.	Hemorrhage.
MOTT.	f.	21	18th "	"
HAYDEN.	f.	57	12th "	"
O'REILLY.	m.	39	13th "	"
PARTRIDGE.	m.	38	4th "	Pericarditis and pleurisy.
LISTON.	m.		13th "	Hemorrhage.
LISTON.	m.		36th "	"

The great danger in these cases is from hemorrhage, depending as this does on the anatomical relations and connections of the artery, which no skill on the part of the operator can in any way lessen. This operation ought, in my opinion, to be banished from surgical practice.]

Axillary aneurisms are sometimes attended with fluctuation, in consequence of the blood becoming effused in the cellular tissue, and the pulsation in the deeper part of the swelling is then concealed. In such a case, Dupuytren once suspected the disease to be a chronic abscess, and made an exploratory puncture into the swelling; but a gush of blood made him promptly withdraw the knife and close the wound. The puncture healed up. Dupuytren wished to have tied the subclavian artery, but he was opposed by one of his colleagues; and, in the end, a point of the skin sloughed, hemorrhage took place, and the patient died. (*Clin. Chir.* t. iv. p. 520.)

A case, in which an axillary aneurism, unattended with pulsation, was punctured, and the child bled to death, is recorded. (See *Med. Chir. Journ.* vol. iv. p. 78.)

Mr. Guthrie observes, whenever an aneurismal tumor in the neck is accompanied by an alteration of the sterno-clavicular articulation, the case is clearly unfit for any operation, except that suggested by Brasdor, even if any operation at all be admissible. (See *Guthrie, On the Arteries,* p. 397.) The same, he adds, may be said of any case of aneurismal swelling, either internal or external to that articulation, in which the stethoscope, applied on the sternum in the course of the arteria innominata, or the arch of the aorta, indicates disease. A swelling at the root of the carotid is more likely to be an aneurism of the arch of the aorta or of the innominata, than of the carotid itself, and the stethoscope will remove all doubt. In one case of subclavian aneurism, where the tumor left no room for the application of a ligature on the tracheal side of it, and where there was great reason to suspect that the arteria innominata was itself enlarged, Baron Dupuytren took up the axillary artery on the 12th of June, 1829, in the Hôtel Dieu. The patient was placed in the recumbent posture, with the right arm raised from the side. An incision was begun near the inner end of the clavicle, two finger-breadths below it, and extended outwards nearly parallel to that bone for about three inches. The fibres of the great pectoral muscle, and then the upper third of the lesser pectoral, were divided. The axillary artery having been next separated from the vein and brachial plexus of nerves, a ligature was passed under it, with an eye-probe, and tightened, the doing of which occasioned no pain. In the course of the operation, which lasted thirty-five minutes, several arterial branches were cut and secured. Immediately after the axillary artery had been tied, the pulsations of the tumor became stronger and irregular, but soon returned to their former strength; simple dressings were applied to the wound, and a bladder of ice to the swelling. An anodyne draught was also exhibited ten hours after the operation; the pulse was strong and under ninety in the minute. Some blood was now taken from a vein in the arm. On the 13th of June, the patient was feeble, and complained of restlessness and want of sleep. The pulsations in the tumor had not sensibly lessened, but the tension seemed diminished; and the limb retained its natural temperature. On the 16th, the pulse was only eighty, and the tumor and throbbing of it had manifestly diminished. Venesection was afterwards practised several times, and about six ounces of blood came away from the wound. The patient died on the 20th, and was supposed to have been too much lowered by the rigorous antiphlogistic treatment. The origin of several large arterial branches from the subclavian near the tumor, is regarded as a great cause of the little success which this method of operating promises, as applied to subclavian aneurisms; yet it deserves notice, that in the case before us, the vertebral, internal mammary, and inferior thyroid branches were all found obliterated. This, according to Dupuytren, must frequently happen, when the aneurism has attained a certain size; and, therefore, he infers, that their presence should not deter a surgeon from applying a ligature between the tumor and the capillaries. No doubt, the diseased state of the right lung, and the morbid changes in the aorta, as observed after death, must have had a very unfavourable influence. (*Clin. Chir.* t. iv. p. 594.) Dupuytren publicly declared, that the preceding case would not deter him from repeating a similar operation in the same kind of case. (P. 611.)

Ligature of the Arteria Innominata.

In certain cases of subclavian aneurism, it has been proposed to tie the arteria innominata. In the dead subject, Mr. Allan Burns applied two ligatures to it; and after cutting through the vessel in the interspace, he injected the aorta, when the injection was found to pervade the anastomosing vessels of the right arm, and all those of the head. But notwithstanding this fact, and others noticed by Mr. Hodgson, tending to show the probability that a ligature upon the arteria innominata would not prevent the arm and head from receiving an adequate supply of blood, other objections were made to the practice. The principal of these were founded upon the difficulty of the operation in the living body; the inflammation likely to be excited by it in neighbouring important organs; the danger of hemorrhage from the adhesion of the vessel being likely to be broken by the force of the circulation; and the equal practicableness, in most cases, of tying the subclavian artery on the tracheal side of the scalenus.

Dr. Mott, of New York, impressed with the value of Mr. Allan Burns' remarks upon this subject, has, ever since he became acquainted with them, maintained in his lectures the propriety of attempting to tie the arteria innominata, under particular circumstances of subclavian aneurism. At length Dr. Mott put this new operation to the test of experience in the New York Hospital, on the 11th of June, 1818. The case was a subclavian aneurism on the right side; and the patient, a sailor, aged fifty-seven, to whom seventy drops of tinct. opii were first given. Dr. Mott began the first incision directly over the swelling above the clavicle, extending it along this bone, and ended it at the trachea, just above the upper portion of the sternum. Here he commenced the second incision of about the same length as the first, and reaching along the inner margin of the sterno-cleido-mastoideus. Dr. Mott next detached the skin from the subjacent platysma myoides, cut through the latter, and cautiously divided the sternal portion of the mastoid muscle, in the direction of the first incision. The anterior jugular vein now presented itself close to the swelling, and adherent to it; a circumstance that rendered the subsequent part of the operation very difficult. After detaching a portion of the latter vein from its connection, Dr. Mott cut through the sterno-hyoideus and sterno-thyroideus, and turned them back over the trachea. The carotid was now exposed a few lines above the sternum; and after he had separated the par vagum and internal jugular vein from it, they were drawn towards the outer side of the neck. Dr. Mott then laid bare the subclavian artery, which part of the operation he chiefly accomplished with the handle of the scalpel, as there was nothing to be separated but cellular membrane. The subclavian artery was found to be very much enlarged and diseased; and, as Dr. Mott recollected that this state of the vessel had seemingly hindered its successful closure, in the example operated upon by Dr. Colles, of Dublin, he decided to take up the arteria innominata itself. In detaching the cellular membrane from the lower surface of the subclavian artery, a small branch, situated about half an inch from the innominata, was injured, and the wound was six or eight times filled with blood from it. The hemorrhage was soon suppressed, however, by means of a little pressure. Had not the bleeding been so easily stopped, Dr. Mott would have concluded, from the situation of the vessel, that it was the internal mammary; but, if it were not this branch, he conceives it must have been an artery not regularly originating in this situation; perhaps the superior intercostal.

Dr. Mott continued the operation with a small round-ended sharp scalpel, until he came to the division of the arteria innominata, which great vessel he traced below the sternum; and after freeing it from all the cellular membrane with the handle of the scalpel, and drawing aside the recurrent and phrenic nerves, he tied it with a round silk ligature, about half an inch from its bifurcation.

On account of the difficulty of tying large arteries in a deep small wound, Dr. Mott recommends a set of instruments, invented for the purpose, in Philadelphia, by Drs. Parish, Hartshorn, and Hewson; consisting, 1st. Of several blunt-pointed needles, of various sizes and curvatures, furnished with an eye at each end, and calculated at one end to screw into a strong handle. 2ndly. Two strong instruments, with handles, having at one end an eye, or hole; they resemble those sometimes used for applying a ligature to the tonsils. 3rdly. A small round-pointed scalpel. 4thly. A small hook fixed in a strong handle. (*Parish, in Eclectic Rep.* vol. iii. p. 229.) After Dr. Mott had introduced the ligature into the eye of one of the above-described needles, and screwed the needle into a handle, he pressed with its convexity the cellular membrane and pleura carefully downwards, while he carried it from below upwards round the artery. As the point now appeared on the other side of the vessel, the above-mentioned hook was passed into its eye, and the handle unscrewed from the other end of it, when it was easily drawn out from under the artery, and the ligature left under the vessel. In this part of the operation, Dr. Mott urges the necessity of being particularly attentive to two important circumstances; one, is, to convey the ligature round the artery from below upwards, as the only way to prevent injury of the pleura; and the other is, to fix the hook in the eye of the needle before the handle is unscrewed from its other end, because, after this has been done, the needle loses all steadiness, and it is then difficult to get the hook into the eye.

Dr. Mott now made a noose, pressed it with the forefinger down to the artery, and tightened it very gradually, in order not to stop the flow of blood through the vessel all at once. A moderate constriction was kept up some seconds, so that the effect of the ligature upon the heart and lungs might be observed; and as no disturbance was produced in the functions of these organs, Dr. Mott tightened the ligature, and stopped the current of blood through the vessel. At this instant, the pulsation of the right temporal and radial arteries ceased. The noose was tightened still more with the above-mentioned ligature irons, and then a second knot was made. Dr. Mott was greatly pleased at finding his patient's countenance remain perfectly unchanged, and no complaint made of pain in any other part. Immediately after the ligature had been applied, the aneurismal swelling lost one-third of its size, and the clavicle could be felt through its whole extent. The divided muscles and detached skin were now brought into their natural situation; the wound closed with three sutures and adhesive plaster, and a compress applied. In the operation, three small arteries were tied: the first lay under the sternum, and seemed to be a branch of the internal mammary; the second was a descending branch of the superior thyroideal; and the third a branch of the inferior thyroideal. From two to four ounces of blood were lost, most of which came from an injured small branch of the subclavian. The operation took up about an hour. The curved spatulæ, recommended by Dr. Colles, were found very useful for holding the carotid and par vagum aside, while, by their uniform pressure, they materially assisted in restraining the effusion of blood from small vessels, and, as taking up little room, were infinitely more convenient in a deep narrow wound than the fingers of an assistant.

The day after the operation, the veins of the right forearm and hand had a turgid appearance. When the circulation in them was promoted by pressure, they became empty for some distance above the pressed part, but filled again immediately the pressure was removed; a circumstance that seemed to show that the circulation in this arm, notwithstanding the ligature of the arteria innominata, still went on with great celerity, though no pulse could be felt in the brachial and radial arteries. On the contrary, the pulse was very plain in the front branch of the temporal artery, just above the outer angle of the orbit. The left external carotid beat with unusual force. In a few days, however, the pulse became perceptible again at the right wrist.

My limits will not allow me to enter into all the details of this interesting case: suffice it to mention that the patient suffered considerable febrile disturbance at some periods after the operation, and it was necessary twice to have recourse to venesection. He was also afflicted with a severe cough. The discharge from the wound was copious and fetid. The main ligature separated on the fourteenth day. On the twentieth day, the patient was sufficiently recovered to walk in the garden. On the twenty-first day, the wound was almost closed; the patient could move his right arm with the same facility as his left, and he was gaining such strength, that no doubts were entertained about the successful result of the operation. On the twenty-third day, hemorrhage came on from the wound; it was stopped by the introduction of lint, and the employment of pressure. About twenty-four ounces of blood were lost, whereby the patient was so depressed, that the pulse was no longer distinguishable. On the twenty-fourth day, in the evening, he lost four ounces more blood; on account of his restlessness and the painful state of his arm, two grains of opium were administered to him. After one or more returns of bleeding, he died on the twenty-sixth day.

When the body was opened, no traces of inflammation or its consequences were found either in the arch of the aorta, the origin of the innominata, or the lungs. The aorta was now slit open longitudinally, and a probe then cautiously passed through it into the innominata, when the instrument went through the latter vessel into the cavity of the wound. The inner coat of the innominata was smooth and soft; but, about half an inch from the place where the ligature had cut through the vessel, marks of inflammation were noticed, and a coagulum adhered to the sides of the artery with considerable firmness; so that nature had probably endeavoured, by means of adhesive inflammation, to close the vessel, but had been prevented from completing the salutary process by the destructive ulceration. One portion of the parietes of the innominata was thickened by inflammation, and an anomalous branch, as large as a crow's quill, arose from this artery.

The ulcer was twice as extensive inwardly as it was superficially, reaching laterally to the trachea and under the clavicle to the swelling. The tripod of great vessels, viz. the innominata, the subclavian, and the carotid, was destroyed by ulceration to the extent of about an inch, and the ends of both the last vessels opened into the wound. At this place, the pleura was considerably thickened by a layer of organized lymph.

The inner surface of the carotid was covered with a coagulum, and its coats so much thickened, that a probe could hardly be passed into it. The consolidation reached up to the division into the external and internal carotid. The subclavian was pervious as far as the situation of the disease. The diameter of the brachial and other arteries of the right arm was natural. The external mammary artery was enlarged, but not the internal. The clavicle was carious, and several lymphatic glands under it in a state of suppuration.

Though the result of the operation was unsuccessful, it proves, as Dr. Mott correctly remarks, some interesting points; namely, that tying an artery of such magnitude, and so near the heart, may be done without occasioning any disturbance either in the functions of the brain, the heart, the lungs, or the right arm.

The suppuration, which continually extended itself more and more deeply, is set down by Dr. Mott as the cause of the patient's death; for, as no bleeding took place for several days after the detachment of the principal ligature, he believes that this must have fulfilled its duty, and that the artery had been closed. (See *New York Med. and Surgical Register*, 1818, vol. i.)

The arteria innominata was also tied by Graefe, on the 5th of March, 1822, in the Clinical Hospital of the University of Berlin, on account of a subclavian aneurism. The carotid was exposed, and traced down to the innominata, to which a ligature was applied by means of a blunt tenaculum constructed for the purpose, the vessel being tied about an inch from the curvature of the aorta, and two inches from the heart. As soon as the ligature was tightened, the pulsation of the arteries of the right arm, right carotid, and right temporal artery ceased; at the same instant, the throbbing of the aneurism stopped, and the tumor became flaccid. The constriction of the cord produced no disturbance of any function. The patient went on so well for several weeks afterwards, that no doubt was entertained of his recovery. However, when the wound was nearly healed, hemorrhage came on; and though it was suppressed, and hopes began to be again indulged, the bleeding recurred, and the patient died on the sixty-seventh day. Below the ligature the innominata was found closed with lymph. Graefe has written a distinct essay on the method in which the operation was done: the daily particulars of the case, and preparation from it, are placed in the Royal Anatomical Museum at Berlin. (See *Journ. de Chirurgie, von C. F. Gräfe. und Ph. v. Walther*, b. iii. p. 596, &c. b. iv. p. 587.) The ligature of the innominata is stated to have been lately done at Paris; but in this third example the patient also died of hemorrhage. (See *Dupuytren*, *Leçons Orales, &c.* t. iv. p. 611.) Of Mr. Wardrop's practice of tying the subclavian artery in aneurism of the arteria innominata itself, we shall presently speak.

[The innominate artery, as may be seen by the accompanying table, has been ligatured nine times, and in every instance with a fatal result. In eight of these cases the operation was performed for subclavian aneurism, in the remaining one (that of Hutin), for hemorrhage from the axilla, after ligature of the subclavian.

OPERATOR.	AGE.	RESULT.	REMARKS.
1. MOTT.	57	Died on 26th day.	Tied an inch below bifurcation. Ligature separated in fourteen days. Hemorrhage on twenty-fifth day, stopped by pressure. Recurred on twenty-sixth.
2. GRAEFE.		Died on 67th day.	Ligature separated in fourteen days. Died of hemorrhage.
3. HALL.		Died on 5th day.	Coats of artery were diseased, and were transfixed by the aneurism needle. Wound plugged without success.
4. DUPUYTREN.		Died.	Case referred to as occurring in the practice of Dupuytren.
5. NORMAN.		Died.	
6. BLAND.	31	Died on 18th day.	Hemorrhage on seventeenth and eighteenth days, shortly after separation of ligature.

In three other cases the operation has been commenced, but abandoned owing to unforeseen and unavoidable difficulties; and this by three of the most skilful operators that their respective countries can boast of; Messrs. Porter, Post, and Aston Key. In Mr. Porter's case, the aneurism occupied the whole of the posterior inferior triangle of the neck, being nearly six inches broad; as no pulsation was traceable in the vessels beyond the aneurism, it was useless to attempt the ligature on the distal side. On exposing the innominata, that vessel was found to be diseased, and it was not thought desirable to pass the ligature round it. In consequence of the exposure of the artery, however, the pulsation in the tumor gradually diminished, and at last ceased entirely, its bulk also becoming less.

In Mr. Key's case, in which it was impracticable to pass the ligature, it was found after death that the innominata was diseased, being dilated immediately after its origin into an oblong tumor, which occupied the whole of the artery. It is remarkable, that in this case, as in Mr. Porter's, inflammation seems to have taken place in the artery in consequence of the necessary handling to which it was subjected, and that the pulsation in the sac consequently diminished. The failure in deligating the artery appears then to be less disastrous in its consequences than success; for of the three cases just referred to, one was cured of the disease, the artery being obliterated by adhesive inflammation; and, in another, an attempt to set up this action appears to have been made, the tumor becoming solid and ceasing to pulsate; whereas, in every case in which the vessel was ligatured, a fatal result speedily ensued. Under these circumstances, I think it is an operation that few prudent surgeons would again venture on performing.]

CAROTID ANEURISMS.

There is no part of the body where the diagnosis of aneurisms is more liable to mistake than in the neck. Here the disease is particularly apt to be confounded with tumors of another nature. I have already cited in this article examples in which aneurisms of the arch of the aorta so resembled those of the carotid, as to have deceived the surgeon who was consulted. A swelling of the lymphatic glands, or of the cellular substance which surrounds the carotid artery; an enlargement of the thyroïd gland; and especially abscesses, may resemble an aneurism by the pulsations communicated to them from the neighbouring artery. On the other hand, aneurisms of long standing, which no longer throb, and the integuments over which are changed in colour, and likely to burst, may the more easily be mistaken by an inattentive practitioner for chronic abscesses, as the neck is remarkably often the seat of such diseases. (*Boyer, Maladies Chir.* t. ii. p. 185.)

Scarpa mentions one unfortunate patient, who was killed by a knife being plunged in a carotid aneurism, on the supposition that the case was an abscess. I need scarcely observe, that, by opening a carotid aneurism, a surgeon would expose himself to the disgrace and mortification of seeing the patient die under his hands, as happened in the example cited by Harderus. (*Apiar. Observationum*, Obs. lxxxvi.)

The possibility of tying the carotid artery, in cases of wounds and aneurisms, without any injurious effect on the functions of the brain, is now completely proved. Petit mentions, that the advocate Vieillard had an aneurism at the bifurcation of the right carotid, for the cure of which he was ordered a very spare diet, and directed to avoid all violent exercise. Three months afterwards, the tumor had evidently diminished; and, at last, it was converted into a small, hard, oblong knot, without any pulsation. The patient having died of apoplexy, seven years afterwards, the right carotid was found closed up and obliterated, from its bifurcation, as low down as the right subclavian artery. (*Acad. des Sciences de Paris*, an. 1765.) Haller dissected a woman whose left carotid was impervious. (*Opuscula Pathol. Obs.* xix. tab. 1.) An example of the total closure of both carotids, in consequence of ossification, is stated by Koberwein to be recorded by Jadelot. (*German Transl. of Mr. Hodgson's Work*, p. 293.) Hebenstreit (vol. iv. p. 266, ed. 3, of his *Translation of B. Bell's Surgery*) mentions a case in which the carotid artery was wounded in the extirpation of a scirrhous tumor. The hemorrhage would have been fatal, had not the surgeon immediately tied the trunk of the vessel. The patient lived many years afterwards. This is probably the earliest authentic instance in which a ligature was applied to the carotid artery. Mr. Abernethy's case is perhaps the second: and that in which Mr. Fleming, a naval surgeon, tied the common carotid in a sailor, who attempted suicide, and who was saved by the operation, is still later, not having occurred till the year 1803. (See *Med. Chir. Journ.* vol. iii. p. 2.)

Dr. Baillie knew an instance, in which one carotid was entirely obstructed, and the diameter of the other considerably lessened, without any apparent ill effects on the brain. (See *Trans. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 121.) Sir Astley Cooper has also recorded an example, in which the left carotid was obstructed by the pressure of an aneurism of the aorta; and yet, during life, no paralysis, nor impairment of the intellects, had occurred. (See *Med. Chir. Trans.* vol. i. p. 223.) A similar case is related by Pelletan. (*Clin. Chir.* t. i. p. 68.)

Mr. Abernethy was under the necessity of tying the trunk of the carotid, in a case of extensive lacerated wound of the neck, where the internal carotid, and the chief branches of the external carotid were wounded. The patient at first went on well; but, in the night, he became delirious and convulsed, and died about thirty hours after the ligature was applied. This case fell under my own notice; and the inference which I drew was, that the man died more from the great quantity of blood which he lost, and the severe mischief done to the parts in the neck, than from any effect of the ligature of the artery on the brain.

In another instance, in which the common carotid was tied, on account of a wound of the external carotid by a musket-ball, complicated with fracture of the condyle and coronoid process of the lower jaw, every thing went on favourably until the seventh day after the operation. Neither the intellectual faculties, nor the functions of the organs of sense, had been at all disturbed. But, at that period, stupor, confusion of ideas, restlessness, a small unsteady pulse, discoloration of the face, and loss of strength came on, followed in the evening by a violent paroxysm of fever. On the eighth day, three copious hemorrhages took place from the whole surface of the wound, and on the ninth the man died. In this case, however, the affection of the brain and the other unfavourable symptoms would be ascribed by nobody to the effects of the ligature on the carotid, but every one would see the cause in the severe and extensive local mischief, produced partly by the musket-ball, and partly by the mode in which the operation was performed, the surgeon having extended his incisions from the parotid gland to within an inch of the clavicle! (See *Journ. Général de Méd. &c. par Sédillot.*)

That the carotid may be tied without injuring the functions of the brain, and that aneurisms of this artery admit of being cured by the operation, is now fully proved. The following is the second instance in which I have been present at the operation of tying the carotid trunk on account of a wound.

Sir Astley Cooper has the honour of having been the first surgeon who ever tied the carotid for the cure of aneurism. The operation referred to was performed November, 1805, on Mary Edwards, aged forty-four, who had an aneurism of the right carotid artery: the tumor reached from the vicinity of the chin to beyond the angle of the jaw, and downward to within two inches and a half from the clavicle. The swelling had a strong pulsatory motion. The woman also complained of a particular tenderness of the scalp, on the same side o the head, and of such a throbbing in the brain as prevented her from sleeping.

An incision, two inches long, was made at the inner edge of the sterno-cleido-mastoideus muscle, from the lower part of the tumor to the clavicle. This wound exposed the omo-hyoideus and sterno-hyoideus muscles, which being drawn aside towards the trachea, the jugular vein presented itself to view. The motion of this vein produced the only difficulty in the operation, as, under the different states of breathing, the vessel sometimes became tense and distended under the knife, and then suddenly collapsed. Sir Astley Cooper introduced his finger into the wound, to keep the vein out of the way of the knife; and, having exposed the carotid artery by another cut, he passed two ligatures under this vessel by means of a curved aneurism-needle. The ligatures were then tied about half an inch asunder; but the intervening portion of the artery was left undivided. The pulsation of the swelling ceased immediately the vessel was tied; and on the day after the operation the throbbing in the brain had subsided, while no diminution of nervous energy in any part of the body could be observed.

The patient was occasionally afflicted with bad fits of coughing, but upon the whole went on at first pretty well. On the eighth day, however, a paralysis of the left leg and arm was noticed, attended with a great deal of constitutional irritation. November 8th, the patient could move her arm rather better; but became unable to swallow solids. November 12th, the palsy of her arm had now almost disappeared. The ligatures came away. November 14th, she was in every respect better; she swallowed with less difficulty; and the tumor was smaller, and quite free from pain. On the 17th, she became very ill; the tumor increased in size, and was sore when pressed. The wound was as large as immediately after the operation, and discharged a sanious serum. Great difficulty of swallowing, and a most distressing cough, were also experienced. The pulse was ninety-six, and the left arm again very weak. On the 21st, the patient died, the difficulty of swallowing having previously become still greater, attended with a further increase of the tumor, the skin over which had acquired a brownish red colour.

On opening the swelling after death, the aneurismal sac was found inflamed, and the clot of blood in it was surrounded with a considerable quantity of pus. The inflammation extended on the outside of the sac, along the par vagum, nearly to the basis of the skull. The glottis was almost closed, the lining of the trachea was inflamed and covered with coagulating lymph. The pharynx was so compressed by the tumor, which had been suddenly enlarged by the inflammation, that a bougie of the size of a goose-quill could hardly be introduced into the œsophagus. Sir Astley Cooper concludes with expressing his opinion that *these causes of failure may, in future, be avoided by operating before the tumor is of such size as to make pressure on important parts; or, if the swelling should be large, by opening it, and letting out its contents, as soon as inflammation comes on.* (See *Med. Chir. Trans.* vol. i.)

In one case, under the care of Mr. Coates, of Salisbury, the making of an opening, about a month after the operation, gave relief by discharging seven ounces of fetid blood and pus; but three weeks afterwards hemorrhage came on from the sac, and the patient was carried off by repeated loss of blood. On dissection, an artery, capable of admitting a probe, was found to pass into the cavity of the sac. (See *Med. Chir. Trans.* vol. xi. p. 2.)

In June, 1808, Sir Astley Cooper operated, in Guy's Hospital, on a man, aged fifty, who had a carotid aneurism, attended with pain on one side of the head, throbbing in the brain, hoarseness, cough, slight difficulty of breathing, nausea, giddiness, &c. The patient got quite well, and resumed his occupation as a porter. There was afterwards no perceptible pulsation in the facial and temporal arteries of the aneurismal side of the face. On the opposite side, the temporal artery became unusually large. The tumor was at last quite absorbed, though a pulsation existed in it till the beginning of September. The man's intellects remained perfect; his nervous system was unaffected; and the severe pain, which, before the operation, used to affect the aneurismal side of the head, never returned. The swelling, at the time of the operation, was about as large as a pullet's egg, and situated on the left side about the acute angle made by the bifurcation of the common carotid, just under the angle of the jaw.

Sir Astley Cooper began the incision opposite the middle of the thyroid cartilage, at the base of the tumor, and extended the wound to within an inch of the clavicle, on the inner side of the sterno-cleido-mastoideus muscle. On raising the margin of this muscle, the omo-hyoideus could be distinctly seen crossing the sheath of the vessels, and the nervus descendens noni was also brought into view. The sterno-cleido-mastoideus was now separated from the omo-hyoideus, when the jugular vein was seen. This vessel became so distended at every expiration as to cover the artery. When the vein was drawn to one side, the par vagum was manifest, lying between that vessel and the carotid artery. The nerve was easily avoided. A double ligature was then conveyed under the artery with a blunt iron probe. The lower ligature was immediately tied, and the upper one was also drawn tight, as soon as about an inch of the artery had been separated from the surrounding parts above the first ligature, so as to allow the second to be tied at this height. A needle and thread were passed through the vessel below one ligature, and above the other. The artery was then divided. In a little more than nine weeks, the wound was quite healed, and the patient entirely recovered. (See *Med. Chir. Trans.* vol. i.)

Another successful instance, in which the carotid was tied for the cure of an aneurism, is related in a work, to which I always have the greatest pleasure in referring. (See *Hodgson's Treatise on the Diseases of Arteries*, p. 329.)

Mr. Travers tied the carotid artery in a woman, who had an aneurism by anastomosis in the left orbit. The disease had pushed the eye out of its socket. Two small ligatures were applied, which came away on the twenty-first and twenty-second days. No hemorrhage, nor impairment of the function of the brain took place, and the disease in the orbit was effectually cured. (See *Med. Chir. Trans.* vol. ii.) Another highly interesting example, in which an aneurism by anastomosis in the orbit was effectually cured by tying the carotid artery, is recorded by Mr. Dalrymple, surgeon at Norwich. This gentleman performed the operation on the 12th of November, 1812. The patient was a female, aged forty-four. The protrusion of the eye was relieved in proportion as the swelling diminished. The violent headaches also subsided; but the eyesight was irrecoverably lost. (See *Med. Chir. Trans.* vol. vi. p. 111.)

The carotid artery has sometimes been tied with the view of enabling the surgeon to cut away swellings from the neck and side of the face, where, from particular circumstances in the cases, there was reason to fear a fatal hemorrhage without that preliminary measure. (See *Goodlad's and Arenat's Cases, in Med. and Chir. Trans.* vols. vii. and xii.)

An interesting case, in which my friend Mr. Vincent tied the carotid trunk for an aneurism, is published in the 10th volume of the latter work. (P. 212, &c.) In this example the internal jugular vein did not appear to be at all in the way during the operation; some of the fibres of the omohyoideus, however, could not be conveniently drawn aside, and were therefore divided. A single ligature was applied; the pulsation in the tumor did not entirely cease at first, when the artery was tied, but it did so two days afterwards; and the swelling was rapidly diminishing. The ligature came away about three weeks after the operation, and there was every hope of a cure; but, between the fourth and fifth week, a considerable swelling occurred between the wound and the jaw, impeding deglutition, but not the breathing. This state was followed by febrile symptoms, increased difficulty of swallowing, an attack of coughing, and impeded respiration. In the hope of affording relief, an incision was made in the tumor, from which a small quantity of pus and coagulum issued; but it was in vain, for the patient was dying. On dissection the carotid artery was found perfectly closed as far as the division of the arteria innominata. But, above the ligature, the vessel was open and inflamed, and pus was found in it. The most remarkable circumstance noticed was globules of air, adhering to the inner surface of the aorta and other large arteries, and found also under the tunica arachnoidea. The bulk of the swelling in the neck depended upon effusion of serum in the cellular membrane.

The cure of carotid aneurisms by the operation has now been so often exemplified, that even to refer to every case upon record would demand more space than I can afford. A successful instance is reported by Macaulay (*Edin. Med. Surg. Journ.* April, 1814); another by Dr. Post, who used two ligatures, and divided the artery in the space between them (*New England Journ. of Medicine and Surgery*, vol. iii. p. 205, Boston, 1814); another by Mr. Giles Lyford, proving the sufficiency of a single ligature (*Med. Chir. Trans.* vol. xi. p. 97, &c.) The case in which Mr. Goodlad tied the carotid, in order to prevent hemorrhage in the removal of a tumor involving the parotid gland, is contained in vol. vii. p. 112, &c. of the latter book. The example, in which the carotid was tied by Dr. Frick, in the hospital at Hamburgh, for the cure of a diseased parotid, is reported in the *Lancet*, No. 182. Some diminution of the swelling, and increased power of swallowing, followed; but suppuration took place, and the case ended fatally.

For the particulars of a carotid aneurism cured by the ligature of the artery by M. Dumont, see *Diss. sur l'Aneurisme de l'Artère Carotide, par P. J. Vanderhagen*, Paris, 1815. Walther, of Landshut, in the year 1814, tied the carotid artery for the cure of an aneurism with complete success: he applied only a single ligature. (*Breschet, Fr. Transl. of Mr. Hodgson's Work*, t. ii. p. 83.) In this translation are reported several instances, in which Dupuytren and other continental surgeons applied a ligature to the carotid. Dr. Holscher, of Hanover, has also operated with success. (See *Lond. Med. Repository*, vol. xvi. No. 94.)

Of the plan of tying the carotid above the aneurism, when it is situated so low that the ligature cannot be applied below it, I have also spoken. The facts, by which the propriety of this practice has now been completely established, have also been noticed: they appear to me to reflect considerable credit on Mr. Wardrop, by whom this method of operating has been revived and extended. The practice of tying the carotid for the cure of aneurism of the arteria innominata will be noticed in the ensuing section.

On the subject of tying both carotids, I find some interesting observations made by my friend Mr. Crosse:—"Although (says he) some animals will bear a ligature to both carotids simultaneously, the human frame cannot sustain so great and so sudden an interruption to the supply of blood to the sensorium. Professor Mott has tested this question; and a case came under my own observation very recently, showing the fatal tendency of a ligature, if applied almost simultaneously to each of these arteries. An approximation has, however, been made towards ascertaining the shortest interval at which the second carotid may be tied after a ligature to the first; and it has been safely done at an interval of thirty-eight, seventeen, and even twelve days. Amongst the most striking of these cases, is that related by Professor Kuhl of Leipzig, who, on account of a pulsating aneurismal tumor of the scalp, arising from a wound of the occiput, and extending over nearly the entire surface of the head, attended by frequent hemorrhages, first placed a ligature on the left common carotid. This proceeding only partially subduing the disease, and frequent hemorrhages from the affected portion of the scalp still occurring, and threatening life, a ligature was put upon the right common carotid after twenty-seven days. This was followed by convulsions; but, after a train of very troublesome symptoms, the patient recovered, and was cured of his disease. It is worthy to be noticed, that in this, and also in other like cases, some days after both carotids had been tied, heaviness and throbbing in the head have occurred, requiring free venesection. (*J. Green Crosse, in Provincial Med. Chir. Trans.* vol. v.)

[Norris has collected the details of 149 cases in which the common carotid had been ligatured. Of these, thirty were for wound of the vessel; thirty-eight for aneurism; and the remainder for various morbid conditions about the head and neck. Of the whole number, thirty-two proved fatal, and of these, eighteen deaths occurred from cerebral disease.

The cerebral symptoms evinced by the ligature of the carotid artery are, doubtless, due to the disturbance of the circulation through the brain that results from the diminution of the supply of blood to that organ. They consist generally of twitchings, convulsions, and hemiplegia; and in other cases of drowsiness, stupor, coma, and apoplexy.

After deligation of the carotid, the lungs, also, are apt to suffer from congestion, as has been pointed out by Jobert and Miller, in some instances at least, apparently secondary to, and probably dependent on, the cerebral disturbance.]

Distal Operation for Aneurism of the Arteria Innominata.

It having been established, that aneurisms may be cured by simply lessening the impetus of the blood flowing through them, and that, although a circulation may yet continue in them for some time, the layers of coagulable lymph within the sac augment, and ultimately bring about a complete consolidation of the swelling, it occurred to Mr. Wardrop, that in aneurism of the arteria innominata, the progress of the disease might be arrested by tying its two great branches, the carotid and subclavian. Although a certain portion of blood would still continue to pass along the innominata to those branches of the subclavian on the cardiac side of the ligature, the ligature being necessarily placed on the subclavian artery, after it emerges from between the scaleni muscles, Mr. Wardrop conceived that such would yet be the diminution of the impetus of the blood in the sac, that the future increase of the tumor would be prevented, and even a permanent obliteration of the aneurismal cavity would be accomplished. (*On Aneurism*, p. 58.) The knowledge of this principle, indeed, he thinks, may be useful in the cure of many aneurisms which have hitherto been considered beyond the reach of art. In an aneurism of the innominata, Mr. Mackelcan found that nature had nearly completed a cure on this principle. The carotid artery was plugged up, and the large aneurismal swelling was filled with a coagulum, leaving only a comparatively small channel for the passage of the blood into the subclavian artery. (See *Appendix to Wardrop on Aneurism.*) However, Mr. Guthrie takes a different view of this case, and infers that a ligature on the carotid above the aneurism would have been of no use, so far as the obliteration of the arteries was concerned, unless it had been followed by inflammation of the sac and coagulation of its contents. (See *Guthrie, On the Dis. of Arteries*, p. 206.) He makes this inference, because though the artery was rendered impervious, by a natural process, the disease went on increasing, till it destroyed the patient. The coagulation of blood is all that the advocates of this plan have in view. Mr. Wardrop has seen instances, and several are on record, which illustrate the important pathological fact, and prove, beyond a doubt, that blood may coagulate in an aneurism so as to strengthen he parietes of the sac, and ultimately fill its cavity, without the circulation in the sac being, in the first instance, either suddenly or entirely interrupted.

It was the knowledge of this fact that led Mr. Wardrop to perform the operation which he has elated. Nature, in the case alluded to, had aleady instituted a curative process by diminishing he circulation in the carotid artery; and when he found this alone not sufficient to stop the enargement of the aneurism, he determined to place ligature on the subclavian. In doing this, e conceived that he was strictly imitating the process which nature herself had commenced. (P. 61.) The case of Mrs. Denmark, aged forty-five, in whom he tied the subclavian artery, and thus cured an aneurism of the arteria innominata, is highly interesting. The particulars may be read in his own publication, or in the *Lancet* for 1827. Suffice it here to state, that the operation had the effect of diminishing the size of the tumor, and causing it almost to disappear. The swelling afterwards enlarged, however, and the patient died. In the *post mortem* examination, the tumor was found occupying the central space between the sterno-mastoid muscles, and composed of three portions; one arising immediately above the sternum; another upwards along the trachea; and the third was the original portion of the aneurism, consolidated by the effects of the operation. The swelling, which underwent no diminution after death, felt like a firm fleshy mass. On laying it open longitudinally, it appeared nearly solid. The clavicular and tracheal portions of the sac were filled with firm coagulum, the cavity being chiefly limited to the division between the sternal and tracheal portions, and it was about the size of a walnut. The coats of the aorta were somewhat thickened; and it presented a few points of ossification. "On cutting into the innominata from the aorta, the aneurism was found to have originally extended from its origin to its bifurcation. The subclavian artery is divided at the place where the ligature had been applied; and both the cardiac and distal orifices are contracted, and the sides of the vessel coalesce, and adhere firmly together. The right carotid pervious, and quite healthy." I think with Mr. Guthrie, that the account of the dissection would have been improved by the statement, whether the branches of the subclavian, given off nearer the heart than the ligature, were pervious, or not. The following is the view taken by Mr. Guthrie of Mrs. Denmark's case: "It appears to me (he observes) that the operation gave rise to inflammation, and consequent coagulation in the sac, which led to a diminution of its size, without interfering with the channel by which the blood passed into the right carotid. The disease was, therefore, for the time, arrested; but, as the artery was unhealthy in the parts surrounding the aneurism, it again returned, and ultimately destroyed the patient. The same thing is clearly taking place in Mr. Evans's patient." (See *Guthrie, On the Dis. of the Arteries*, p. 190.) In the advertisement prefixed to this work is a similar prognostication with reference to Dr. Mott's very interesting case. In the appendix to Mr. Wardrop's publication, and in the *Lancet* for November, 1828, is a case in which Mr. Evans, of Belper, Derbyshire, treated an aneurism of the innominata and root of the carotid, by tying the latter vessel. Three months after the operation, the patient, a butcher and horse-dealer, thirty years of age, was well enough to attend regularly the markets and fairs of Derby, seven miles from his home. In the course of the case, three remarkable circumstances occurred: 1st. An obliteration of the principal arteries of the right arm. 2ndly. A profuse salivation. 3rdly. A disposition to paralysis of the right side; supposed, by Mr. Evans, to have arisen from a greater quantity of blood being sent to the left hemisphere of the brain than to the right. However, as such paralysis has not attended other operations, in which the carotid was tied, the truth of the explanation seems doubtful. The palsy afterwards nearly subsided. This case did not terminate, however, in a cure; for he led a very irregular life, and the tumor, which had been stationary, began to increase, and another tumor made its appearance on the other side of the sternum. "If I were to hazard an opinion (says Mr. Evans), I should be disposed to affirm, that the operation succeeded in arresting the disease for a time, and that, under more favourable circumstances, that time might have been prolonged: but the patient's return to his usual irregular habits, and the fatigue and exercise his avocations necessarily led him into, excited the disease in the lower portion of the innominata, or, perhaps, in the aorta itself; for the original tumor is yet easily distinguished from the later enlargements." Of course, until the time for a *post mortem* examination arrives, this case must be attended with obscurity. The following are some of the particulars of the case, in which Dr. Mott, of New York, tied the carotid artery for an aneurism of the innominata. The patient, Moses R. Gardner, aged fifty-one, a farmer of sound constitution and good habits of life, about three years before he consulted this gentleman, while occupied in removing a building, was attacked with pain in the upper and back part of the neck. This afterwards extended to the right shoulder and arm, but, in time, partially subsided, and his voice became hoarse. About eighteen months before he consulted Mr. Mott, he discovered a small swelling at the upper part of the breast-bone, but did not at first remark any throbbing in it. Dr. Mott found, above the sternum, a pulsating tumor, about the size of a pigeon's egg, spreading some distance under the clavicular and sternal portions of the right sterno-mastoideus, in the course of the subclavian artery, and extending as low down as the second rib, compressing the bronchial tubes, and producing, on the least coughing or exercise, a wheezing, not unlike that of asthma. The patient shrunk from the least pressure upon it, complaining of impeded respiration, followed by pain; its pulsations were synchronous with those of the heart, and decidedly aneurismal.

After fully explaining to him the nature of his disease, and its probable fatal termination should it be left to itself, Dr. Mott advised him to return to his home, to avoid all exertion, to be occasionally bled, and to confine himself principally to a vegetable diet; but, should he observe the least increase, either in the tumor or any of his symptoms, to apply again. In a few months he again came to New York. Dr. Mott now found that the tumor above the sternum had much increased, and, upon a careful application of the stethoscope, that it had evidently encroached more upon the chest. The *bruit de soufflet* could be heard; the thoracic viscera were sound, and the respiratory murmur distinct. In either speaking, walking, or coughing, respiration was very much impeded, and almost entirely suspended by the least pressure upon the tumor. The action of the right carotid was more feeble than that of the left, and no pulsation could be felt in its branches; the right subclavian, external to the scaleni muscles, was natural, while the axillary and brachial arteries could hardly be felt; and at the wrist no pulse could be distinguished; but the pulsations of the arteries of the left side were natural. The general health was good.

Dr. Mott was persuaded the aneurism was one of the arteria innominata, involving the subclavian and the root of the carotid, and he considered it a proper case for the operation proposed and successfully performed by Mr. Wardrop. From the evident interruption of the circulation in the right arm, and the apparent efforts of nature to effect a spontaneous cure, he determined to tie the carotid first, and afterwards the subclavian, should it be required.

"On the 20th Sept. the artery was taken up in the usual manner. 27th, 9 A.M. Slept well, and feels refreshed; thinks there is more room, as he expresses it, in breathing; complains of a little soreness of the tonsils; pulse 58, regular and tranquil; the skin natural; pulsation and size of the tumor evidently diminished. 9 P.M. Much more restless; pulse 68, and tense; in other respects the same as in the morning; being habituated to laudanum, was permitted to take a teaspoonful. 28th, 9 A.M. Slept well; breathes more easily; feels less of the pulsation in the tumor; pulse 63, and not so tense; skin natural, and cough less. Ordered a dose of magnesia and Epsom salts. 9 P.M. Has passed a comfortable day. His wife, who arrived from the country since the morning, expressed her surprise at the improvement in his voice and breathing, as well as at the difference in the beating. Pulse of the right radial artery very distinct, but intermitting from ten to fifteen beats; in the left arm 80, and stronger; coughs frequently, and expectorates freely; skin natural; tongue a little white; salts have not operated. Ordered the dose to be repeated; and if restless after its operation, to take his usual anodyne. 29th. Saluted Dr. Mott this morning with a full and fine voice, and said he was well enough to call on him. His cough and expectoration much less. Dr. Mott found him lying down, and breathing quietly; pulse 71, and regular. The radial artery of the right arm beating as last evening, with fewer intermissions, but of longer continuance; skin over the tumor more wrinkled; pulsation less and weaker. The ligature came away on the night of the 15th, and the *tumor above the sternum, and pulsation, entirely had disappeared;* the cough and breathing better; voice nearly natural; pulse 66, with now and then a very faint pulsation of the right radial artery; right hand a little swelled, and numbed. 22nd. Wound has just healed; weakness of the arm considerable; fingers very thick and clumsy; whole arm swelled, and pits upon pressure; no pulse in the right radial artery; breathing easy; cough and expectoration much less; can sleep easy in any position, *which he has not been able to do for many months.* 26th. Left town for his residence in New Jersey." This patient died seven months after the operation.

[Three distinct modifications of the distal operation have been practised for the cure of aneurism of the innominata. 1. The ligature of the subclavian only. 2. The ligature of the carotid only. 3. Of both vessels, with an interval of greater or less extent.

The ligatures of the subclavian only, in the third part of its course, for the cure of aneurisms of the innominata, has been practised in three cases only. Of these, two proved fatal, and the third was partially successful, owing, probably, to the carotid being occluded by disease.

The ligature of the carotid only has been practised in eight cases, and in one instance only does the disease appear to have been benefited by the operation, and in that instance the good effects appear not to have been due so much to the operation itself as to the accident of the sac becoming inflamed, and suppurating, and thus undergoing a spontaneous cure.

In three instances, both the carotid and the subclavian have been tied; and, in the most favourable of these, two years elapsed between the ligatures of the carotid and that of the subclavian, the patient dying three months after the second operation. In one of the other cases, both arteries were tied simultaneously, the patient surviving six days. The last case in which distal ligature of the carotid has been practised, is one by Mr. Lane, of which the following is a short account:—

"J. F., thirty-six years of age, admitted into St. Mary's Hospital, July, 1852, for aneurism of left carotid, immediately above the sternal end of the clavicle, which first appeared six months previously. July 7th. The carotid was ligatured on the distal side of the tumor; the chief point worthy of note being the large size of the anterior jugular vein. After the operation, the pulsation in tumor increased somewhat, but no pulsations in branches of external carotid. On the 10th, tumor being much the same, ice was applied to it. On the 16th, it was rather harder. 19th, ligature came away; less impulse in tumor. On 29th, indistinct return of pulsations in left temporal. Aug. 5th, Tumor decidedly harder. 6th. Considerably less prominent; and the whole tumor felt more solid. 7th. Tumor was rapidly decreasing; pulsation merely at inner and lower side; some humid discharge took place from the wound, and in the night of the 22nd pure blood was discharged; V. S. ad ℥ xij. was prescribed. The patient now became feverish, and symptoms of broncho-pneumonia, with bloody sputa set in, from which he died on Sept. 13th. After death, the aneurism was found adhering to apex of left lung, with which it communicated by a circular ulcerated aperture; it was filled with firm layers of coagulum, except at commencement from aorta, and part adjoining left lung. The artery above tumor obliterated as high as external carotid."]

OF ANEURISMS OF THE AORTA, AND VALSALVA'S TREATMENT.

This afflicting and fatal disease is by no means unfrequent, and the arch of the aorta is its most common situation. Dr. Hunter was of opinion, that the latter circumstance depended on the forcible manner in which the blood, propelled from the left ventricle of the heart, must be driven against the angle of the curvature of the vessel. Mr. A. Burns considered aneurism of the thoracic aorta more frequent, perhaps, than that of any other vessel in the body. "I have had (says he) an opportunity of examining fourteen who had died of this disease, but have not seen more than three instances of external aneurism." (*On Diseases of the Heart, &c.* p. 215.) These proportions, however, would not correspond to common observation, external aneurisms, taken collectively, being supposed to be about as numerous as those of the aorta alone, a calculation long ago made by Dr. A. Monro, primus.

It was the opinion of Dr. W. Hunter, that the aneurismal sac was composed of the dilated coats of the artery, which parts nature thickened and studded with ossifications, after the origin of the disease, for the purpose of resisting its increase. Mr. Hodgson also declares his decided belief, and adduces facts to prove, that many aneurisms of the aorta are formed by dilatation. Yet the celebrated Scarpa believed that the generality of aneurisms of the aorta were the consequence of a rupture of the proper coats of this large vessel; and that its cellular sheath was distended into the aneurismal sac. While Dr. W. Hunter considered the ossifications of the sac as consequences of the disease, Haller looked upon the scales of calcareous matter in the aorta as the very cause of the affection, by rendering the artery inelastic, and incapable of yielding to each pulsation of the heart. On this point Haller was right.

Aneurisms of the aorta are most common in persons who are advanced in life; and the aorta of every old subject, whether affected with aneurism or not, is very commonly marked in some place or another with ossifications, or rather with calcareous concretions. Such productions occasion a decay, or absorption, of the muscular and inner coats of the vessel, so that at length the force of the blood makes the artery give way; and this fluid, collecting on the outside of the laceration, or rupture, gradually distends the external sheath of the artery into the aneurismal sac.

"If any person, who is not prejudiced in favour of the common doctrine with regard to the nature and proximate cause of this disease (says Scarpa), will examine, not hastily and superficially, but with care and by dissection, the intimate structure and texture of the aneurism of the aorta, unfolding with particular attention the proper and common coats of this artery, and, in succession, those which constitute the aneurismal sac, in order to ascertain distinctly the texture and limits of both, he will clearly see that the aorta, properly speaking, contributes nothing to the formation of the aneurismal sac, and that, consequently, the sac is merely the cellular membrane which in the sound state covered the artery, or that soft cellular sheath which the artery received in common with the neighbouring parts. This cellular substance, being raised and compressed by the blood effused from the corroded or lacerated artery, assumes the form of a circumscribed tumor, covered externally, in common with the artery, by a smooth membrane such as the pleura in the thorax, and the peritoneum in the abdomen." Scarpa then comments upon the differences of the mere dilatation of an artery from aneurism, a subject which has been already fully considered in the foregoing pages. (*Scarpa, On the Anatomy, Pathology, and Surgical Treatment of Aneurism, transl. by Wishart,* p. 55, 56.)

As I have already explained in the preceding columns, the views taken of this part of the subject by Scarpa are not entertained by the generality of surgeons; or rather, his doctrine is not carried by others to the extent which he has insisted upon, and it would be useless repetition to bring again before the reader the facts proving that his statements are liable to many exceptions. A case, however, recited by M. Roux, which I have met with since the foregoing pages were printed, merits notice; it was an instance in which a popliteal aneurism, unattended with pulsation, had been mistaken for an abscess and punctured, whereby the patient lost his life. On dissecting the limb, M. Roux says, "the three coats of the artery participated in the dilatation, and the case was one of the clearest specimens which I have ever seen of a true aneurism." (*Nouveaux Elémens de Méd. Opératoire*, t. i. p. 517.)

The best pathologists now admit six varieties of aneurismal disease of the aorta. 1. *A Dilatation*, involving the whole circumference of the artery. 2. *True aneurism*, or a sacculated dilatation of only a portion of its circumference. 3. *False aneurism*, formed by ulceration or rupture of the internal and middle coats, and a dilatation of the external one into a sac. 4. *Mixed* or *sacculated aneurism*, where, after partial or general dilatation of all the three coats, the internal and middle burst, and the external alone expands into another sac, engrafted as it were upon the original dilatation, or true aneurism. 5. The case in which the inner coat protrudes through the outer ones. (*Dubois; Dupuytren; Laennec, De l'Auscult.* t. ii. p. 693.) A fine specimen of this is contained in Mr. Liston's collection. 6. A few very rare examples have been noticed in which, after the rupture of the internal and middle coats of the aorta, the blood, instead of distending the external coat into a swelling, insinuates itself more or less extensively between this coat and the middle one. Thus Laennec saw a case in which the internal and middle coats had a narrow fissure in them extending across two thirds of the circumference of the artery; and the blood had interposed itself between the external and middle coats, over more than half of the circumference of the aorta, from its arch to its bifurcation. (*Laennec, De l'Auscult.* t. ii. p. 700.) Two similar cases are reported by Mr. Guthrie. (*On Dis. of Arteries*, p. 40 and 43.) The late Mr. Shekelton met with a still more curious form of aortic aneurism, where the blood, after making its way through the internal and middle coats, had separated the external from the middle to the extent of four inches, and then passed again through the middle and internal coats into the canal of the artery; thus forming a new channel, and the old one being obliterated. (*Shekelton*, in *Dubl. Hosp. Rep.* vol. iii.)

As Dr. Hope observes (*Cyclop. of Pract. Med.* art. *Aorta*), the foregoing are the only instances on record where a fissure of the internal and middle coats has been followed by more than a circumscribed effusion of blood around it, occasioning a slight swelling of the external coat. Nichols found this in the body of George II. (*Phil. Trans.* vol. lii. p. 269); and Hodgson once met with it. (*On Dis. of Arteries*, p. 63.)

Aneurisms, and the diseases of the coats of the arteries which precede their formation, are well known to be far more common in men than in women. (*Sir A. Cooper, Hodgson, Lisfranc*, &c.) Yet women are perhaps quite as frequently afflicted with aortic aneurisms as men, though, with respect to external aneurisms, they may only exhibit the proportion of one case to fifteen or twelve in male subjects. (See *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*) With respect to dilatation affecting the whole circumference, I may observe, that the great arterial trunks given off at right angles from the aorta, as the innominata and cœliac axis, generally participate in it; but, as Laennec observes, the left subclavian commonly remains unaffected, on account of the acute angle at which it leaves the arch of the aorta.

As for *true aneurisms*, almost all those of the ascending aorta and arch are originally of this description; but the false is sometimes engrafted upon them. The tumor, which mostly inclines to the right side of the chest, generally springs from the anterior or the lateral part of the vessel, while the posterior is little, if at all, implicated. When it springs from the root of the aorta, and the middle and internal coats give way, the consequence is not a false aneurism surmounting the true, as in other parts, but a fatal extravasation into the pericardium. The reason of this is, that the portion of the aorta referred to is destitute of the cellular coat, and the pericardium, which supplies its place, not being equally extensible, bursts while the aneurism is but of small size. (See *Scarpa, On Aneurism, by Wishart*, p. 80; *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta; Bertin, Bouilland*, &c.) It does not appear certain to me, that the preparation, No. 367, in the Hunterian collection at the College of Surgeons, proves, as Mr. Guthrie believes it does (*On Dis. of Arteries*, p. 70), that this doctrine is incorrect, because, though it is true that the aneurism, in this instance, is of unusual size, the inner membrane can be distinctly seen passing over the atheromatous patches. As Dr. Hope remarks, the preparation is then not one of false *aneurism*, as the middle coat is perfect, the internal one alone being removed or diseased (it is doubtful which), at the base of the sac. Scarpa only maintains, that the pericardium becomes incapable of resisting a false extravasation after the inner coats have given way.

In the Museum of the University College, the preparation No. 616 exhibits three diminutive aneurismal sacs just above the valves of the aorta, one of which has burst into the pericardium. The preparation No. 617, in the same collection, is the heart of a patient who died of the rupture of a small aneurism within the pericardium. He had been operated upon for a popliteal aneurism only three months previously. The little tumor burst just above the pulmonary artery, and a bristle is passed through the opening from the inside of the aorta, where the sac is seen directly above the valves. We know that in one case, when Sir Astley Cooper had just commenced the operation for popliteal aneurism, the patient suddenly expired, owing to a small aneurism near the root of the aorta happening to burst into the pericardium at this moment of agitation and suffering.

In thin subjects, the throbbing of the abdominal aorta is sometimes unusually plain through the integuments and viscera, and this has occasionally given rise to the suspicion of an aneurism; a circumstance which deserves to be remembered by every surgeon desirous of not pronouncing a wrong opinion. The preternatural pulsations, however, which are liable to be mistaken for those of aortic aneurisms, are of various kinds, and form a subject to which the attention of Dr. Albers, of Bremen, the late Mr. A. Burns, and others, has been very usefully directed. (See ABDOMEN.)

While thoracic aneurisms of the aorta are not accompanied by external swelling, the symptoms are all equivocal, as very similar ones may depend on a disease of the heart, angina pectoris, phthisis pulmonalis, &c. However, some difference depends upon the volume, position, and nature of the aneurism. Simple dilatation, when in a moderate degree, hardly produces any effect, but the most inconsiderable false aneurisms may give rise to very serious disorder. The first and most common of these effects is, the compression of the heart and lungs. (See *Laennec, On Diseases of the Chest, by Forbes*, p. 676, ed. 2.) Amongst its worst effects are those which it produces on the trachea and bronchi; for though the pressure be slight, it often suffices, in consequence of the great irritability of these parts, to produce considerable dyspnœa. It must not be imagined, however, that dilatation is an unimportant affection; for, when complicated with hypertrophy of the heart, it is one of the most formidable diseases of the organs of the circulation. (See *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*)

The only unequivocal general sign of an aneurism of the thoracic aorta, is a tumor presenting itself externally, and attended with an expansive heaving pulsation synchronous with the action of the heart. Many of the other general signs are acknowledged to be like those of organic disease of the heart; viz. palpitation, dyspnœa, cough, tendency to syncope, terrific dreams, starting from sleep, hæmoptysis, livid complexion, cerebral or hepatic congestions, serous infiltration, &c. The identity of the general signs arises, as Dr. Hope explains, from an identity of cause; namely, an obstacle to the circulation, which depends either upon the aneurism alone, or conjointly upon it and a disease of the heart, to which sooner or later the aneurism almost invariably gives birth. When, however, the general signs coincide with those learned by auscultation, they lose their ambiguity. (See *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*)

In aneurism of the aorta forming a defined tumor, violent and irregular throbbings frequently occur between the fourth and fifth true ribs of the left side; the same irregularity of the pulse prevails as often proceeds from organic affections of the heart; sometimes a dissimilarity of the pulses in the two wrists, an effect depending upon obstruction, or obliteration of the arteria innominata or left subclavian; the respiration is exceedingly obstructed; the voice altered; and in a more advanced period of the malady, the patient is at times almost suffocated, or actually perishes from this cause. The pressure of the internal swelling on the trachea, bronchi, and lungs, is sufficient to account for this difficulty of breathing. When the trachea, or primary bronchial divisions, are compressed by an aneurismal tumor, a harsh, wheezing, or sibilous sound characterises respiration; and when the heart is simultaneously diseased, dyspnœa sometimes occurs in most severe paroxysms, threatening suffocation. (See *Hope*, op. cit.) In many instances, the irritation and compression produced by the tumor occasion atrophy of the greater part of the lungs, and abscesses and induration throughout the portion which remains. The function of deglutition suffers interruption, in consequence of the pressure made on the œsophagus, which may even be in a state of ulceration. Thus, in one example, "the cavity of the windpipe was nearly obliterated from the pressure of the aneurism; and the extremities of four of its cartilages lay in the œsophagus, having entered that canal through an ulcer in its coats." (*Trans. for the Improvement of Med. and Chir. Knowledge*, vol. iii. p. 83.) After what has been stated, it cannot be surprising, that ere the disease manifests itself externally, affection of the lungs, or strictures of the œsophagus, should often be suspected. (*Hodgson*, p. 91; *Porter*, in *Dubl. Journ. of Med. Science*, vol. iv. p. 207.) On the supposition of a stricture in the œsophagus, probangs have frequently been used.

The greater weakness of one radial pulse than the other, or its total extinction, may proceed from a variety of causes, independent of aneurism of the aorta, as contraction of the origin of either of the subclavian arteries from calcareous, cartilaginous, steatomatous, or other depositions; obstructions in the course of the artery produced by tumors, wounds, or subclavian aneurism, or from an irregular subdivision of the radial or brachial artery. (See *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*)

An aneurism of the arteria innominata, not discovered till after the patient had died of suffocation, gave rise to great difficulty of drawing air into the chest, without any other symptom calculated to throw light on the nature of the disease. The aneurismal swelling was situated behind the first bone of the sternum, and pressed upon the trachea. The front of this tube was pushed in by the tumor, so as to present a convex prominence on the inner surface, which, however, diminished its area in a very slight degree. Mr. Lawrence adduces this fact to prove that spasm of the air-cells may be the cause of great distress in breathing. "The termination of this case (says he) is the more remarkable, inasmuch as in another patient an aneurism rising out of the arch of the aorta, and pressing on the corresponding part of the trachea, so as to produce ulceration of the internal membrane, under which there was a slight appearance of coagulated blood, caused no affection of the breath at all. The person died of a different complaint, and the discovery of the aneurismal tumor, which was very small, and filled with firm laminated coagula, was quite accidental." (*Med. Chir. Trans.* vol. vi. p. 227.) Thus, we find in thoracic aneurisms, at least previously to their attainment of a certain size, that no regularity prevails even with regard to difficulty of breathing, the symptom, which, *à priori*, one might suppose would invariably be present.

One of the least equivocal signs of an aneurism of the thoracic aorta, is a pulsation felt under the sternum, or ribs, at the upper part of the chest. But a positive opinion is not to be formed from this symptom alone, which has been known to be occasioned by some other kind of tumor behind the sternum, by adhesion of the pericardium to the heart, by fluid in the cavity of this membrane, and by hypertrophy of the heart. (*Baillie's Morbid Anat.*; and *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*) Then another symptom of aneurism of the thoracic aorta, is pulsation above the sternum or clavicles. But this may also proceed from enlarged glands in the course of the subclavian artery, and receiving its pulsation; by varix of the jugular vein at its junction with the subclavian; or by a subclavian aneurism. A gentleman, under Mr. Maul, of Southampton, lately consulted me for a considerable throbbing felt above the sternum and clavicles, and which had been suspected to denote on the left side a subclavian aneurism. The radial pulse in the left arm was rather weaker than in the right. But the carotids also pulsated with unusual force a good way up the neck; and every little exertion brought on powerful beating of the heart. In a consultation with Sir Astley Cooper, these circumstances led us to set down the case as one of dilatation of the great arteries at the source of the circulation, with an imperfect state of the valves, and some degree of hypertrophy. A pulsation above the sternum may be occasioned by carotid aneurism, which is liable to be confounded with aneurism of the aorta, or of the subclavian artery. Dr. Hope informs us, that in April, 1826, he saw in Guy's Hospital a case which led to much deliberation respecting the propriety of taking up the carotid above a pulsation tumor, supposed to be an aneurism of that artery. The plan, however, was judiciously abandoned, for the disease proved to be a dilatation of the aorta and innominata. (See *Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*)

Few diseases, according to Laennec, are so insidious as aneurism of the thoracic aorta. He affirms, "that it cannot be known with certainty till it shows itself externally. It can hardly be suspected, even when it compresses some important organ, and greatly deranges its functions. When it produces neither of these effects, the first indication of its existence is often the death of the individual, as instantaneously as if by a pistol-bullet." One case, recorded by Mr. Pattison, confirms the same fact, for the patient had only symptoms leading to a suspicion of rheumatism in the neck, and died suddenly of apolexy. (*Burns, On the Head and Neck, ed. by Pattison.*) Laennec has known persons cut off in this manner, who were believed to be in the most perfect health. He admits, that percussion will sometimes enable us to detect a tumor of large size, existing within the mediastinum, or even in the back; but not to discriminate the nature of the swelling. His experience had not been sufficient to let him pronounce how far the difficulty of diagnosis was likely to be removed by the stethoscope. Dr. Hope has met with six or seven instances in which large aneurisms had existed without awakening even a suspicion of them. One, in particular, eluded the penetration of a distinguished foreign auscultator, though he explored the lungs with eminent success. (*Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*) Aneurisms of the abdominal aorta, Laennec admits, may be recognised with the utmost facility by means of the stethoscope. In this case we are sensible of tremendous pulsations, which painfully affect the ear, and the intensity of which is not at all recognised by the hand, even when sufficiently perceptible to the touch. As high up as the cœliac artery, the contractions of the auricles are not in the least distinguishable. The sound of the pulsations is clear and loud. (*Laennec, On Diseases of the Chest*, p. 678, &c.)

Laennec believed that thoracic aneurism might sometimes be recognised by its *simple* or rather *single* pulsation, which is much stronger than the double pulsation of the heart; but that, in most instances, this criterion would fail, in consequence of the sound of the heart and that of the aneurism being confounded together. But as the auricular sound is not audible over the abdomen, Laennec had no difficulty in recognising ventral aneurism by the *simple* pulsation. The following are some of the criteria, specified by Dr. Hope, for distinguishing the pulsation of thoracic aneurisms from the beating of the heart; and, in some important points, his observations have received confirmation from the experience of Dr. Greene. (See *Researches on the Symptoms, &c. of Aneurisms of the Thoracic Aorta, Dubl. Journ. of Medicine*, vol. vii. p. 231.) 1. The first aneurismal sound, coinciding with the pulse, is invariably louder than the healthy ventricular sound, and generally than the most considerable bellows-murmurs of the ventricles. 2. On exploring the aneurismal sound from its source towards the region of the heart it is found to decrease progressively, until it either becomes totally inaudible, or is lost in the predominance of the ventricular sound. If the sound emanated from the heart alone, instead of decreasing, it would increase on approximating the præcordial region. 3. The second sound actually does sustain this progressive augmentation on advancing towards the heart. 4. The aneurismal pulsation is a deep hoarse tone, of short duration, with an abrupt commencement and termination. It is compared to that of the rasping of a sounding-board heard from a distance. But the sound occasioned by valvular disease of the heart has more analogy to the bellows-murmur, being somewhat soft and prolonged, with a gradual swell and fall. 5. In simple dilatation of the thoracic aorta, the *frémissement cataire*, or purring tremor, is more considerable than in sacculated aneurism, particularly if the former be accompanied with much asperity of the internal membrane. It is also very correctly noticed by Dr. Hope, that the sound of aneurisms is, in most instances, audible on the back; and when the tumor occupies the descending aorta, it is often louder behind than on the breast; and if it is of the abrupt rasping kind, it amounts almost to positive evidence. Pulsation, he observes, attends every species of enlargement of the aorta. In dilatation, it exists only above the sternal ends of the clavicles, and always on both sides of the neck simultaneously; though, when the enlargement is confined to the ascending aorta, it is stronger on the right than on the left side. When dilatation is in the form of a pouch, and of great magnitude, it may occasion pulsation under the sternum. Carotid and subclavian aneurisms produce impulse, sound, and tremor, on the affected side only; and by this circumstance they may easily be discriminated from aortic enlargements. In sacculated aneurisms in the upper part of the chest, pulsation exists both above and below the clavicles; but Dr. Hope has generally found it stronger below. (*Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*) M. Bertin also believed, as Dr. Hope does, that Laennec underrated the power of the stethoscope to detect aneurism of the thoracic aorta. (*Mal. du Cœur*, p. 143.) Still, it is a fact, that, even with the assistance of this instrument, thoracic aneurism sometimes cannot be detected, and produces symptoms leading to a suspicion of other affections, to which the treatment is directed accordingly. (See *Porter*, in *Dubl. Journ.* vol. iv. p. 206, &c.)

I have mentioned, that the symptoms of thoracic aneurisms, previously to the formation of any outward swelling, often resemble those of phthisis, and the latter is sometimes actually supposed to be the disease under which the patient is labouring. But there is one distinction between the cases, pointed out by Mr. Hodgson, which may be of use, in combination with other circumstances, in facilitating the diagnosis: "In phthisis, the expectoration is either puriform, or thick and clotted; but in aneurisms which are not accompanied with disease in the lungs, as far as I have observed, it always consists of a thin frothy mucus." (*On Dis. of Arteries, &c.* p. 93.) According to Kreysig's experience, the cough comes on at irregular periods, is violent, and attended with great efforts, the expectorated matter being forced up with vehemence. He agrees with Mr. Hodgson respecting the general quality of what is expectorated, where thoracic aneurisms are not complicated with diseased lungs; but he says that the matter coughed up also frequently consists of masses of lymph, blended with brick-red particles of blood, which masses, when thrown into water, seem as if they were composed of a ball of stringy substances. (*Germ. transl. of the latter work*, p. 137.)

From a review of many cases of aortic aneurisms, Mr. A. Burns was inclined to think, that when the ascending aorta is aneurismal, the breathing is more affected than when the arch of the vessel is enlarged; but that, in the latter case, the impediment to deglutition is greatest. (*On Dis. of the Heart, &c.* p. 244.)

False aneurisms are most common in the descending aorta, and true ones in the ascending portion of the vessel and its arch. Laennec never met with any species of false aneurism in the latter situation, but such as is consequent to the true, or simple dilatation of the artery. (*On the Dis. of the Chest*, p. 676, *ed. by Forbes.*)

[The *symptoms* of intra-thoracic aneurisms are of two kinds, *auscultatory* and *rational.*

The *auscultatory signs* vary greatly in distinctness, and even in presence. In some cases, more especially in fusiform aneurisms, they are almost from the first of a very marked and obvious character; in others, especially in sacculated aneurisms, they are absent throughout, the aneurism terminating fatally without its existence having been determined by the stethoscope. They consist of murmurs of various kinds and degrees of intensity, bellows, rasping, or whizzing; by the second sound of the heart being audible over a greater space than normal, and by the existence of dullness on percussion. These various signs may often be heard more distinctly upon, or to the left side of, the spine than at the anterior part of the chest; when occurring anteriorly they are chiefly met with on the right side.

The value of the auscultatory signs in the diagnosis of aneurisms within the chest, is not perhaps so great as in many other thoracic diseases in the early stages of the affection, and in those cases in which the aneurism continues small and sacculated throughout, or is so deeply seated as not to approach the parietes of the chest. This need not be a matter of surprise, when we reflect on the depth at which the ascending portion of the aorta and the arch are situated, how it is covered in front by the lungs and loose cellular tissue, through which sound is with difficulty transmitted; and how it is covered in behind by the spine and its muscles. When, in addition to this, it is borne in mind that aneurisms of the arch often prove fatal by bursting into contiguous cavities and canals before they have attained a greater size than a walnut or a pigeon's egg, and thus are incapable of furnishing a murmur of any very marked kind, it can easily be understood that the value of auscultation is but small in many cases of thoracic aneurisms.

The *rational signs* of intra-thoracic aneurism are of three kinds: — 1. Pressure effects. 2. Pulsation. 3. Tremor.

Pressure effects may be exercised on any of the contiguous structures, and a glance at the anatomical relations of the thoracic aorta, more particularly the arch, will enable the surgeon to judge of their complexity and importance. They will necessarily vary according to the size of the aneurism, and the portion of the aorta that is affected by it, more by the latter than the former condition. When the aneurism arises from the root of the aorta, and more especially when it is intra-pericardial, it is usually of small size, and its pressure effects will be little obvious. When the aneurism arises from the termination of the arch, or the descending aorta, it may often attain a considerable amount of development without any very obvious pressure effects being induced. Aneurisms that are situated within the concavity of the arch must necessarily give rise to pressure effects, by the compression they must exercise upon some one or other of the very important structures that are spanned by, and included within, the aortic arch. Where the anterior part of the aorta is affected, the aneurism may attain a very considerable bulk, even coming forward so as to project and pulsate between the intercostal spaces, without any very noticeable pressure effects being induced. But when the posterior wall of the artery is the seat of the disease, then severe symptoms are early set up by the structures lying contiguous to the artery and along the spine being compressed. When the upper part of the aortic arch is the seat of aneurism, a peculiar train of cerebral symptoms, such as vertigo, insensibility, or defective vision, may be induced by its interference with the circulation through the carotids.

The pressure effects that need chiefly engage our attention are: 1. Pain; 2. Dyspnœa; 3. Dysphagia; and 4. Œdema.

1. *Pain* is usually one of the earliest symptoms of intra-thoracic aneurism, and is often of great value in a diagnostic point of view, as it is often more marked when the other symptoms are the least developed. It is generally more severe in sacculated than in fusiform aneurisms, and when the posterior rather than the anterior aspect of the vessel is the seat of disease. The pain, as has been pointed out by Dr. Law, is of two distinct kinds. The first form is lancinating, intermitting, and neuralgic in its character, evidently dependent upon pressure on the spinal or sympathetic nerves. These pains are chiefly seated on the left side, shoot up the side of the head and face, down the upper arm to the elbow, along the intercosto-humeral nerve, through the chest or between the scapulæ. The second form of pain usually occurs at a later stage of the disease, is continuous, and of a boring, hot, or burning character. It seems to depend upon the perforation of the tissues, more especially the bones, by the aneurismal tumor, and chiefly occurs on the right side of the chest.

2. *Dyspnœa* is of very frequent occurrence in intra-thoracic aneurisms; in all probability it is more uniformly met with than any other single symptom. It may arise from five distinct conditions, and its characters vary with its cause.

a. From direct pressure on the trachea. In these cases the dyspnœa is attended by much and constant wheezing cough, often by whistling sounds in the chest, and by slow expansion of that cavity. There is expectoration usually of thick, tenacious, or ropy mucus.

β. From direct pressure on the bronchus. In these cases there is wheezing cough, and some degree of expectoration, with probably diminished respiratory murmur in the side affected, and puerile respiration in the opposite lung, as has been pointed out by Dr. Stokes.

γ. From pressure upon the lung. In these cases the respiration is comparatively little interfered with, the spongy tissue of the lung accommodating itself and yielding to the pressure of the tumor. After a time the pulmonic tissue will become incorporated with the wall of the sac, and then more serious difficulty of breathing, with hæmoptysis, will supervene.

δ. Dyspnœa may be, and very commonly is, induced by the irritation, compression, flattening out, or stretching of the left vagus and recurrent laryngeal nerves, by the pressure of the tumor. In these cases the larynx becomes the seat of the difficult respiration, its muscles being thrown into a state of spasm, so as to occasion paroxysmal attacks of intense difficulty of breathing. The voice becomes hoarse, croupy, or croaking. The cough has a hard, croupy, or metallic sound, and is attended by the expectoration of a thin frothy mucus. The laryngeal spasm and stridor often does not occur in ordinary respiration, but is produced under exertion, or in making the patient respire fully and deeply. The laryngeal symptoms are sometimes so much more prominent than any of the other signs of intra-thoracic aneurism, and so closely resemble chronic, or even acute, laryngitis with supervening asphyxia, that there are not a few cases in which surgeons have performed tracheotomy, on the supposition that they had to do with cases of pure and uncomplicated laryngeal disease, and in other instances this operation has been performed with the view of prolonging life, even when the dependence of the laryngeal spasm on aneurism of the aorta has been recognised.

ε. Dyspnœa may be dependent on the compression of the pulmonary veins by the aneurismal tumor. In such cases as these there would be considerable lividity of surface, and signs of pulmonary congestion.

The dyspnœa of aneurism will often be sufficiently intense to occasion death.

It may be mistaken for ordinary asthma. But the diagnosis may usually be effected by observing that in aneurism the dyspnœa of the paroxysms often comes on in the day as well as at night; are greatly increased by change of position, placing the patient either upright or recumbent, the tumor thus shifting its point of pressure. It is not, as Dr. Bellingham has pointed out, influenced by atmospheric changes, and is generally associated with laryngeal stridor. When such symptoms as these are associated with pain and dysphagia, they point very strongly, even in the absence of all auscultatory signs, to the presence of an aneurismal tumor.

Aneurisms situated within the concavity of the aortic arch are those that, either directly by their pressure on the air tube or the pulmonary veins, or indirectly by the influence they exercise on the recurrent laryngeal nerve, are chiefly associated with dyspnœa.

3. *Dysphagia* is a symptom of sufficiently frequent occurrence in aortic aneurism, Dr. Green having determined its existence in nine out of twelve cases. It seldom occurs, however, in the earlier stages of the disease, or when the aneurism is small, and hence is of much less diagnostic value than dyspnœa. When, however, it is associated with that symptom, the combination becomes important, as the co-existence of the the two conditions clearly points to the compression of the œsophagus and the air tubes by a tumor, which other diagnostic signs may prove to be aneurismal.

It is of importance to bear in mind, that in some aneurisms, especially of the descending thoracic aorta, dysphagia may be one of the most marked signs. In such cases as these, stricture of the œsophagus has erroneously been supposed to exist, and the patient has even been treated by the introduction of bougies on this supposition ; an error of practice that has terminated fatally by the perforation of the aneurismal sac, when projecting against the œsophagus, by the point of the instrument.

The difficulty of deglutition in cases of compression of the œsophagus by aortic aneurism is always invariably referred to the epi-sternal notch. The dysphagia is commonly associated with pain, or the sensation of a tight cord drawn around the body.

4. *Œdema*, with more or less lividity of the upper extremities, and head and neck, occasionally, but rarely, occurs. It is generally more marked on the left side, and arises from the compression of the superior cava or the innominate veins, by aneurisms springing from the fore or upper part of the arch.

Pulsation and tumor in intra-thoracic aneurisms, so far as they are observable externally, are always absent in the earlier stages of the disease, and very frequently continue so throughout the progress of the affection. Indeed, in aneurisms springing from the intra-pericardial aorta, or the concavity of the arch, death usually takes place, either by rupture into one of the serous cavities, or the air tube, or by the exhaustion induced by dyspnœa long before the aneurism has attained a sufficient size to be cognisable externally. There are, however, three portions of the thoracic aorta which, when affected by aneurism, yield external evidence, by the existence of pulsation or tumor, of the true nature of the disease. These are—1. The anterior aspect of the ascending aorta ; 2. The summit of the arch ; and 3. The posterior aspect of the descending aorta.

When the aneurism is situated in the anterior aspect of the ascending aorta and commencement of the arch, pulsation may be detected by pressure between the intercostal spaces on the right side of the sternum, and a thrill, as well as distinct impulse, may often be felt over that side of the chest, before any external tumor becomes visible, thus simulating the beat of the heart in addition, and opposite to the seat of the true cardiac impulse. As the aneurism increases in magnitude, an external tumor appears by the wall of the chest becoming absorbed and perforated opposite the point of greatest impulse.

When an aneurism springs from the summit of the arch, a pulsating tumor appears at the root of the neck, behind, or even above the margin of the sternum, most commonly towards the right side; and it occasionally rises so high out of the thorax, and is so distinctly felt in the neck, as to run the risk of being confounded with aneurism of the brachiocephalic or carotid arteries ; an error that may be avoided by the impossibility of tracing with the finger the lower boundary of the tumor, and the evidence of dullness on percussion, probably of impulse, or of auscultatory evidence of aneurism below the level of the upper margin of the sternum or clavicle.

When an aneurism springs from the posterior wall of the descending aorta, a pulsating tumor may gradually develop itself to one side of the spine, or under the scapula, commonly on the left side, which may attain an excessive development fully as large as the head.]

The way in which aneurisms of the thoracic aorta prove fatal, is subject to considerable variety. These swellings do not always destroy the patient by hemorrhage: in numerous instances, the functions of the lungs, bronchi, heart, and œsophagus are so deranged by compression, that death is induced, and not a drop of blood is found internally effused. Frequently (to use the description of Mr. John Bell) before the awful and fatal hemorrhage has had time to occur, the patient perishes of sufferings too great for nature to bear. The aneurismal tumor so fills the chest, oppresses the lungs, compresses the trachea, and curbs the course of the descending blood, that the system, with a poor circulation of ill-oxydated blood is quite exhausted. And thus, though the patient is saved from the most terrible scene of all, he suffers great miseries; he experiences in his chest severe pains, which he compares with the stabbing of knives; terrible palpitations; an awful sense of sinking within him; a sound within his breast, as if of the rushing of waters; a continual sense of his condition; sudden startings during the night; fearful dreams and dangers of suffocation; until with sleepless nights, miserable thoughts by day, and the gradual decline of an ill-supported system, he grows weak, dropsical, and expires. (See *Anatomy of the Human Body, by John Bell*, vol. ii. edit. iii. p. 234, 235.) Cruveilhier relates the particulars of one very interesting case of aortic aneurism, where two swellings existed, one of which had pressed so strongly on the pneumo-gastric nerve, as entirely to have disorganised a portion of it. The patient suffered frequent syncopes, and died from general derangement of the pulmonic and gastric functions, and not from the rupture of the aneurism, which, however, if the patient had lived a little while longer, would have burst into the trachea, the mucous membrane of which was ulcerated in more places than one. (See *Cruveilhier, Anat. Pathol.*) In this example the left subclavian vein had been rendered impervious by the pressure of the swelling.

Mr. A. Burns saw two examples, in which the patients died instantaneously, though their aneurismal tumors were very small, and had not burst. Both these patients were in the early stage of pregnancy. (*On Diseases of the Heart*, p. 236.)

The situations in which aneurisms of the curvature of the aorta burst, are different in different cases. Sometimes the swelling bursts into the cavity of the chest, or that of the pericardium, and the patient drops suddenly down. The left cavity of the pleura is by far the most frequent situation in which thoracic aneurisms of the aorta burst. (*Laennec, On Dis. of the Chest*, p. 677.) They also frequently burst into the posterior mediastinum. They rarely open into the cavity of the right pleura. When the coats of the aorta give way within the pericardium, where they only receive a slight external membranous covering, this is apt to be also ruptured at the same time, so as to bring on copious effusion of blood, which oppresses the action of the heart, and produces immediate death. In other examples, the blood is effused into the trachea, or bronchi; and the patient, after violent coughing and ejections of blood from the mouth, expires. Sometimes, after the tumor has become closely adherent to the lungs, it bursts into the air-cells, through which the blood is widely diffused. An example of this termination of the disease was observed by Laennec; who also saw another case, in which, if the patient had lived a little longer, the same occurrence in all probability would have happened. Ehrhardt is not aware that this mode of rupture has been noticed by other writers. (*De Aneurysmate Aortæ*, p. 21, 4to. Lips. 1820.)

Amongst the most remarkable local effects of aneurisms of the aorta, are those on the vertebral column. They often destroy it to a very great depth. This is entirely the work of interstitial absorption, there never being any mark of suppuration. On the side next the vertebræ, the sac is completely destroyed, and the circulating blood is bounded by the naked bone. In certain cases, the swelling beats its way through the ribs; even the spinal marrow may be injured, and the patient suffers a species of death somewhat less violent and sudden. In one case of an enormous aneurism of the abdominal aorta, reported in No. 259 of the *Lancet*, the left leg and thigh were much wasted, and quite paralytic. This seemed to arise, however, from the pressure on the nerves of the lower extremity, and not from injury of the medulla spinalis.

The preparation No. 623 in the Museum of the University College is an aneurism of the aorta, which made its way through the ribs, destroying part of them and the lateral portion of the spine, so as to expose the medulla. The tumor presented itself below the scapula, and burst into the trachea by an ulcerated opening near its bifurcation. In the Hunterian Collection is a large aneurism of the commencement of the descending aorta, which caused the absorption of parts of several of the ribs, and of the bodies of the fourth and fifth dorsal vertebræ, the aneurism forcing its way there into the spinal canal. (See *Guthrie, On Dis. of Art.* p. 96.)

The effect of aneurism in producing absorption of the osseous texture, while the intervertebral substance remains little or not at all injured, is noticed in the previous part of this article.

But although aneurisms in the chest do sometimes protrude at the back, a circumstance that depends on the particular situation of the disease (see *Pelletan, Clinique Chir.* t. i. Obs. 7, p. 84), they more commonly rise towards the upper part of the breast, where a throbbing tumor occurs, which has caused an absorption of the opposing parts of the ribs and sternum, and sometimes dislocated the clavicle. Corvisart saw an instance in which an aneurism of the aorta had dislocated the sternal extremity of the clavicle; and Duverney makes mention of a case in which, besides the displacement and injury of the clavicle, the sternum and scapula were partially destroyed. I attended a case with Dr. Pinckard, where an aortic aneurism had produced considerable displacement of the scapula. Guattani speaks of an example in which the clavicle was bent by a large aneurism, of which a portion as large as a pigeon's egg projected above the bone. (*Lauth*, p. 168.) And Morgagni has described a case where the upper bone of the sternum, the sternal ends of the clavicles, and the adjoining ribs were destroyed by the pressure of a large aneurism of the front of the curvature of the aorta, and the disease presented itself externally, somewhat in the form of a boil. (*Epist.* 26, art. 9.)

The swelling towards the close pulsates in an alarming way. The blood is only retained by a thin covering of livid skin, which is daily becoming thinner and thinner. At length, a point of the tumor puts on a more conical, thin, and inflamed appearance than the rest; a slough is formed, and on this becoming loose the patient is sometimes instantaneously carried off by a sudden gush of blood.

MM. Payen and Zeink met with an instance of the rupture of an aneurism of the aorta into the pulmonary artery. (*Bulletin de la Faculté de Méd.* 1819, No. 3.) And Dr. Hope informs us, that Professor Monro, tertius, showed him a preparation of an aneurismal pouch, springing from the aorta, directly against the pulmonary artery; so that, if the patient's life had been prolonged, the aneurism would probably have burst into the latter vessel. (*Hope*, in *Cyclop. of Pract. Med.* art. *Aorta.*) In the Hunterian Collection at the Royal College of Surgeons in London is a preparation, No. 366, exhibiting a sacculated aneurism of the ascending part of the aorta, and a communication formed between the nipple-like portion of the tumor and the pulmonary artery by ulceration, immediately above and between two of the sigmoid valves. (*Guthrie, On Dis. of Art.* p. 60.)

Some additional examples of this nature are detailed by other writers. (See *Bulletin de la Faculté de Médecine*, No. 3, in which there are two cases; *Sue*, in *Journ. de Méd. continué*, t. xxiv. p. 124; and *Bulletin de la Faculté, &c.* t. xvii. p. 16.)

Aneurisms of the arch of the aorta are stated to have adhered to, and burst into, the right auricle of the heart, and thus to have produced instant death. (See *Med. Chir. Journ.* vol. vi. p. 617; *Bulletin de la Société de Médecine à Paris*, 1810, No. 3, p. 38.)

A case in which an aortic aneurism projected into the ventricles of the heart, is described in a modern publication. (See *Dublin Journ. of Med. Science*, No. 27.)

The cases recorded, in which aneurisms of the thoracic aorta have burst into the œsophagus, are beginning to be more numerous than formerly. Bonetus and Morgagni relate no examples of it; nor are there any in the comprehensive treatises of Scarpa and Hodgson. Corvisart speaks of an instance which had been seen by Dupuytren, of which, however, no description is given. Yet the possibility of the occurrence is not a matter of speculation or doubt. A case of this description is noticed by Matani (*De Aneurism. Præcordiorum Morbis*, p. 120); another is alluded to by Ehrhardt as being related by Copeland (*Comment. de Aneurismate Aortæ*, p. 22; *Cerutti, Catal. Prop.Pathol.*); an instance is described by Bertin (see *Bulletin de la Faculté de Méd.* 1810, p. 14); and a very interesting one, attended with disease of the spinal cord and paralysis, is given by Dr. Molison. (See *Edin. Med. Chir. Trans.* vol. iii. p. 173.)

I have recorded one example myself (see *Med. Chir. Trans.* vol. xvi.). This was remarkable for the length of time which the patient lived after the first rupture of it, and on account of the diminution of the external swelling and of the displacement of the scapula.

Sauvages is one of the writers who have adduced proofs of this mode of rupture: *Cadavere aperto, inveni ventriculum septem vel octo libris sanguinis distensum, aortam ad brachii magnitudinem per spatium septem vel octo pollicum dilatatam, et orificium denarii magnitudine aortæ et œsophago continuo commune, quod tamen quinque cristæ carneæ, veluti valvulæ, ex ambitu orificii oriundæ et circumpositæ potuerunt obturare. Per hoc orificium, sanguis ex aorta fluxerat in œsophagum.* (*Nov. Method*, t. ii. p. 298.) A similar case was published by Brichetau. (See *Bulletin de l'Athenée de Méd. de Paris*, Dec. 1816.) Laennec met with three examples of death from this cause. (*On Dis. of the Chest*, p. 677, *ed. by Forbes.*) The same distinguished professor met with an aneurism of the descending aorta, where the tumor had made such pressure on the thoracic duct, that this tube was partly destroyed, and all the lymphatic vessels were found uncommonly turgid. (*Journ. de Méd. par Corvisart*, t. ii. p. 15.) With the exception, perhaps, of one instance given on the authority of Lancisi (*Lauthii Collect.* p. 38), no other example of this description is upon record.

An instance is reported by Corvisart, in which the pressure of an aneurism of the ascending aorta had nearly obliterated the termination of the lower vena cava, and a fatal attack of apoplexy was the consequence. (*Mal. du Cœur*, p. 342.) Other examples of this are reported by Corvisart, Bertin, and Dr. Hope.

Aneurisms of the arch of the aorta may occasion a tumor, so much like that of a subclavian aneurism, as to be in danger of being mistaken for the latter disease. An example of this kind is related by Mr. Allan Burns: "A case," says he, "on which several of the most distinguished practitioners of Edinburgh, and almost every surgeon in Glasgow, were consulted. The nature of the disease appeared to be so decided, and its situation in the subclavian artery so clear, that, on that subject, there was no difference of opinion. Some were, however, of opinion that an operation might be performed, while others were fully convinced that the case was hopeless. For myself, I must confess that I was firmly persuaded, that, in the early stage of the disease, an operation might have been beneficial," &c. (*Surgical Anatomy of the Head and Neck*, p. 30.) After death, the vessel which was supposed to have been most materially affected, was found perfectly healthy. (P. 39.)

After detailing all the particulars of this interesting case, Mr. A. Burns observes, that "it corroborates Sir Astley Cooper's remark, that aneurism of the aorta may assume the appearance of being seated in one of the arteries of the neck; an inference drawn from the examination of a case which came under his own observation, and of which he had the goodness to transmit a short history to me, along with a sketch illustrative of the position of the tumor. In one case the aneurism was attached to the right side of the aortic arch, and involved a part of the arteria innominata; in Sir A. Cooper's, the tumor arose from the left side of the arch, from between the roots of the left subclavian and carotid arteries. It formed a

Florence flask-like cyst, the bulbous end of which projected at the root of the neck from behind the sternum, and so nearly resembled aneurism of the root of the carotid artery, that the practitioner who consulted Sir A. Cooper actually mistook the disease for carotid aneurism." (*Allan Burns,* op. cit. p. 41.)

The preceding statement has received full confirmation from the observations of an intelligent writer. "I have seen (says Mr. Hodgson) several cases of aneurism arising from the superior part of the arch of the aorta, which protruded above the sternum and clavicles; and, in one instance, the space between the tumor and the sternum was so considerable, that it was proposed to tie the carotid artery for an aneurism, which dissection proved to arise from the origin of the arteria innominata, and from the arch of the aorta." (*On the Dis. of Arteries and Veins*, p. 90.)

As I have already noticed, aneurisms of the aorta are most frequent at its curvature; but they are also met with on the other portion of this vessel in the thorax, and likewise on that part of it which is below the diaphragm. In subjects predisposed to aneurisms, such swellings are frequently seen affecting various parts of the aorta at the same time.

When the disease occurs in the abdominal aorta, a preternatural pulsation generally becomes perceptible at some particular point. The pressure of the tumor disturbs the functions of the viscera. The functional derangements, however, produced by aneurisms of the abdominal aorta, are generally much less urgent than those arising from aneurism in the thorax. The abdominal viscera bear compression without evil consequences much better than the thoracic ones; and the tumor, instead of being pent up in a rigid bony case like the chest, are not prevented from expanding freely, in almost every direction, because the intestines and the abdominal parietes readily yield in the requisite degree. As Dr. Hope observes, here the pressure of the tumor on any particular organ is in a great measure obviated by the want of counter-pressure. "Ventral aneurism, however, sometimes deranges the respiration by preventing the due descent of the diaphragm; an effect which may proceed either from the magnitude alone of the tumor, or what is much more common, from its being seated near or in the substance of the muscle, and impeding its motions. Ventral aneurism is also occasionally characterised by involuntary evacuations of the urine and fæces, by remarkable alternations of constipation and diarrhœa, and by deep-seated excruciating pains, resembling those of lumbar abscess. These symptoms arise from compression of the nerves, particularly the hypogastric plexus around the aorta." (See *Hope,* in *Cyclop. of Pract. Med.* art. *Aorta.*)

In the Museum of the University College are several valuable preparations, illustrative of aneurism of the abdominal aorta. No. 619 is an aneurism of this vessel, implicating the mesenteric and renal arteries. No. 621 is an aneurism of the aorta at its bifurcation. No regular sac. Tumor extends down over the forepart of the sacrum. Vena cava obliterated at the point where it receives the two iliac veins. No. 622 is an aortic aneurism, consisting of two large sacs at the sides of the lumbar vertebræ, the texture of whose bodies is more or less destroyed, while the intervertebral substance is entire. During life, the disease was not suspected. The patient suffered excruciating pain in the lower part of the belly. A few days before death a large tumor presented itself on the left side of the abdomen, with symptoms of internal hemorrhage. In the *post-mortem* examination blood was found between the abdominal muscles and the peritoneum, and the viscera were covered with coagula. The tumor had burst in two places on the right side. The shape of the kidneys was altered by the pressure of the tumor, which adhered to the spleen and pancreas. No. 625 is an aneurism of the aorta, where it passes between the crura of the diaphragm, and projects into both sides of the chest; while a portion of it, on the right side, descends into the abdomen. The bodies of the vertebræ partly absorbed. Death from effusion of blood into the chest.

VALSALVA'S TREATMENT.

Aneurisms within the thorax and abdomen, being entirely out of the reach of operative surgery, have been too commonly abandoned as unavoidably fatal, and when any thing has been done in such cases, it has generally been only with a view to palliation. Moderating the force of the circulation by bleedings and low diet, avoiding every thing that has the least tendency to heat the body, or quicken the motion of the blood, keeping the bowels well open with laxative medicines, and lessening pain with opiates, have been the means usually employed. Of late years, also, digitalis, which has a peculiar power of diminishing the action of the sanguiferous system and impetus of the blood, has been commonly prescribed. In Germany, the superacetate of lead has been used for many years for the same purpose; and Dupuytren, Laennec, and Bertin have employed it frequently with advantage in France. The dose, at first, should be half a grain, combined with the same quantity of opium, and given thrice a day. The dose is gradually increased to a grain three or four times a day. Dr. Hope informs us, that he has always found any gastric irritation from it removed by a dose or two of castor oil, promptly administered, and mucilaginous diluents. (See *Cyclop. of Pract. Med.* art. *Aorta.*)

That the diminution of the force of the circulation will prevent the increase of an aneurism, Mr. Hodgson considers illustrated by the following circumstance: If two sacs exist in the course of the same artery, the obstruction which is caused by the passage of blood into the upper, serves to remove the force of circulation from the lower, which becomes stationary, or its cavity is obliterated with coagulum. (*On Diseases of Arteries, &c.* p. 149.) Mr. Crosse refers to a recent case, in which a popliteal aneurism was cured by another aneurismal swelling taking place in the thigh. The latter was afterwards cured by an operation. (See *Prov. Med. Surg. Trans.* vol. v.)

It was the opinion of the celebrated Valsalva, that the utility of a lowering plan of treatment might do more than merely retard the death of aneurismal patients. It was his belief that the method might entirely cure such aneurisms as had not already made too much progress; and he put it into practice with such rigour and perseverance that the treatment became considered as particularly his own. The plan alluded to is not described in his writings, but was published in the first volume of the Commentaries of the Academy of Bologna, by Albertini, one of his fellow-students; and several persons, who had learned this method of Valsalva, afterwards imparted it to others. Thus, as Morgagni was passing through Bologna, in 1728, Stancazi is said to have informed him of Valsalva's practice. (See *Kreysig, Ueber die Herzkrankheiten*, b. ii. p. 728.)

After taking away a good deal of blood by venesection, Valsalva used next to diminish the quantity of food gradually, till the patient at length was allowed only half a pint of soup in the morning and a quarter of a pint in the evening, and a very small quantity of water, medicated with mucilage of quinces or with the lapis osteocolla. When the patient had been so reduced as to be incapable of getting out of his bed, Valsalva used to give him more nourishment, till this extreme debility was removed. Valsalva was sure that some aneurisms thus treated had got well, because every symptom disappeared; and his conviction was verified by an opportunity which he had of dissecting the body of a person that had been cured of this disease, and afterwards died of another affection; for the artery which had been dilated was found contracted and in some degree callous.

Morgagni states that this method of treating aneurisms is somewhat like the plan which Bernard Gengha tried with success, as well as Lancisi; and he refers us to the 24th chapter of the 2nd vol. of the Anatomy of the one, and to lib. ii. cap. 4 of the Treatise on the Heart and Aneurisms of the other. But Sabatier tells us that, in consequence of this instruction, he examined both these works, without finding anything on the subject. However this may be, we are informed by the latter, that he noticed the good effects of the practice in an officer, who had an alarming aneurism in front of the humeral extremity of the clavicle, in consequence of a sword-wound in the axilla. The patient, after having been bled several times, was confined to his bed, and kept to an extremely low diet. He was allowed as drink only a very acid kind of lemonade. He took pills containing alum, and the swelling was covered with a bag full of powder of oak bark, which was every now and then well wet with port wine. By perseverance in this treatment, the swelling was reduced to a smallish hard tubercle, having no pulsation, and a perfect cure ensued. (See *Sabatier, Médecine Opératoire*, tom. iii. p. 170—172.)

Guerin recommended the application of ice-water, or pounded ice, to aneurismal swellings; a plan which he represents as being often of itself sufficient to effect a cure. This topical employment of cold applications may be rationally and conveniently adopted in conjunction with Valsalva's practice.

The most interesting facts in proof of the efficacy of this mode of treatment were published some years ago by Pelletan. The following extract from a well-written critique on "Pelletan's Clinique Chirurgicale," will serve to convey to the reader some idea of the important information contained in the memoir on internal aneurisms:—"The intent in the treatment is to reduce the patient gradually to as extreme a degree of weakness as is possible without immediately endangering life. It is done by absolute rest, a rigorous diet, and bleeding: to these means, M. Pelletan adds the external application of ice, or cold and astringent washes, &c. He has here detailed many cases, from his own practice, of partial or complete success, which cannot be too generally known, as they may be the means of creating in some, and of confirming in others, a good opinion of the only method of treatment which has been found at all efficacious in a dreadful, and not an unfrequent, organic disease.

"Of the cases here recorded, some appear to have been cured; in others, the treatment had marked good effects. In extreme cases, at best, it afforded but partial and temporary relief. In one case, that of a robust man, an aneurism at the root of the aorta, with a pulsating tumor of the size of an egg, projecting between the ribs (the edges of which were already partly absorbed), was reduced, so as to recede within the ribs in the course of eight days. At the end of this time, the patient refused to submit any longer. The tumor did not appear again for nearly a year, although he returned to very drunken and irregular habits. He died in about two years and a half, with the tumor again appearing, and much increased in volume. The aneurismal sac communicated with the aorta, by a smooth and round opening opposite to one of the sigmoid valves. There can be no doubt of the efficacy of the treatment in this case; and it is highly probable, that his health and his life might have been long preserved but for his own indiscretion. In a case somewhat similar, but not so far advanced, the patient appears to have been cured. There was a swelling on the right side of the breast, about six inches in circumference, with a very strong beating. The pulsation was accompanied with a pain, which stretched towards the scapula and the occiput. It was evident that the disease was an aneurism of the arch of the aorta. The patient was a crier, of a strong frame, who was accustomed to drink freely. In the four first days, he was bled eight times, drawing three basins, 'palettes,' in the morning, and two in the evening. On the fifth, the pains and the beating were much lessened, but the pulse was still full. He was again bled once. The pulse was in a favourable state as to strength till the seventh day, when it again rose, and the man was twice bled.

"During this time, the man was kept to a most rigorous diet. A cold poultice of linseed and vinegar was placed on the tumor, and renewed when it became warm. At the end of eight days, the good effects of this plan were very evident; the pain and the pulsation were gone. The patient, though weak, was in health, and tranquil. He was now allowed more food by degrees. At the end of four weeks from the commencement of the treatment he left the Hôtel Dieu well. He afterwards led a sober life, and became fatter, without any vestige of disease, except a slight and deep pulsation at the part in which the aorta may always be felt beating in its natural state. He died two or three years afterwards of another complaint. His death was not known, and the body was not examined." (See *London Med. Review*, vol. v. p. 123.)

Pelletan also cured by similar treatment a large axillary aneurism, which was deemed beyond the reach of operative surgery. On the thirteenth day, the patient was reduced to a degree of weakness which alarmed many of the observers. From that time, all pulsation in the tumor ceased. The contents were gradually absorbed;

and the patient returned to his former laborious life with his arm as strong as ever. The pulse at the wrist was lost in consequence of the obliteration of the axillary artery, and the limb only receiving blood through the branches of the subclavian artery. "*Il y a beaucoup d'exemples d'aneurismes guéris spontanément et sans le secours de l'art* (says Pelletan) ; *mais on ne peut leur comparer le cas que nous venons de décrire : l'état extrême de la maladie, l'energie des moyens employés, et l'effet immédiate et successif qui en est résulté, prouvent assez que le succès a été dû tout entier à l'art.*" (*Clinique Chir.* tom. i. p. 80.)

In this work we find not less than three cases in which aneurism of the aorta is stated to have been effectually cured. One instance was greatly relieved ; but the disease returned the next year in consequence of the patient's intemperate mode of life. In another example, an aneurism at the origin of the aorta was cured ; but the disease recurred in another part of that vessel further from the heart. Even such cases as proved incurable, to the number of fourteen, all received various degrees of palliation from the treatment adopted.

In Mr. Hodgson's work on Diseases of the Arteries, p. 146, 147, several other instances are adduced, in which the utility and efficacy of a debilitating plan of treatment are illustrated. In the same publication, as I have previously explained, are various interesting facts, which tend to prove, that when aneurism of the aorta is lessened or cured, this great vessel itself may remain pervious. The progress of the disease is stopped by the blood coagulating in the sac, and closing the communication between the cavity of the aneurism and that of the artery.

The diet should consist principally of fluids, and it should be gradually reduced. Pelletan sometimes allowed only two basins of broth in twenty-four hours, and lemonade as a common drink. Valsalva, by degrees, increased the food to half a pound of pudding in the morning, and a quarter of a pound in the evening, with a limited quantity of water. By gradual reduction, the solid food may be brought down to four ounces, and fluids to eight. Both the body and mind should be kept in the most perfect quietude ; and if the plan is to be strictly enforced, the recumbent position must be constantly maintained. The frequent administration of purgatives, which weaken the action of the heart, is another part of this system of treatment.

It must be confessed, in regard to Valsalva's mode of treatment, that some experienced men do not place confidence in it. Boyer declares himself against it, as not being really efficacious ; and he states, that some time ago, it was tried twice in the Hôtel Dieu of Paris. The first trial was made on a patient with an axillary aneurism, which could not be operated upon on account of ts situation; the second on a woman, who had an aneurism of the abdominal aorta. In both cases the tumor was large, and its parietes reduced to the cellular coat and the surrounding ellular substance. In these two aneurisms, the progress of the swelling was rapid, and its rupture happened precisely at the moment when the reatment had been pushed to the utmost, and there ought to have been the greatest hope. *Traité des Maladies Chir.* t. ii. p. 121.)

Sir Astley Cooper declares, that he has seen but little benefit result from this treatment of the disease. According to his experience, only two measures are useful ; viz. venesection when the pulse is hard and full ; and the administration of the carbonate of soda in considerable doses, which, with entire rest, seem to prevent the increase of the swelling. But, he adds, that the soda is at length unavoidably given up, on account of its producing petechiæ. Sir Astley believes, that the irritability and quickened pulse produced by antiphlogistic treatment, often do as much injury as the natural force of the circulation. (*Lectures, &c.* vol. ii. p. 48.)

Small occasional bleedings are safer than large ones. In an aneurism of the aorta, especially when combined with organic disease of the heart, bleeding should never be carried to syncope, as, in such cases, this is apt to be alarmingly protracted, and sometimes to terminate fatally. (*Sir Astley Cooper, Dr. Hope,* &c.) The blood should, therefore, be drawn slowly, and in the recumbent posture. Nor should venesection be performed during a paroxysm of palpitation, as the exhaustion consequent on it, superadded to that occasioned by the loss of blood, might depress the patient beyond the possibility of restoration. (See *Hope,* in *Cyclop. of Pract. Med.* art. *Aorta.*)

M. Roux expresses his entire disbelief in the possibility of an aneurism of the aorta being ever completely cured by Valsalva's mode of treatment, because he imagines that such change could not happen without the tube of that great vessel becoming impervious, and of the lower parts of the body then perishing from stoppage of the circulation. But he bears witness to the utility of such treatment, and recites a case which he attended himself, where an aneurism made a considerable projection on the left side of the sternum, where the cartilages of the third and fourth ribs were raised, the throbbings very forcible, and the sense of suffocation such that the patient was obliged to keep himself constantly quiet ; yet, says M. Roux, though the disease now exists, it forms no prominence on the chest ; the pulsations can only be obscurely felt between the ribs ; the respiration is but slightly oppressed ; and the patient is capable of attending to his business. (*Nouveaux Elém. de Méd. Opér.* t. i. p. 510, 8vo. Paris, 1813.) If any one doubt the possibility of retarding the progress of an aortic aneurism by bleeding, I would refer him to a case which was laid by me before the profession not long ago. The aneurism burst by a small ulcerated opening into the œsophagus ; and after the loss of a vast quantity of blood, not only did the hemorrhage cease for a considerable time, but the external swelling subsided, and the base of the scapula, which had been pushed forwards and backwards by it, returned into its natural position again. (See *Med. Chir. Trans.* vol. xvi. p. 320.)

[Aneurisms occur in connection with two distinct constitutional conditions that require different methods of treatment : —

1. When occurring in robust and plethoric individuals the object should be to reduce the hyperæmic condition, and thus to lessen the dilatation of and the pressure upon the arteries. This may be effected by rest in bed, the avoidance of all stimuli, and the gradual diminution in the quantity of animal food that is given, with the occasional administration of a purge, and perhaps the em-

ployment of small bleedings from time to time. The diet recommended by Dr. Bellingham, consisting of two ounces of bread and butter for breakfast; two ounces of bread and the same quantity of meat, for dinner; and two ounces of bread for supper, with a little milk and water, is perhaps the best on which patients of this class can be placed.

2. When aneurism occurs in feeble, cachectic, or anæmic individuals, the object is to improve the plasticity of the blood, at the same time that the irritability of the heart is lessened. This is usually best effected by putting them on a dry diet, by the administration of opiates, and of iron. In all cases bodily exertion and mental excitement must be carefully avoided.]

INTRACRANIAL ANEURISM.

[Aneurisms within the cranium may arise from any of the arteries that are met with in this situation, though some are much more liable than others to the occurrence of this disease. Wherever situated, however, they are of rare occurrence.

Of twenty-seven cases of this disease, I find
10 affecting the basilar artery.
5 ,, anterior cerebral.
3 ,, one internal carotid.
1 ,, at junction of internal carotid and posterior communicating.
2 ,, anterior communicating.
1 ,, posterior cerebral.
2 ,, both internal carotids.
1 ,, posterior communicating.
1 ,, artery of the corpus callosum.
1 ,, branch of the meningeal artery.

The greater frequency of this disease in the basilar artery may probably be dependent on its larger size, and the consequently greater impetus of the blood to it.

Intracranial aneurisms are almost always formed by the uniform dilatation of the whole of the calibre of the artery; the false or sacculated variety being rarely if ever met with. I am not acquainted with any mention of this. The coats of the arteries in this situation being very thin and unprovided with any external cellular sheaths that would support the impetus of the blood, rupture of the vessel would rather occur than partial dilatation if one portion only of the circumference were diseased. Occasionally, though more rarely, the dilatation is fusiform; of this a preparation in University College Museum, is a good illustration. When it does occur, it is probably confined to the basilar artery.

The disease would appear to be of slow growth, and the sac becomes filled with lamellated coagula, sometimes so completely as to occlude the orifice of the artery from which it springs.

The size the disease in this situation attains before death results, is sometimes considerable; thus, in a case that occurred some years ago at the University College Hospital of aneurism of the basilar artery, the tumor was nearly as large as a walnut; in another case it somewhat exceeded this size. Mr. Smith, in the *Dublin Journ.* vol. xxv. mentions a case of multilocular aneurism of the left posterior cerebral artery as large as a small apple, and Serres one as large as a hen's egg. On the other hand, it occasionally proves fatal by rupture, before having reached beyond a very small size, not larger than a pea or nut.

It is seldom that more than one of the arteries of the brain suffers aneurismal dilatation. In the Museum of the College of Surgeons, however, are the preparations (Nos. 1687 and 1688) of an aneurismal dilatation of both internal carotid arteries resembling "two bulbs about five-eighths of an inch in diameter, filling up the hollow on each side of the sella turcica, which were evidently dilatations of the carotid arteries, and from their being filled with laminæ of coagulated blood there could be no doubt of their being aneurisms. Of these aneurisms, the one on the left side was largest. That on the right side communicated with the cavity of the artery, which was not the case with the other."

A case occurred in University College Hospital some years ago, under the care of Dr. Thomson, in which a somewhat similar condition existed. A man, forty-nine years of age, had fallen on his head some months before admission into the Hospital; since then he had been garrulous, silly, and very irritable, becoming readily intoxicated. He suddenly became insensible and convulsed, with vomiting and laborious breathing; he could close both eyes, but the right pupil was dilated; the left side was paralysed. He was treated for apoplexy, got slightly better, but died in ten days from the first attack. On examination, an aneurism a little larger than a hazel nut was found on the trunk of the right carotid, where it gives off the middle cerebral artery, and another small one on the curve of that artery. There was a globular aneurism on the same artery on the opposite side. The basilar artery was thickened, white, and opaque, as was also the other larger arteries of the brain. There was softening of both anterior cerebral lobes, especially the right one.

The arteries of the brain are very commonly healthy in these cases; out of four instances of intracranial aneurism that have fallen under my observation, the other vessels of the brain have been healthy in three cases, and atheromatous in but one. In one case I have seen aneurism within the cranium associated with aneurism elsewhere, —in the thoracic aorta.

The causes of intracranial aneurism are very obscure. It may be supposed that the comparatively small diameter of the arteries within the cranium would render them little liable to the occurrence of spontaneous aneurism, were it not that the anatomical characters and physiological, relation of these vessels predispose considerably to the occurrence of this affection, there being no other set of arteries in the body of the same size as those within the cranium, in which spontaneous aneurism so frequently occurs. This can only be accounted for by the thinness of their coats, and the want of an external cellular sheath rendering them unable to support the increased pressure from within, to which they are occasionally subjected in consequence of the alteration in the pressure of the cerebral circulation at different periods, the result of some variation in the relative quantities of the different fluids within the cranium, or of determination of blood to the brain. This would more particularly be the case if their natural elasticity had already been impaired by the occurrence of atheromatous or other degeneration of their coats. As these changes are the natural consequences of advance in age, we shall find the tendency to the occurrence of this disease increase with advancing years. Thus of nineteen cases in which the patient's age is given, we find only one case which occurred as early as fourteen. Of the remaining eighteen cases, four only occurred in persons under fifty; of the remaining fourteen, ten were met with between fifty and sixty, and four in the next decennial period.

The immediate exciting cause of the disease is most commonly involved in obscurity, sometimes it may be traced to a blow on the head, a fall or concussion, or to excessive drinking; but more frequently the symptoms manifest themselves suddenly, without being in any way attributable to such external influences, and occur in vigorous and apparently healthy persons.

The pressure exercised by an aneurismal sac situated within the cranium is almost exclusively directed against the yielding cerebral substance, which is often extensively disorganised; the bones of the skull, however close their proximity to the sac may be, frequently escaping, and seldom suffering much. This peculiarity in the effects of aneurism in this situation may be partly owing to the very dense and compact character of the inner table of the skull, but is, doubtless, principally due to the very soft and yielding nature of the contents of the cranium. Absorption of the subjacent bone, however, sometimes takes place to a limited extent: thus in one case the body of the sphenoid bone was indented and partially absorbed.

The parts compressed will necessarily vary according to the situation of the tumor; but those that principally suffer are those seated at the base of the brain, and forming the floor of the lateral ventricles. In Moore's case one of the optic nerves was flattened by the pressure of the substance of the anterior lobe, the laminæ perforated the roots of the olfactory tract, the anterior part of the corpus striatum, and a considerable quantity of the neighbouring white matter of the anterior lobe was removed. In a case by Dr. Eager (Ranking, vol. vi.) the portio dura of the right side was paralysed from this cause. In Mr. Smith's case (*Dub. Journ.* vol. xxv.), the floor of the ventricle, the tuber cinereum, and origin of the optic nerve suffered.

Rupture of the sac usually takes place by a gradual thinning of one part of it, which at last gives way by a rent or fissure, the blood being effused either at the base of the brain into the arachnoid cavity and the meshes of the pia mater, or into the lateral ventricles, either directly, or by breaking through an intervening portion of cerebral substance.

Besides the changes that take place in the cerebral substance as the result of pressure, important lesions may be met with as the effect of the interruption that the pressure of the aneurism offers to the circulation in, and nutrition of, the cerebral hemispheres. Thus in the case of aneurism of both internal carotids that has already been referred to as occurring at University College Hospital, there was white softening of both the anterior cerebral lobes, and this lesion was most marked on that side that corresponded to the largest aneurism, and where consequently it may be supposed the greatest amount of obstruction to the circulation existed.

The symptoms of aneurism within the cranium are extremely equivocal, and indeed aneurisms of large size may exist at the base of the brain without occasioning any symptoms whatever. An interesting instance of this occurred at University College Hospital in 1848. A man, fifty-seven years of age, died of pulmonary apoplexy and chronic pneumonia of the left lung, consequent upon the pressure of an aneurism of the commencement of the descending aorta on the pulmonary veins of that side. On examining the head after death, an aneurism of the basilar artery as large as a hazel nut was met with, of which no suspicion had been entertained during life, there having been no head symptoms whatever. The sac of the aneurism was very thin, and there was much atheroma in the vertebrals.

The only symptoms that are of constant occurrence when this disease goes on to a fatal termination, are those of hemiplegia and apoplexy. These may come on suddenly without any previous warning, or may be preceded by a train of phenomena indicative of the existence of chronic disease within the cranial cavity.

The most constant of these symptoms is pain, which offers, however, great variety, in seat, extent and character. It may be diffused or occupy a fixed point; it may be continuous or intermitting; increased by movement, accompanied by peculiar sensations, such as pulsation or of opening and shutting of the top of the cranium.

The sight and hearing are often impaired; dimness of sight, dilatation of one or both pupils, photophobia, diplopia, and loss of vision have been noticed in several of the cases recorded. Ptosis may likewise be met with. Buzzing noises in the ears and deafness are also not uncommon symptoms. Deafness more particularly appears to be of frequent occurrence.

The patient rarely loses the power of articulation and of deglutition; imperfect speech and dysphagia have however occurred.

There may be paralysis of the side of the face, shaking palsy, or complete hemiplegia, or fits of an epileptic nature may occur. The mental condition may undergo changes indicative of chronic disease of the brain. There may be depression of spirits, listlessness, or, as was noticed in the case above related, the temper may become irritable, and the patient may be garrulous or silly. Insanity has been noticed in one case, and, as is usually the case in cerebral affections, the gastric functions are often impaired.

But very frequently no premonitory symptoms of any kind manifest themselves, the patient being suddenly seized, when apparently in good health, with apoplexy, which terminates rapidly in death.

In some cases the presence of the aneurism has been detected by a rough "whizzing" noise being heard on the application of the stethoscope over one side of the head, and perhaps being audible to the patient. This sign, however, occurs in but few cases, but when it does occur is unquestionably the most pathognomonic of all. I am not aware that it has been met with in any form of cerebral disease except intracranial aneurism.

Thus it will be seen by a reference to this list of symptoms that, with the exception of the whizzing noise, no special signs are afforded by aneurisms within the skull which will enable us to distinguish between the symptoms occasioned by their presence, and those of other tumors of the brain, and of organic cerebral disease.

The fatal termination may occur from one of four causes:—

1. The tumor may exercise such pressure upon the whole cerebral mass as to occasion death. This mode of termination is rare, and I am only ac-

quainted with one case of this description, which is reported by Dr. Ruschenberger in the *American Journal*, Jan. 1846. The symptoms in this case were very remarkable, consisting of complete hemiplegia of the left side, with involuntary antero-posterior vibration of the head and body, and paralysis agitans of the right leg. He slept heavily, with loud snoring; ate voraciously, but had considerable difficulty occasionally in deglutition and in articulation. The intellect was clear, but very slow. After death, an aneurism of the basilar artery as large as a pigeon's egg, and containing an irregular, very hard, dry clot of blood, was found. The sac had given way at one point, extravasation taking place into the substance of the Pons Varolii, which was softened, and of a black colour.

2. The most frequent mode in which death takes place in these cases is by the sudden rupture of the sac, and the extravasation of its contents into the cavity of the arachnoid at the base of the brain, or into the lateral ventricles. This latter takes place either from the aneurism projecting into them, and there giving way or rupturing into these cavities by breaking down the intervening cerebral substance. When this mode of termination occurs there are occasionally no warning or premonitory symptoms of any impending danger; the patient being, apparently in good health, struck down by an attack of apoplexy which is speedily fatal. More frequently a series of those symptoms that have already been mentioned as attending many cases of this disease preceded the fatal event for a longer or shorter time. When rupture of the sac and extravasation of blood takes place, death is inevitable; at least I am not acquainted with any case in which the appearances found after death could lead me to the belief that this condition had been even temporarily recovered from.

3. Death may result from another cause than pressure of the aneurismal sac, or its rupture and the extravasation of its contents—viz. from softening or disorganisation of the substance of the brain to a greater or less extent, in consequence of the obstruction offered to the passage of the blood through the aneurismal vessel. In the case of aneurism of both carotids, already mentioned as having occurred at University College Hospital, this was the case; both anterior cerebral lobes were affected with white softening, and this condition was especially observable on that side on which the aneurism was largest.

4. Lastly, death may be produced by the irritation occasioned by the presence of one or more aneurismal tumors within the cranium. Of this an interesting example is offered by the history of a case of aneurism of both internal carotids contained in the Museum of the College of Surgeons, and related by Sir G. Blane (*in the Trans. of the Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 192). In this case the patient, a lady, sixty-nine years of age, had suffered for four years from attacks of giddiness, headache, and imperfect vision; about sixteen months before her death she became insane, recovered, and then relapsed twice in the same state. After having regained her senses for some months, she became affected with giddiness, redness of the eyes, and maniacal delirium, with fever, which continuing for some months, caused her death.

After death, the following appearances were found:—"Upon examining the body, there was no appearance in the brain itself that could in any way account for the symptoms. There was, indeed, a greater quantity of fluid than common in the ventricles, and the surface of it was moister than it is usually found in a sound state; but in all other cases which have occurred to me of organic affections of the brain proving fatal, except those which are sudden, such as apoplexy, there has been a preternatural quantity of fluid in its ventricles. There were also spicula of bone in the membrane forming the falx. The inner substance of the crura cerebri was of a brown colour, and more tender than natural. The optic nerves were smaller than natural, as if they had been wasted. The septum lucidum was more more than usually dense.

"But the morbid appearance in this case, which was so singular, and to which the symptoms of complaint seem chiefly referrible, was two bulbs, about five-eighths of an inch in diameter, filling up the hollow on each side of the sella turcica, which were evidently dilatations of the carotid arteries, and, from their being filled with laminæ of coagulated blood, there could be no doubt of there being aneurisms of these arteries. The dissection was made by Mr. Hunter, assisted by Mr. Home, in the presence of Dr. Jenner and myself, and all concurred in the opinion that these tumors were aneurisms. The one on the left side was largest. That on the right side communicated with the cavity of the artery, which was not the case with the other."

In the treatment of intracranial aneurism there is usually little to be done. The nature of the case not being sufficiently obvious, in the majority of cases, to justify active measures. Should, however, the loud rough whiz be distinctly audible to others, besides the patient, over one side of the head, and more especially about the base of the cranium, or by application of the stethoscope to the mastoid process, ligature of the carotid artery on the affected side might with propriety be practised. This has been successfully done in a most interesting and instructive case of intracranial aneurism, by Mr. Coe, of Bristol, and reported by him in the *Association Journal*, Nov. 9, 1855.]

Aneurismal Varix; Varicose, or Venous Aneurism; Aneurism by Transfusion.

By these terms surgeons mean a tumor arising from a preternatural communication formed between a large vein and a subjacent artery. Thus, in venesection, performed immediately over the artery, at the bend of the elbow, if the lancet be carried too deeply, it may transfix the vein, and wound the artery; in which event, the arterial blood, in consequence of the proximity of the two vessels, instead of being effused in the areolar tissue, will pass directly into the cavity of the vein, which will become dilated in the form of a varix by the jet of arterial blood into it.

Although Sennertus probably referred to an instance of this disease (op. t. v. l. v. cap. 43), Dr. W. Hunter is undoubtedly the first who gave an accurate description of it. Scarpa is disposed to claim a share of the merit for his countryman Guattani; but, as Mr. Hodgson has remarked, Dr. Hunter's observations on this disease were published in the years 1757 and 1764; whereas, Guattani did not see his first patient until the year 1769, and his book was not published until the year 1772.

"Does it ever happen in surgery," says Dr. Hunter, "that when an artery is opened through a vein, a communication, or anastomosis, is afterwards kept up between these two vessels? It is easy to conceive this case; and it is not long since I was consulted about one that had all the symptoms that might be expected, supposing such a thing to have actually happened, and such symptoms as otherwise must be allowed to be very unaccountable. It arose from bleeding; and was of some years' standing when I saw it, about two years ago, and I understand very little alteration has happened to it since that time. The veins at the bending of the arm, and especially the basalic, which was the vein that had been opened, were there prodigiously enlarged, and came gradually to their natural size, at about two inches above, and as much below the elbow. When emptied by pressure, they filled again almost instantaneously; and this happened even when a ligature was applied tight round the fore-arm, immediately below the affected part. Both when the ligature was made tight and when it was removed they shrunk, and remained of a small size, while the finger was kept tight upon the artery, at the part where the vein had been opened in bleeding. There was a general swelling in the place and in the direction of the artery, which seemed larger and beat stronger than what is natural; and there was a tremulous jarring motion in the vein, which was strongest at the part which had been punctured, and became insensible at some distance, both upwards and downwards." (*Med. Obs. and Inq.* vol. i.)

In the second vol. of the same work, Dr. Hunter adds some further remarks:—"In the operation of bleeding, the lancet is plunged into the artery through both sides of the vein; and there will be three wounds made in these vessels, viz. two in the vein and one in the artery, and these will be nearly opposite to one another and to the wound in the skin. This is what all surgeons know has often happened in bleeding, and the injury done the artery is commonly known by the jerking impetuosity of the stream whilst it flows from the vein, and by the difficulty of stopping it when a sufficient quantity is drawn.

"In the next place, we must suppose that the wound of the skin and of the adjacent or upper side of the vein heal up as usual; but that the wound of the artery and of the adjacent, or under side of the vein, remain open (as the wound of the artery does in the spurious aneurism), and by that means the blood is thrown from the trunk of the artery directly into the trunk of the vein. Extraordinary as this supposition may appear, in reality it differs from the common spurious aneurisms in one circumstance only; viz. the wound remaining open in the side of the vein as well as in the side of the artery. But this one circumstance will occasion a great deal of difference in the symptoms, in the tendency of the complaint, and in the proper method of treating it: upon which account the knowledge of such a case will be of importance in surgery. It will differ in its symptoms from the common spurious aneurism, principally thus:—The vein will be dilated, or become varicose, and it will have a pulsating jarring motion, on account of the stream from the artery. It will make a hissing noise, which will be found to correspond with the pulse for the same reason. The blood of the tumor will be altogether or almost entirely fluid, because kept in constant motion. The artery, I apprehend, will become larger in the arm and smaller at the wrist than it was in the natural state; which will be found out by comparing the size and the pulse of the artery, in both arms, at these different places, the reason of which I will speak of hereafter; and the effects of ligatures, and of pressure upon the vessels above the elbow and below it will be what every person may readily conceive who understands any thing of the nature of arteries and veins in the living body.

"The natural tendency of such a complaint will be very different from that of the spurious aneurism. The one is growing worse every hour, because of the resistance to the arterial blood, and if not remedied by surgery must at last burst. The other, in a short time, comes to a nearly permanent state; and, if not disturbed, produces no mischief, because there is no considerable resistance to the blood that is forced out of the artery.

"The proper treatment must, therefore, be very different in these two cases; the spurious aneurism requiring chirurgical assistance, as much, perhaps, as any disease whatever; whereas, in the other case, I presume it will be best to do nothing.

"If such cases do happen, they will no doubt be found to differ among themselves in many little circumstances, and particularly in the shape, &c. of the tumefied parts. Thus the dilatation of the veins may be in one only, or in several, and may extend lower or higher in one case than in another, &c., according to the manner of branching, and to the state of the valves in different arms. And the dilatation of the veins may also vary, on account of the size of the artery that is wounded, and of the size of the orifice in the artery and in the vein.

"Another difference in such cases will arise from the different manner in which the orifice of the artery may be united, or continued with the orifice of the vein. In one case, the trunk of the vein may keep close to the trunk of the artery, and the very thin stratum of areolar tissue between them may, by means of a little inflammation and coagulation of the blood among its filaments, as it were, solder the two orifices of these vessels together, so that there shall be nothing like a canal going from one to the other; and then the whole tumefaction will be more regular, and more evidently a dilatation of the veins only. In other instances, the blood that rushes from the wounded artery, meeting with some difficulty of admission and passage through the vein, may dilate the cellular membrane between the artery and vein into a bag, as in a common spurious aneurism, and so make a sort of canal between these two vessels. The trunk of the vein will then be removed to some distance from the trunk of the artery, and the bag will be situated chiefly upon the underside of the vein. The bag may take on an irregular form, from the areolar tissue being more loose and yielding at one place than at another, and from being unequally bound down by the fascia of the biceps muscle. And if the bag be very large, especially if it be of an irregular figure, no doubt coagulations of blood may be formed, as in the common spurious aneurism."

A concurrence of two circumstances is requisite for the production of an aneurismal varix: 1. The puncture in the vein, and that in the artery, must be exactly in the same direction; 2. The solution of continuity in the integuments and upper side of the vein must heal, while the wound in the deeper side of that vessel, and the puncture in the upper surface of the artery, remain open, and communicate so readily that the arterial blood finds greater facility in entering from the artery into the vein, than in being effused from the artery into the surrounding areolar tissue.

If one of these two circumstances be wanting, either because the wounding instrument has entered the artery a little obliquely from the vein, or because the vein has not been sufficiently near to the artery, on account of the areolar tissue between them, the arterial blood most frequently does not produce the aneurismal varix; or, if it does, the disease is always complicated with effusion of arterial blood into the areolar tissue, or with an aneurism and aneurismal varix at the same time. In this case, the small aneurismal sac serves as a short canal of communication between the artery and the vein (*Med. Facts and Obs.* vol. iv. p. 115); two distinct diseases, in fact, being formed from the same cause, and placed one over the other, viz. an aneurism and an aneurismal varix. (*Scarpa*, p. 421, ed. 2.) The following marks of distinction between aneurism and aneurismal varix are pointed out by the same author; the aneurismal varix always forms a circumscribed tumor; aneurism does not always do so. The areolar tissue, which constitutes the sac of the aneurism, does not always resist so strongly the impetus of the arterial blood as the coats of the vein do. Not unfrequently, therefore, aneurism, from being *circumscribed* at first, becomes *diffused;* extends along the course of the wounded artery; compresses strongly the surrounding parts; occasions acute pain and inflammation; and the parts are threatened with gangrene. On the contrary, the aneurismal varix is always *circumscribed*, increases very slowly, does not produce much pain, and as it augments it always extends more or less above or below the place where venesection has been done; and this extension is in proportion to the greater or less force with which the arterial blood is thrown from the artery into the vein, and the greater or less resistance made by the valves situated in the vein below the puncture; and according to the greater or less number of veins communicating with the aneurismal varix. The seat of the disease is generally the basilic or median basilic vein, which appears dilated in an unusual manner, forming an oblong tumor of the size of a walnut, if the disease is recent. In the centre of the swelling is the cicatrix left by the lancet. The vein is less dilated the further it is from this scar; and, in general, at the distance of two inches and a half above and below this point the vessel resumes its natural size. The small tumor, as has been explained, pulsates like an artery, with a tremulous motion and hissing noise, which is sometimes so great that the patient cannot sleep, if he is lying with his head low, and resting on the injured arm. The trunk of the brachial artery, from the axilla down to the place where it has been wounded with the lancet, vibrates with extraordinary force. There is no change of colour, nor inflammation of the skin; and the pain is inconsiderable. The swelling is compressible and yielding; but it returns as soon as the pressure is removed from it. When the arm is kept for some time raised up towards the head, the tumor diminishes; and the same thing happens when pressure is made on the communication between the artery and vein, or when a tight tourniquet is applied near the axilla. If the disease be complicated with aneurism, a second pulsating tumor will be found lying under the aneurismal varix. (*Scarpa*, p. 424, ed. 2.)

A simple aneurismal varix is gradual in its formation, never attaining a considerable size, and never exposing the patient's life to danger by the rapidity of its increase, or a tendency to burst; but, if it be a less serious disease in these respects than a consecutive false aneurism, it does not, like the latter, present any chance of a spontaneous cure, and its duration is perpetual. However, after it has acquired some size, and the veins have become exceedingly varicose, the patient complains of numbness and weakness of the limb, diminution of its temperature; and there is a bluish, or somewhat purple, discoloration of it, which Breschet ascribes to the passage of some of the venous blood into the artery, and to there being a smaller quantity of scarlet blood conveyed by the artery into all parts beyond the tumor. (*Mém. Chir. sur Différentes Espèces d'Aneur.* p. 102.)

It is generally believed that only the blood of the artery leaves its proper vessel; but, according to the investigations of M. Breschet, at the same time that arterial blood passes into the veins the artery itself receives a certain quantity of venous blood. The symptoms, he observes, demonstrate this during life, as well as the examination of the parts after an operation on the tumor: it is also proved by the appearances of the vessels in *post mortem* examinations. (*Breschet, Mém. sur Différentes Espèces d'Aneurysmes*, p. 100.)

After relating two cases, illustrative of the nature of aneurismal varix, Dr. W. Hunter proceeds to inquire, "Why is the pulse at the wrist so much weaker in the diseased arm than in the other? — surely the reason is obvious and clear. If the blood can easily escape from the trunk of the artery directly into the trunk of the vein, it is natural to think that it will be driven along the extreme branches with less force, and in less quantity.

"Whence is it that the artery is enlarged all the way down the arm? I am of opinion, that it is the consequence of the blood passing so readily from the artery into the vein, and is such an extension as happens to all arteries, in growing bodies, and to the arteries of particular parts when the parts themselves increase in their bulk, and at the same time retain a vascular structure." (See *Med. Obs. and Inq.* vol. ii.) This explanation is not deemed by Breschet altogether correct. M. Breschet has endeavoured to give a more particular and precise explanation of the changes which the vessels and adjacent textures undergo, and the effects of the communication between the arteries and veins. In consequence of the artery receiving venous blood, the flow of this fluid through it becomes slower, and the pulse weaker. The artery itself dilates throughout its whole extent, a fact long ago noticed by Morand; its tunics grow thinner, and become nearly as soft and flaccid as those of a vein.

The artery becomes likewise tortuous, and gradually assumes the characters, first, of a vein, and then of a dilated vein. All this happens, however, only below the communication between the two vessels. (*Breschet, Mém. Chir. sur Différentes Espèces d'Aneur.* p. 103.) If it were not for the passage of some of the blood of the vein into the artery, Breschet conceives, that it would be impossible to account for the diminished rate of the circulation in the latter vessel, the reduction of sensibility and temperature of the limb, and especially the enlargement of the artery beyond the tumor, its assuming the characters of a vein, and the deeper colour of the blood in it. The vein, likewise, becomes altered around the wound (below, and particularly above it), its coats assuming greater solidity and firmness: and though the vessel is enlarged, the suppleness of its parietes is diminished. (See *Breschet*, op. cit. p. 104.)

No doubt M. Breschet has extended his criticisms of Dr. Wm. Hunter's account too far, inasmuch as the atrophy and loss of temperature in the extreme part of the limb are certainly, in some measure, owing to a part of the arterial blood flowing directly and prematurely into the venous system. Dr. Wm. Hunter has chiefly erred in overlooking the effect of the entrance of venous blood into the artery. If, as Hunter states, a greater quantity of blood arrives by the artery above the wound, how does it happen, inquires M. Breschet, that the artery should diminish in diameter below the puncture, as Dr. Wm. Hunter affirms that he had ascertained to be the case at the wrist? "For (observes M. Breschet), by the more considerable afflux of red blood, the lower continuation of the artery must be indemnified for the quantity of this fluid which passes into the vein. *A new channel, opened for the arterial blood, cannot* (says he) *bring on a dilatation of the vascular trunk above the aperture of the new channel.* This effect would be more likely to arise from some impediment to the circulation, and is actually what does happen in old consecutive false aneurisms." (See *Mém. sur les Différentes Espèces d'Aneur.* p. 105.) M. Breschet, further on, expresses a suspicion, that Dr. Wm. Hunter perhaps confounded the weakness and softness of the pulse at the wrist with a diminution of the artery. I am of opinion that little foundation exists for this suspicion, because it is certain that, in some cases of aneurismal varix, the arteries below it, so far from being enlarged, are diminished; and therefore correspond to Dr. Wm. Hunter's description. In proof of this fact, I may refer M. Breschet to the evidence of his distinguished countryman, M. Jules Cloquet, who has given the particulars of the dissection of an aneurismal varix illustrated by a diagram (pl. 1, fig. 13), where the brachial artery below the tumor was not larger than the middle portion of the radial artery. (See *Jules Cloquet, Pathol. Chir.* p. 85, 4to. Paris, 1831.) According to M. Breschet, in old varicose aneurisms of the limbs, and especially of the lower extremities, the principal artery, as well as its branches, are manifestly dilated, and their coats resemble those of veins. "If the same quantity of red blood passed through a vessel of this description, its pulsations would not have the same character as those of the artery of the opposite limb. We think, then, that this change in the pulsations of the artery in old aneurisms depends both upon the dilatation of the vessel, demonstrated in the dead subject, and upon the passage of venous blood into the artery; for how could dilatation and alteration of the parietes of the vessel be accounted for in any other way?"

In the foregoing passage, the statement that a new channel for the blood, arising from an arterial trunk, will not be followed by an enlargement of that trunk above such channel, seems to me incorrect; for if there be a new channel, blood will be required for it: an increased quantity will therefore pass through the trunk above the new channel, and such trunk of course increase in size, agreeably to a well-established law of the animal economy. The case of an old false aneurism, referred to by M. Breschet, seems to me rather to invalidate than strengthen his conclusion, respecting the cause of the enlargement of the arterial trunk above the disease. This change is not ascribable to impediment of the circulation, but to the blood having new channels to supply: viz. the sac, and the enlarged collateral anastomosing vessels.

An interesting circumstance, pointed out by M. Breschet, is, that the dilatation of the artery beyond the injury, is not exemplified in all varicose aneurisms. Their situation has considerable influence in producing it; for it can only take place in vascular trunks of large calibre; and it is requisite also that venous blood pass into the artery, and that the circulation of this fluid be favoured by the laws of hydraulics and the power of gravitation. Hence, this dilatation of the injured artery, regarded by M. Breschet as the consequence of the admission of a certain quantity of venous blood into it, is principally noticed in varicose aneurisms of the limbs, and not in those of the neck, or subclavian region. The wound in the artery must likewise have a certain extent, be constantly gaping, and in direct communication with the vein. (See *Breschet* in *Mém. sur Différentes Espèces d'Aneur.* p. 107.) In the remarkable case of spontaneous varicose aneurism of the thigh, recorded by Mr. Perry, the posterior tibial artery and the other arteries in the neighbourhood of the aneurism were apparently sound, (See *Lond. Med. Gaz.* Nov. 1835.)

In thin subjects, the median basilic vein is so close to the brachial artery, the track of which it crosses at a very acute angle, that it is almost impossible to open it at this point, without risk of wounding the artery at the same time. Although the bend of the arm is the situation in which the aneurismal varix and venous aneurism are usually noticed, it is easy to conceive that they may happen wherever an artery of a certain diameter lies immediately under a large vein. Thus, Lassus saw an aneurismal varix in the ham, the consequence of a wound with a sword, which had transfixed the popliteal vein and artery. (*Méd. Opér.* t. ii. p. 442.) Breschet records instances of it at the upper and inner part of the arm; in the thigh; and in the neck, from a communication formed between the common carotid and the internal jugular vein, by a wound. He likewise gives the particulars of several occasioned by venesection at the bend of the arm, the ordinary situation of the disease. Larrey records examples of it in the subclavian vessels, the external iliac, the popliteal, and between the carotid artery and internal jugular vein. (*Mém. de Chir. Clin.* t. iii.)

The frequency with which Dupuytren met with these arterioso-venous aneurisms, as he terms them, was considerable; for, during fifteen years, not a single year passed without his being consulted for at least two cases. For the prevention of them, he recommends the following rules: — 1. That venesection should never be practised until the pulsation of the artery is felt. 2. That the vein immediately over the artery should never be punctured. 3. That some other vein should be selected. He admits, however, that other veins sometimes cannot be readily found, and that they do not always yield the requisite quantity of blood; still he deems these inconveniences slight, in comparison with that of exposing the patient to a wound of the artery. (*Dupuytren*, *Clinique Chir.* t. i. p. 262.) While I fully coincide with this eminent surgeon, in recommending a vein to be generally preferred which does not lie directly over the artery, I do not agree with him that the practitioner should not open the median basilic vein, if another could not be easily found which would furnish the proper quantity of blood. I frequently bleed in the median basilic vein; and as there is the fascia between it and the artery, believe, that the latter vessel can only be wounded by a very careless or unskilful hand. Indeed, when Dupuytren, in censuring the custom of letting perfect novices in the profession attempt venesection (p. 261), he is adverting to the chief cause of the accident. The last case which I saw, was in a woman who had been bled by a farrier.

Baron Larrey, surgeon to the hospital at Toulouse, saw a case of aneurismal varix, which had been occasioned by a wound of the popliteal vein and artery; and a history of the disease, accompanied with the pathological preparation, was sent to the former Royal Academy of Surgery at Paris. "The varicose swelling, which was as large as two fists, occupied the whole of the ham in a middle-aged man, who some years previously had been wounded with a sword in that part of the limb. At a consultation, amputation was deemed necessary, and was performed with success. At the bottom of the varicose pouch, the communication between the popliteal vein and artery was observed. The sac itself was evidently composed of the vein, the parts of which, adjacent to the varicose swelling, were dilated, especially the lower continuation of the vessel. The popliteal nerve was rendered flat, like a piece of tape, and adherent to the outside of the cyst." (See *Mém. de Chir. Mil.* t. iv. p. 340; *Boyer*, *Traité des Mal. Chir. &c.* t. ii. p. 177.)—Two cases are likewise recorded by Mr. Hodgson. In one, the disease was caused in the thigh, about four inches below Poupart's ligament, by the point of a heated iron rod, which had passed through the femoral artery and vein. In the other example, the aneurismal varix was situated in the ham, and was the consequence of a wound in that part with a pistol-ball. (*On the Diseases of Arteries*, p. 498.) Larrey records one example of aneurismal varix situated under the clavicle.

P. Cadrieux was wounded with a sabre in a duel, on the 20th of November, 1811: part of the attachment of the sterno-mastoid muscle was divided, the anterior scalenus, the subclavian artery and vein at a very deep point, and probably also a portion of the brachial plexus. A most violent hemorrhage took place, followed by syncope. Pressure was applied to the wound, and the patient conveyed to the hospital at Gros Caillou. The external wound, which was small, did not bleed at all the following morning; but the clavicle was quite concealed by a large tumor, which throbbed with the arteries, particularly at its lower part. A peculiar noise, like that of the passage of a fluid through tortuous metallic tubes, could also be felt more deeply in the direction of the axillary vein. The arm was quite cold, insensible, motionless, and without any pulse even in the axillary artery itself. On the 22nd, the tumor was not larger, but its throbbings were stronger; the jugular vein on the same side was considerably dilated; and the pulsation of the carotid, and of the arteries of the opposite arm, had augmented. A vein in the right arm was opened, and compresses dipped in camphorated vinegar, muriate of ammonia, and ice, applied to the swelling. It would be superfluous here to detail the diet, bleedings, and other parts of the treatment. On the eighth day, the outer wound was quite healed. On the tenth, the veins of the limb were observed to be swelled, and sensibility and warmth were returning in it; though no pulse could yet be felt. The tumor was much smaller, and restricted to a circumscribed place behind the great pectoral muscle; but the hissing sound was still plainer. By degrees, the muscles of the arm and forearm regained their power of motion. The hand, however, continued useless, and affected with pricking pains. On the twentieth day, the tumor was quite gone; but the hissing sound was unaltered, and the throbbings were still evident in the veins of the neck and arm. The arm was not at all emaciated. On the fifty-fifth day, a pulse at the wrist could be slightly felt: the hissing sound had become less distinct; the veins were less turgid and their throbbing had diminished. A second instance of aneurismal varix, or, rather, perhaps, of a varix of all the veins of the arm, caused by a sword-wound of the axilla, is recorded by Larrey. In the most prominent of the large vessels there was a pulsation. (*Mém. de Chir. Mil.* t. iv. p. 341, &c.)

Dr. Dorsey, of Philadelphia, published a case of aneurismal varix, which is in several respects interesting. A patient was wounded in the leg with buck-shot; and after the cure of the injury, an aneurismal varix was noticed just below the knee; and in a little time the superficial veins of the limb became dilated, and the hissing noise, characterising this species of aneurism, could be plainly distinguished. The patient was seen by Dr. Dorsey, twelve years after the accident; the veins were then considerably distended from the toes up to the groin, all about which latter part pain was constantly experienced, and some ulcers situated on the foot and ankle could not be healed by any of the remedies which were tried. The patient was under the care of Drs. Physick and Wistar. The enormous distension of the vessels of the leg, and the uncertainty of finding out the communication between the artery and vein, led these gentlemen to tie the first of these vessels in the middle of the thigh. Gangrene soon ensued, and in this state the patient was further weakened by an unexpected hemorrhage from one of the distended veins; and though the vessel was secured with a ligature, the bleeding recurred, the patient became more and more enfeebled, and at length expired. When the limb was examined after death, the whole of the trunk of the femoral artery was found preternaturally dilated, while all the veins of the limb were considerably distended; a bougie could readily be passed from the popliteal into the posterior tibial artery which participated in the dilatation, and from this last artery the instrument could be passed into the vein, through a cyst situated on the inside of the leg below the knee. (See *Dorsey's Elements of Surgery*, vol. ii. p. 210. Philadelphia, 1813.)

In November, 1835, Mr. Perry, surgeon to the Marylebone Infirmary, communicated to the Royal Medical and Chirurgical Society of London, the history of a remarkable case of varicose aneurism. It was a case in which death ensued six days after an operation for aneurism of the femoral artery, in consequence of the sac having communicated with the accompanying vein. I believe this patient was shown to me some months before the operation, when, from the peculiar thrilling sensation and hissings then perceptible, I intimated my expectation, that a communication existed between the femoral vein and the artery. This is not the only instance on record, where a similar condition was spontaneously established between a great vein and a neighbouring artery, for Mr. Syme, of Edinburgh, has published the particulars of a case, in which a free communication was found between the descending vena cava and the aorta, close to the bifurcations, attended with a considerable swelling of the latter vessel. (See *Edin. Med. and Surgical Journ.* No. 108.)

Professor Scarpa, Dr. Hunter, B. Bell, Pott, and Guattani, mention cases of aneurismal varix, which remained stationary for fourteen, twenty, and thirty-five years. Several cases are related by Brambilla, Guattani, and Monteggia, of a cure having been obtained by means of compression. But, as this method of cure, if it does not succeed, exposes the patient to the danger of a complication of the disease with an aneurism, it ought not to be employed, except in recent cases, where the tumor is small, and in slender patients. Sir Astley Cooper mentions in his Lectures, that he once cured an aneurismal varix in a young lady, by compression with an instrument ; and in the Museum of University College is a preparation, given to that institution by Mr. Oldknow, illustrating the power of pressure to effect a cure, even when the disease consists of a varix and a false aneurism together. In this preparation, the communication between the vein and the subjacent aneurism, and that between the aneurism and the artery, are obliterated ; while the remains of a small sac are discernible between the artery and vein. The case was treated by Mr. Oldknow. I have seen one example cured by compression ; the case was recent, and in a woman about forty, who had imprudently suffered herself to be bled by a farrier.

Two cases are recorded, in which it was necessary to operate in consequence of the disease being joined with aneurism of the artery, and even bursting. The sacs were opened, and a ligature applied both above and below the aperture in the artery. (See *Park*, in *Medical Facts and Obs.* vol. iv. p. 111 ; and *Physick*, in *Medical Museum*, vol. i. p. 65.) The latter form of the disease, which is particularly noticed by Dr. Hunter, and also by my friend Mr. Hodgson, is readily understood by recollecting, that the artery and vein, when punctured together, do not always unite in such a manner as to let the arterial blood have a direct passage into the vein ; but they may be separated for some distance from each other, so that the blood passes from the artery into the adjacent areolar tissue, where a sac is formed, into which the blood is poured previously to its entrance into the vein. (See *Gibson's Institutes of Surgery*, vol. ii. p. 158. Philadelphia, 1825.)

In the winter of 1819, I heard a case read to the Medical and Chirurgical Society of London, from Mr. Atkinson of York, who had found it necessary to take up the brachial artery, on account of the large and increasing size of an aneurismal varix ; mortification of the limb ensued. In the Museum of University College is a preparation taken from a person on whom Sir Charles Bell operated for a venous aneurism, and who died of gangrene of the limb. In this case, there was a high bifurcation of the brachial artery, and the radial division had been punctured in bleeding. The preparation exhibits a double aneurism ; one being under the fascia, and communicating with the dilated portion of the vein through an opening in that texture. An anastomosing branch, between the radial and ulnar, is seen equal in size to either of them. I believe that the records of surgery prove, that operations for the cure of venous aneurisms have more frequently been followed by mortification than operations for other aneurisms ; and when it is considered, that the extreme part of the limb, even previously to the ligature of the artery, is deprived of a great quantity of the arterial blood, which ought to be distributed to it, that venous blood gets into the artery, and that it has a difficulty in maintaining its proper temperature, the fact seems accounted for. These considerations, joined with the recollection that the disease, after attaining a certain size, generally remains stationary through life, ought to make surgeons decline an operation, except when the increase of the false aneurism, or an unusual degree of annoyance from the swelling, justifies the opposite line of conduct. Here the artery, then, has a ligature applied to it under very disadvantageous circumstances. When an arterial trunk is tied, soon after the wound of an artery, as M. Breschet observes, hopes may be entertained of the member preserving its vitality, because its several textures are in a favourable state for receiving blood form the vessels of small calibre. The anastomoses between the trunk of the vessel, above and below the ligature, possess the advantage of having the lower portion of the artery sound, and fitted for carying on the circulation. But when a ligature is applied to an artery for venous aneurism of long standing, the part of the artery situated below the disease is dilated ; its coats are weakened ; they no longer possess the contractility requisite to carry on the circulation ; and the vitality of the tissues being thus reduced, the fluids stagnate in them and the parts are soon seized with grangrene or paralysis. (See *Mém. Chir. sur Différentes Espèces d'Aneurysmes*, p. 109.) If the limb be not seriously affected with atrophy, and a diminution of its temperature, sensibility, and power of action, the wisest plan is to let the disease alone, or, at most, only to make gentle equable pressure on the limb, and on the point corresponding to the wound of the artery. In the opposite circumstances, says M. Breschet, a surgical operation is indicated, which should not consist in the simple ligature of the artery between the heart and the wound, because the return of the blood through the lower portion of the artery would reproduce the disease, especially if the wound were not recent. Neither, says he, should it consist in merely tying the artery beyond the injury, or in the separate ligature of the vein above it, because these proceedings would expose the patient to the risk of various inflammatory accidents, or to a false aneurism, either circumscribed or diffused. But it is better and safer to place the injury of the vessels between two ligatures. By acting in this manner, not only do we hinder the blood from returning through the lower end of the artery and reproducing the disease, but we prevent the venous blood from passing into the artery, and thereby avert the stupor which the passage of this black blood into the tissues always creates ; a stupor the more considerable, and the more readily followed by grangrene, inasmuch as the red blood enters the organised textures in less quantity, and with increased difficulty. (See *Breschet, in Mém. sur Différentes Espèces d'Aneurysmes,* p. 153.) If the artery be tied both above and below the communication with the vein, the exchange of blood between the two vessels will be effectually stopped: the proposal once made by Dupuytren, to include the vein in the ligatures along with the artery, must therefore be unnecessary, and, as likely to cause phlebitis, it should not be adopted. Indeed, Dupuytren himself never tried the plan on the living subject. (See *Malgaigne, Manuel, &c.* p. 195.) As for the mode of operating different writers give different advice. Thus, according to Scarpa, when the aneurism is joined with an aneurismal varix, and circumscribed, but the circumstances such as to require the brachial artery to be tied, this vessel should be exposed, and tied above the swelling with a single ligature. It is only when the aneurism is diffused that opening the swelling and applying a ligature both above and below the aperture in the artery, are deemed by him necessary. On the other hand, Mr. Guthrie directs "an incision at the part, and the application of two ligatures to the artery, for although in some cases one has been found sufficient, in others the blood has returned into the sac by the anastomosing branches, and a second operation has been required to effect a cure." (See *Guthrie, On Dis. of Arteries,* p. 334.) M. Lisfranc prefers opening the sac, and applying two ligatures. "Perhaps," says he, "in examples where a sac intervenes between the dilatation of the vein and the injury of the artery, it might be prudent to open the aneurismal pouch without meddling with the vein ; a method that would create less risk of phlebitis, which sometimes arises as a complication of the operation." (*De l'Oblitération des Artères dans les Aneurysmes,* p. 112, 8vo. Paris, 1834.) In three subjects, in whom the brachial artery was tied, the tumor reappeared (*Dupuytren, Breschet*); and in two others, in whom the femoral artery was tied, death ensued from sloughing and hemorrhages. M. Jules Cloquet relates a case where the ligature of the artery above the communication with the vein was followed by a return of the pulsation in the tumor, atrophy of the limb, a lived discoloration of the fingers, and detachment of the nails, and amputation was performed. (*Pathol. Chir.* p. 85, 4to. Paris, 1831.) Hence Dupuytren, Breschet, and Malgaigne are of opinion, that the Hunterian method, with a single ligature above the tumor, should be abandoned. (See *Manuel de Méd. Opér.* p. 195. 12mo. Paris, 1834 ; *W. Hunter,* in *Med. Obs. and Inq.* vol. v. ; *Scarpa on Aneurism,* p. 433, ed. 2 ; also *Guattani, De Cubiti flexuræ aneurysmatibus,* in *Lauth's Coll. Scriptorum, &c. ; P. Adelmann, Tract. Anat. Chir. de Aneurismate spurio varicoso.* Wirceb. 1824 ; *Dupuytren, Répert. Gén. d'Anat. et de Physiologie, &c.* t. viii. p. 104. 1829, and *Clin.* t. i. p. 275, &c. ; *Larrey,* in *Mém. de Chir. Mil.* t. iv., and in *Clin. Chir.* t. iii. ; *G. Breschet, De l'Aneurysme par Transfusion,* in *Mém. Chir. sur Différentes Espèces d'Aneurysmes,* 4to. Paris, 1834.)

ANEURISM BY ANASTOMOSIS

Is the term which Mr. John Bell applied to a species of aneurism, resembling some of the bloody tumors (*nævi materni*) which appear in new-born children, grow to a large size, and ultimately bursting, emit a considerable quantity of blood. Imperfect descriptions of this disease may be traced in writers ; though, before the publication of Mr. John Bell's Principles of Surgery, it was not classed with aneurisms. Thus, Desault has recorded a case of this affection, for the express purpose of proving that pulsation is an uncertain sign of the existence of an aneurism. (See *Parisian Chir. Journal,* vol. ii. p. 73.)

Aneurism by anastomosis often increases from an appearance like that of a mere speck, or mother's mark, to a formidable disease. The tumor is a congeries of active vessels ; and, according to Mr. John Bell, the areolar tissue, through which these vessels are expanded, resembles the gills of a turkey-cock, or the substance of the placenta, spleen, or womb. The irritated and incessant action of the arteries fills the cells with blood, and from these cells it is reabsorbed by the veins. The size of the swelling is increased by exercise, drinking, emotions of the mind, and by all causes which accelerate circulation.

Aneurism by anastomosis is compared by Dupuytren to certain erectile tissues, which naturally appertain to the organisation of the animal body. In this point, there is an agreement between him and John Bell. "A texture of this kind," says Baron Dupuytren, "is met with in the genital organs of many animals of both sexes, and particularly in the urethra, the corpora cavernosa, and the glans penis ; on the heads and necks of many birds ; on the buttocks of several species of ape ; and on parts of the bodies of many other animals. This erectile tissue was regarded by Dupuytren as the model and type of several accidental tissues, which, in consequence of defects of organisation, either original or acquired, may be developed in almost any part of the human body, where they produce tumors, which frequently attain a considerable size. Such growths all exhibit the same vascularity and organisation, the same investment, and the same fibrous interlacement, as the natural erectile tissues do ; but their investment is weaker, and the quantity of nerves in them is less. The skin and subcutaneous areolar tissue are particularly often the seats of tumors of this character, which, however, are sometimes met with in almost every part. In particular, they present themselves on the face and the integuments of the cranium ; and they form the basis of those congenital marks and swellings, which receive the name of nævi. Sometimes they invade the whole of an organ.

Thus, Dupuytren had a case, in which the whole of the external ear and a portion of the contiguous parts were converted into a true erectile mass. In other examples, the new growth leads to the formation of tumors of various size, placed in the very substance, or in the interstices of organs. Under some circumstances, the accidental erectile tissue seemed to Dupuytren to be the product of a degeneration of some natural texture, and of the dilatation of its capillary network; while on other occasions, it appeared to him to be in reality a new organ developed amongst the parts. In the first case, it is confounded on every side with the healthy textures; in the second, it separates these textures from one another, compresses them, and at the same time remains divided from them by a dense investment of areolar tissue, by which it is circumscribed.

The accidental erectile tissues of Dupuytren, corresponding to the aneurism by anastomosis of John Bell, the tetangiectasiæ of Graefe, the cylindroid aneurism of the small arteries of M. Breschet, and the nævi of many writers, are generally of a reddish or brownish colour, often granular on their surface, and situated in the skin, the subcutaneous areolar tissue, or between the muscles. From the investigations of M. Breschet and Scarpa, it appears that the small vessels of the bones, as well as the soft parts, are occasionally the seat of aneurism by anastomosis. (See *Breschet* in *Répert. d'Anat. &c.* t. i. année 1826; *Scarpa, Annali, Univ. di Med.* 1830. Tumors of this character are either flat or prominent. Sometimes the skin, under which they lie, is scarcely altered. A kind of motion is perceptible in them, synchronous with the arterial pulse. Pressure reduces them to a very small size. Though usually soft, any irritation or excitement renders them remarkably tense and turgid; and if they happen to be wounded, the hemorrhage from them is profuse, and often very difficult to stop. The blood, though of a vermilion colour, and manifestly arterial, does not flow out *per saltum*; but trickles away, just like what happens in cases of fungus hæmatodes. (*Dupuytren, Clin. Chir.* t. iv. p. 8.) Tumors of this description do not spontaneously disappear, but, on the contrary, have a tendency to increase in magnitude. In a few instances, however, they have been known to disperse in consequence of an accidental attack of inflammation; and Professor Gibson, of the United States, gives an instance of this, which occurred during a fever. (*Pract. and Inst. of Surgery.*) Like the natural erectile tissues, these tumors undergo, at the same epochs, and from the same causes, a marked development, and alternations of tension and relaxation, which are, in relation to the healthy or unhealthy state, the strength or weakness of the individual. (See *Dupuytren, Clinique Chir.* t. iv. p. 3—5.)

I have mentioned the observation of Dupuytren, that the accidental erectile tissue forms the basis of those congenital marks and substances, which go under the name of nævi materni. As Mr. Guthrie remarks, however, "It is only when these spots, or marks, are subcutaneous, that their nature approaches to that of aneurism by anastomosis. The milder kinds of subcutaneous disease, to which the name of nævi is often applied, differ much both in appearance and size; sometimes remaining stationary through life, and in others, even disappearing altogether, or becoming small solid prominences. A nævus is usually of a red colour, with a bluish cast, shining through the skin, which appears to be exceedingly thin. It has also a tolerably defined and terminating edge; and the disease of the vessels seems to be confined to the part discoloured, or extends to a very short distance around it. The tumor, or nævus, although large and elevated in size, does not pulsate. An aneurism by anastomosis, in its most formidable shape, is a swelling of a more or less elevated form. The skin is in general thickened, and its colour is sometimes but little altered, although it more frequently has a bluish cast, which may even tend to red. The pulsatory nature of the tumor is distinct, and the vessels, both arteries and veins, leading to or from it, are enlarged for some distance. The tortuous forms, which the veins particularly assume, give to this disease a distinct character, which cannot be mistaken. (See *Guthrie, On Dis. of Arteries*, p. 341; also *Breschet, Mém. Chir.* p. 28.)

Several writers describe an essential difference between simple nævi and aneurism by anastomosis to be this: in the former, the veins are chiefly affected; in the latter, the arteries. To this view Mr. Guthrie inclines, for he says, "When the arteries partake most of the disease, the indistinct throbbing attendant on it is soon perceptible, and becomes in a short time a marked pulsation; but in cases which more frequently occur in children, and are congenital, and the disease seems more to affect the veins, the swelling will be considerable, the veins greatly dilated, and the part have a varicose appearance, without any pulsatory motion." (See *Guthrie, On Dis. of Arteries*, p. 344.) The *cylindroid aneurism* in the vessels of the smallest diameter, for instance, in the capillaries, says M. Breschet, is named *aneurism by arterial anastomosis*, and *aneurism by venous anastomosis*. In the first of these tumors, there are pulsations synchronous with the pulse, and alternate rises and falls corresponding to the diastole and systole of the arteries, circumstances not remarked in aneurisms of the second kind; which, however, in certain states of the circulation, exhibit a sort of erection or turgescence, produced by the influx of a greater quantity of venous blood. (See *Breschet*, in *Mém. Chir. sur Différentes Espèces d'Aneurysmes.*)

It is observed by Mr. Syme, that most surgeons have followed John Bell in believing aneurism by anastomosis to consist of a morbid cellular structure, through which the blood passes in its course from the arteries into the veins. However, he has long been one of those who maintain that the apparent cells are really sections of enlarged vessels. (See *Ed. Med. Journ.* No. 98, p. 72.)

In the dissection of a pulsating tumor of the scalp in a patient who had died after the operation of tying the carotid artery, Dr. Maclachlan found the branches of this vessel on the head "degenerated into dilated tubes of extreme thinness and transparency; which, apparently yielding to the impetus of the blood, had become elongated, contorted, and ultimately convoluted on themselves, so as to form, by this species of doubling, the tumors, which constituted this singular disease." They felt like placenta, and the larger portion, immediately over the ear, looked precisely like a bundle of earthworms coiled together. (See *Glasgow Medical Journ.* vol. i. p. 85.) Two cases are given by Pelletan, fully confirming the view taken of the nature of the disease by Dr. Maclachlan and Mr. Syme. (See *Clinique Chir.* t. ii.) Boyer, who saw one of these cases, describes all the arteries of the swelling as being dilated, tortuous, knotty; and though very large in some places, in others contracted. (*Traité des Mal. Chir.* t. ii. p. 295.) In the tumor described by Dr. Maclachlan, none of the cells spoken of by Mr. John Bell were found; no parenchyma, as in the spleen; the bulk of the tumor was formed almost entirely by convoluted dilated arterial *trunks*, the veins being but little changed from their healthy state. He adds, that these arteries did not appear to communicate more freely than by their ordinary inosculations. Some of these conclusions appear to me to require corroboration by a careful anatomical injection of the vessels.

Why, however, should there not be varieties in this disease? The observations of Baron Dupuytren make allusion to modifications of it; and, according to Mr. Guthrie, dissection has shown, that in some instances the tumor has been formed by contortions and reflections of the vessels alone; whilst, in others, the spongelike appearance has been more distinct. (*On Dis. of Arteries*, p. 343.) He adds that in nævi of large size and marked characters, as well as in aneurism by anastomosis, the disease essentially consists of vessels, with the interposition of very little cellular structure. However this may be, I believe Dupuytren correct in describing aneurism by anastomosis as essentially a new growth, consisting of an adventitious erectile areolar tissue, pervaded by a congeries of blood vessels. Thus, in giving the particulars of a case of aneurism by anastomosis of the ear and side of the head, Dupuytren states, that two very different elements were distinguishable in the mass, both by the finger and the eye. The first presented itself in the form of wide, sinuous, irregular knotty tubes, full and compressible, winding over the temple and ear, to which they communicated a knobby appearance. These tubes arose one from another, in the manner of arteries; and the trunk of them, which was equal in size to the little finger, gradually diminished, still retaining, however, in its smallest branches, the diameter of a crow-quill; and these could be traced even into the skin. The origin, the situation, the direction, and the divisions of these tubes, and especially their pulsations, synchronous with those of the heart, and the force of which seemed to threaten every instant a rupture of the tumor, and a perilous hemorrhage, were a sufficient proof that they were formed by the arterial system of the ear, temple, and occipital region, extraordinarily dilated in its trunks, branches, and cutaneous ramifications. All that did not immediately belong to the dilatation of the arterial trunks, was formed of accidental erectile tissue, which filled up the interstices of the network of vessels, and gave to the parts their purple colour, their higher temperature, and their double movement of expansion and subsidence. The tumor shrivelled and became pale under slight compression; but soon resumed its usual colour, size, and tension. (See *Dupuytren, Clin. Chir.* t. iv. p. 13.)

In the female subject, the hemorrhage from the aneurism by anastomosis is sometimes a substitute for menstruation, as the following example illustrates:—Ann Vachot, of St. Maury, in Bresse, was born with a tumor on her chin, of the size and shape of a small strawberry, without pain, heat, or discoloration of the skin. As it produced no uneasiness, nor inconvenience whatever, it excited little attention, particularly as it did not seem to increase with the growth of the child. For the first fifteen years, there was but little alteration; but, about the menstrual period, it increased suddenly to double the size, and became more elongated in its form. A quantity of red blood was observed to ooze from its extremity. This flux became, in some measure, periodical, and sometimes was sufficiently abundant to produce an alarming degree of weakness. Each period of its return was preceded by a violent pain in the head and numbness. Before and after the appearance of these symptoms there was no alteration in the size of the tumor; the only difference was a small enlargement of the cutaneous veins, with an increase of heat in the part, occasioning some degree of tenderness. The menses at length took place, but in small quantity, and at irregular periods, without influencing the blood discharged from the tumor, or the frequency of the evacuation. The breasts were not enlarged till a late period, nor did the approach of puberty seem to have its accustomed influence on those glands, &c. (See *Parisian Chir. Journ.* vol. ii. p. 73, 74.)

In the article Nævus, I shall explain the modes of treatment applicable to the superficial kinds, and at present consider what should be done for the cure or relief of the subcutaneous and deeper forms of the disease, to which the term aneurism by anastomosis more particularly refers.

The first plan which I shall notice is that of removing the disease with a knife. This should only be attempted where the morbid tissue does not extend too deeply, and where there is a fair prospect of being able to take every particle of it away without endangering life by hemorrhage. As Mr. John Bell inculcates, the rule in this operation is not to cut into the diseased part, but to cut it out (see *Principles of Surgery*, Disc. ix.); a piece of advice repeated by Mr. Wardrop, when he says, the surgeon should avoid cutting into the tumor; for, unless this caution be attended to, the hemorrhage is violent; whereas, by making the incisions beyond the diseased structure, the flow of blood is much more moderate. (*Med. Chir. Trans.* vol. ix. p. 212). If the incisions be carried into the morbid tissue, the hemorrhage will be great, because the enlarged and diseased vessels have lost their power of contracting, and there will also be a probability of the return of the disease. "If the nævus be large, round, or of a figure which does not admit of its being removed by two elliptical incisions, so as to give a reasonable hope of union, or if the cicatrix is likely to be large and unseemly, the operation by ligature is to be preferred." (See *Guthrie, On Dis. of Arteries*, p. 346.) I find that extirpation with the knife answers remarkably well when the disease is on the lip, or part of the ear, care being taken to cut in the sound part. I have removed many swellings of this kind from the lips of young children, and always found the hemorrhage cease directly the edges of the wound were brought together with the twisted suture.

The following case, recorded by Mr. Wardrop, affords a valuable illustration of the nature and structure of one form of this disease. A child was born with a subcutaneous nævus on the back part of the neck, of the form and size of half an ordinary orange. The tumor had been daily increasing; and when Mr. Wardrop saw it, ten days after birth, the skin had given way, and a profuse hemorrhage had taken place. The swelling was so soft and compressible, that when squeezed in the hand it yielded like a sponge, and was reducible to one third of its original size. On removing the pressure, however, the tumor rapidly filled again, and the skin resumed its purple colour. "Conceiving the immediate extirpation of the tumor the only chance of saving the infant (says Mr. Wardrop), I removed it as expeditiously as possible, and made the incision of the integuments beyond the boundary of the tumor; aware of the danger of hemorrhage where such tumours are cut into. So profuse, however, was the bleeding, that, though the whole mass was easily removed by a few incisions, the child expired.

"The tumor having been injected, by throwing coloured size into a few of the larger vessels, its intimate structure could be accurately examined. Several of the vessels, which, from the thinness of their coats, appeared to be veins, were of a large size, and there was one sufficiently big to admit a full-sized bougie." This vessel was quite as large as the carotid artery of an infant. The boundaries of the tumor appeared distinct, some healthy cellular membrane, traversed by the blood vessels, surrounding it. On tracing these vessels to the diseased mass, they penetrated into a spongy structure, composed of numerous cells and canals, of a variety of forms and sizes, all of which were filled with the injection, and communicated directly with the ramifications of the vessels. These cells and canals had a smooth and polished surface, and in some parts, resembled very much the cavities of the heart, fibres crossing them in various directions, like the chordæ tendineæ. The opening in the skin, through which the blood had escaped during life, communicated directly with one of the large cells, into which the largest vessel also passed. (*Wardrop*, in *Med. Chir. Trans.* vol. ix. p. 203.)

This case furnishes an instructive warning to us not to attempt to cut out an aneurism by anastomosis, where the size of it, and the age or weakness of the individual, render it probable that he will not bear the loss of blood. I lately saw a child with Messrs. Gilchrist, of Sunbury, aged about two years, with a tumor over the base of the scapula, the nature of which seemed obscure. I made an exploratory puncture in it, meaning to remove it at once, if composed of fat. But the profuse gush of blood which followed the lancet, and the pulsations felt in the swelling during the child's agitation, left no doubt about the case being an aneurism by anastomosis. As the tumor was as large as half an orange, and the child so young, I refrained from the attempt to cut it away, fearful that the bleeding might be more profuse than the little patient would bear. Mr. Lawrence, who has since been consulted, does not recommend the operation.

In the Section on Carotid Aneurisms, I have mentioned the cases, in which Mr. Travers and Mr. Dalrymple cured aneurisms by anastomosis in the orbit, by tying the common carotid artery; a practice which has been repeated with success very lately by Mr. Busk, surgeon to the Dreadnought hospital ship at Deptford. (See *Lond. Med. Gaz. Feb.* 27, 1836.) Professor Pattison cured an immense anastomosing aneurism of the cheek and side of the face by taking up the carotid artery. (See *Med. and Phys. Journ.* vol. xlviii. July, 1822.) These facts prove, that aneurism by anastomosis, like many other diseases, sometimes admits of being cured, on the principle of cutting off, or lessening, the supply of blood to the part affected.

However, surgeons must not be too confident of being always able to cure the disease, by tying the main artery, from which the swelling receives its supply of blood; and the great cause of failure is the impossibility of preventing in some situations the transmission of a considerable quantity of blood into the tumor, through the anastomosing vessels. A case is recorded by Maunoir, in which he applied a ligature for three days to the carotid artery, and obliterated it; yet the benefit effected seemed to be only temporary, as, in a short time, the tumor was as large as before. (See *Med. and Phys. Journ.* vol. xlviii.) In fact, every vessel, artery, and vein, around the disease, seems to be enlarged and turgid; and the inosculations are so infinite, that no point of the circumference of the swelling can be imagined which is free from them. Etienne Dumand was born with two small red marks on the antihelix of the right ear. Until the age of twelve years, the chief inconveniences were a sensation of itching about the part, occasional bleeding from it, and the greater size of this than of the other ear. The disease now extended itself over the whole antihelix, and to the helix and concha; and the upper part of the ear became twice as large as natural. Slight alternate dilatations and contractions began to be perceptible in the tumor, which was of a violet colour, and covered by very thin skin. Soon afterwards any accidental motion of the patient's hat was sufficient to excite copious hemorrhages, which were difficult to suppress, and, at the same time that they produced great weakness, caused a temporary diminution of the tumor and its pulsations. At length the disease began to raise up the scalp for the distance of an inch around the meatus auditorius, and the hemorrhages to be more frequent and alarming. Pressure was applied to the temporal, auricular, and occipital arteries; but, as the patient could not endure it, the first two of these vessels were tied, the only benefit from which was a slight diminution in the pulsation and bulk of the swelling. This treatment did not prevent the return of hemorrhage, and therefore forty-three days after the first operation, a ligature was applied to the occipital artery. As the disease still continued to make progress, the patient entered the Hôtel Dieu, where on the 8th of April, 1818, Dupuytren tried what effect tying the trunk of the carotid artery would produce on the swelling. As soon as the ligature had been applied, the throbbings ceased, and the tumor underwent a considerable diminution. On the eighteenth day, slight expansions and contractions of the diseased part of the ear were again perceptible, though the swelling had diminished one third, and no throbbing could be distinguished in the neighbouring arteries. The ear was now kept compressed between two masses of charpie. On the forty-sixth day Dupuytren tried what benefit would result from pressing the blood out of the tumor, and then covering it with plaster of Paris. This, however, soon cracked in various places, and could not be kept on the part. An instrument was then contrived for the reception and compression of the ear. This had the effect of restraining the enlargement of the ear, but was found inadequate to destroy the erectile tissue, which still continued, notwithstanding the pulsation of the arteries had ceased. To have got rid of this portion of the disease, observes Dupuytren, it would have been necessary either to remove the tissue composing it, or to change its organisation. The first plan, on account of the extent of the disease, he did not consider safe; nor could he alter the nature of the disease.

The history of the foregoing case, resumed fifteen years after the operation, proves that though tying the carotid artery is less efficacious in curing a tumor composed of erectile tissue, than a common aneurism, yet it checks its progress, and diminishes its danger. After the carotid artery had been tied in the preceding case, the tumor made little or no progress; the size of the ear remained stationary; and no return of hemorrhages took place. But whatever may be the degree of benefit resulting from the plan of tying the principal artery leading to the disease, Dupuytren gives it as his decided opinion, that it ought to be resorted to when an erectile tumor has invaded a part where compression, cauterisation, and extirpation with the knife, are all impracticable. If there be no carcinomatous tissue blended with the erectile, the progress of the disease will, at all events, be retarded by the operation. (See *Dupuytren, Clinique Chir.* t. iv. p. 5—26; and *Breschet's Trans. of Hodgson's Treatise*, t. ii. p. 296.) The experiment has been made of tying both carotids where the ligature of one proved insufficient to prevent the return of pulsation in the arteries immediately supplying the tumor. Dr. Mussey, of New Hampshire, in America, was consulted in September, 1829, by J. Patee, aged 20, for a large pulsating purple tumor, situated upon the vertex of the head, with a base of about five inches in diameter, and rising about two inches above the cranium. The tumor, which had existed from infancy, had greatly increased during the three years anterior to the above date. Upon its apex was an ulcer, from which hemorrhages had occasionally taken place, and once to the amount of two quarts. "The left temporal artery and vein in front of the ear, seemed through the integuments five eighths of an inch in diameter, and the pulsations of the artery were visible at the distance of fifteen feet. A vein, passing from the tumor down the forehead, was half an inch in diameter; and when the head had been shaved more than twenty pulsating arteries were seen running to the tumor, none of which were under the size of a goose-quill. Dr. Mussey, on the 20th of September, tied the left common carotid; and finding this effectual, he applied a ligature to the right one, twelve days after the first operation. The tumor was covered with a compress moistened with alum-water, and gentle pressure maintained with a bandage. In about three weeks from the period of the second operation, the swelling was not above one third of its original size. Five or six days later, it began very slightly to enlarge again; its colour became deeper; and a feeble thrill was sometimes perceptible in the left temporal artery. As Dr. Mussey found that the ligature of the carotid promised no further benefit, he determined to encircle the tumor by incisions, and to dissect it away rapidly from the pericranium. More than an hour was occupied in carrying the knife around the base of the tumor; for only an inch and a half of the scalp was cut at a time, and as soon as this was done, firm compression was made upon each lip of the incision, while the vessels were secured with ligatures, more than forty of which were applied in proceeding round the tumor. Notwithstanding these precautions, nearly two quarts of blood were lost. The patient was faint, and continued very feeble for several hours. The naked pericranium, in extent about twenty-five square inches, granulated favourably, and the part healed up. (See *American Journ. of Med. Sciences for Feb.* 1830.)

This case is instructive, as proving still more convincingly than perhaps any other case on record, that tying the carotid artery will not completely cure an aneurism by anastomosis on the head, though the plan has generally succeeded for swellings of this description in the orbit. The ligature, even of both carotids, in Dr. Mussey's case, did not prevent the return of pulsation in the temporal artery; and this unpromising circumstance led him to adopt, without delay, the plan of encircling this disease by a succession of short incisions, in the way practised by Dr. Gibson. Time was not afforded to see whether the growth of the tumor would have been permanently checked, and the return of hemorrhages prevented by the ligature of both carotids, as happened in Dupuytren's case from the ligature of one of them. An interesting question here is, whether the ligature of the carotids made the final excision of the tumor safer, with respect to hemorrhage? Without this preliminary measure, Dr. Gibson, we find accomplished what Dr. Mussey did with it.

Some aneurisms by anastomosis, on or near the surface of the body, may be extirpated with a ligature. A needle, armed with a double ligature, is passed under the erectile tissue. As it is of importance that the ligature go more deeply than the deepest part of the swelling, the assistant ought to raise up the tumor from the subjacent parts, while the needle is pushed under its base. The needle having been cut off, one portion of the ligature is firmly tied over one half of the circumference of the swelling, and the remaining part of it over the other half. Thus the supply of blood to the swelling is completely cut off. After a few days, the diseased mass and the ligatures are detached by an ulcerative process; and, as Mr. Guthrie observes, if the disease has been completely removed, the ulcer heals without difficulty, and the scar is often less than if the operation had been done with the knife. If the disease should not be completely removed, a second ligature may be applied, or, as I have sometimes preferred, the remains of the disease may be extirpated with caustic and pressure. We are informed that this method has been followed, for many years, by the surgeons of the Westminster Hospital. Mr. Keate has made an improvement in it, which consists in employing pins, which, by being passed across, but underneath the tumor, admit of compression being made around a larger surface than could otherwise be included in the ligature. (See *Guthrie, On Dis. of Art.* p. 346.) In one case thus treated by Sir Benjamin Brodie, where the size of the swelling, which was on the forehead, was too extensive to be embraced with a needle and double ligature in the common way, he used straight pins, like those for the hare-lip, which, being pushed under the disease at right angles, enabled him to pass a ligature around the base of it. In this instance it became necessary to employ a second set of pins and a second ligature; but the cure was ultimately complete. (See *Brodie*, in *Med. Chir. Trans.* vol. xv. p. 177.)

An infant, six weeks old, was brought to Mr. Wardrop, on account of an aneurism by anastomosis (a subcutaneous nævus) of a very unusual size, situated on the left cheek. The base of the tumor extended from the temple to beyond the angle of the jaw, completely enveloping the cartilage of the ear. At its upper part, there was an ulcer, about three inches in diameter, presenting a sloughing appearance. The tumor was soft and doughy; its size could be much diminished by pressure; there was a throbbing in it, and a strong pulsation in the adjacent vessels. The disease was daily increasing, and several profuse hemorrhages had taken place from the ulcerated part. Mr. Wardrop knowing, from the case to which I have already adverted, the danger of attempting to extirpate so large a tumor of this nature, was led to try what benefit might be obtained by tying the carotid artery. A few hours after this operation, the tumor became soft and pliable; its purple colour disappeared, and the tortuous veins collapsed. On the second day, the skin had resumed its natural pale colour, and the ulceration coutinued to extend. On the third, the tumor still diminished. On the fourth, the swelling had considerably increased again; the integuments covering it had become livid, and the veins turgid. The inosculating branches of the temporal and occipital arteries had become greatly enlarged. A small quantity of blood had oozed from the ulcer. After remaining without much alteration, the tumor on the seventh day had again evidently diminished. On the ninth, the ulceration was extending itself slowly, and the tumor was lessened fully one half. On the twelfth, the child's health was materially improving. The auricular portion of the swelling had now so much diminished, that the cartilage of the ear had fallen into its natural situation. After poultices had been applied for two days, the central portion of the swelling, which appeared like a mass of hardened blood, was softened, and Mr. Wardrop removed considerable portions of it. On the thirteenth, the child became very ill, and died the following day, exhausted by the irritation of an ulcer, which had involved the whole surface of an enormous tumor. Mr. Wardrop thinks the advantages likely to occur from the plan of tying the main arteries supplying tumors of this nature with blood are, the diminution of the size of the disease; the lessening of the danger of hemorrhage, if the ulcerative process has commenced; and the rendering it practicable to remove the swelling with the knife, though the operation may previously have been dangerous, or impracticable. (See *Med. Chir. Trans.* vol. ix. p. 206—214, &c.)

In the foregoing part of this article, I mentioned the trial of the method of securing the principal branches of the external carotid distributed to the tumor. This plan has generally failed, and it did so in the example under Dupuytren, who, therefore, decided to take up the common carotid itself. Dr. Gibson, in his Institutes of Surgery, however, relates a case, in which the practice succeeded. The patient, a woman, had a large pulsating tumor, which covered almost the whole of the right side of the head, and often bled profusely. Dr. Gibson began with cutting off the supply of blood to the tumor through the occipital and temporal arteries. The swelling now lessened, and its pulsations became weaker; but, as this amendment was only temporary, he proceeded to divide the parts situated between the former incisions, and to tie the vessels. The first cut was two inches in length, and a great deal of blood was lost before all the vessels were secured. The second cut was three inches in extent; but so much blood was now lost, that it became necessary to postpone the completion of the operation. After twelve days, the incisions were extended again; and, at the end of the fortnight, the circumvection of the wound was completed, and the tumor removed: the periosteum being left, from which granulations soon arose, and, in a few weeks, the wound was healed.

Aneurism by anastomosis, when situated on the fingers, may render amputation of them indispensable, provided the whole of the disease cannot be got rid of by other means. I once saw, with Mr. Lawrence, an aneurism by anastomosis, situated on the ring finger of the right hand, in a young woman, about twenty years of age. The disease was attended with painful sensations, extending to various parts of the limb and the breast, and the arm was disqualified for any kind of exertion. In January, 1815, Mr. Hodgson had taken up the radial and ulnar arteries, and the first consequences of the operation were an entire cessation of beating, collapse of the swelling, and relief from pain; but these symptoms all recurred in a few days. Finding compression unavailing, and the sufferings of the patient increasing, Mr. Lawrence proposed amputation of the finger at the matacarpal joint; but as this suggestion was not approved of, he recommended the patient to try the effects of a division of all the soft parts, by a circular incision close to the palm, so as to cut off the supply of blood. This operation Mr. Lawrence performed, in the presence of Mr. George Young and myself, in as complete a manner as can possibly be conceived. All the soft parts, excepting the flexor tendons, with their thecæ and the extensor tendon, were divided. The digital artery, which had pulsated so evidently in the palm of the hand, was fully equal in size to the radial, or ulnar of an adult, and was the principal nutrient vessel of the disease. After tying this and the opposite one, we were surprised at finding so strong a jet of arterial blood from the other orifices of these two vessels, as to render ligatures necessary. I can here only add, that the whole finger beyond the cut swelled very considerably; the incision healed slowly; the swelling subsided, but did not entirely disappear; the integuments recovered their natural colour; the pulsation and pain were removed; and the patient so far recovered the use of her arm, that she could work at her needle for an hour together, and use the arm for most purposes. (See *Wardrop's Obs. on one Species of Nævus*, in *Med. Chir. Trans.* vol. ix. p. 216.)

Mr. Russell, an army surgeon, has published some interesting particulars of an aneurism by anastomosis of the hand. The patient (a laundress), aged 41, had two tumors, each about the size of a walnut; one at the extremity of the ring finger, the other on that of the little finger of the left hand. They extended along each finger to the middle of it, and were of a violet colour, spongy feel, and of a structure resembling placenta. They shrunk under pressure, but recovered their size on its being removed; throbbed strongly, as did all the vessels of the arm: were excessively painful, and attended with irritability of the whole frame. The radial and ulnar arteries were enlarged, the latter tortuous; and the basilic vein had a varicous appearance. The disease had existed five years, and bled freely and frequently. Mr. Russell recommended the removal of the two fingers at the metacarpal joints, which the woman objected to. In about two months, however, she returned, willing to undergo any operation which Mr. Russell deemed necessary. The disease had now extended itself, so as to form one aneurismal tumor at the commissure of the two fingers. The placenta-like appearance reached to the wrist; the arm was of an erythematous hue to the elbow; the tumors had ulcerated and sloughed; and the carious phalanges protruded from the gangrenous fingers, which were enlarged, and dreadfully painful. The increased pulsation and magnitude of the arteries extended to the axilla. Mr. Russell first tied the ulnar artery, and then amputated the ring and middle fingers, with their metacarpal bones, at the carpus. The stump healed well; and a valuable portion of the hand was saved. Three years after the operation, the vessels of the arm had resumed their natural appearance, and the woman was able to follow the business of a laundress. This case Mr. Russell believes unusual, as having occurred in a person of advanced life; and he considers that it exemplifies the truth of Mr. Wardrop's observation, that a ligature on the artery, leading to the disease, may render the excision of it practicable, when this proceeding would otherwise be unsafe. However, Mr. Russell took up the ulnar artery, he says, for a different purpose; namely, that of enabling him to cut close to the disease. The case proves also, that the secondary effects on the surrounding parts, and, especially, the extensive enlargement of the blood-vessels, will subside after the excision of the erectile tumor. (See *J. Russell*, in *Lond. Med. Gaz. for April*, 1836.)

Most of those aneurisms by anastomosis which admit of being extirpated by a ligature, may also be destroyed with strong caustic, like pure potassa, the acid nitrate of mercury, &c. This plan, which was particularly recommended by Mr. Wardrop, and is an old practice, was sometimes adopted by Dupuytren. I have followed it in some instances, and found it answer, though the necessity of repeating the application several times makes it a more tedious method of cure than the ligature. I lately attended a child with Mr. Jephson, of Hampton, for a large thick nævus on the forearm: in this instance, the caustic answered exceedingly well, but it was indispensable to apply it several times. It seems to act partly by converting portions of the tumor into sloughs, and partly by exciting an ulcerative process in the remainder. Dupuytren regarded the actual cautery as a still surer means of extirpating erectile tumors than caustic, though rarely employed, on account of the terror which it excites. (*Clin. Chir.* t. iv. p. 33.) The acid nitrate of mercury was the caustic which he was in the habit of using. (Op. cit. p. 28.)

Whatever will change the texture by exciting a general and severe inflammation of an erectile tumor, and an obliteration or annihilation of its vessels, will effect a cure. The treatment on this principle is sometimes practicable. Thus, swellings composed of erectile tissue have occasionally been cured by compression; a plan which Abernethy wrote in favour of, and which both he and Dupuytren tried in several instances with success. The latter sometimes applied this method to the lips, the diseased portion of which was placed between a compressing instrument.

On the principle of changing the organisation of the erectile tissue, and converting it into the fibrous, M. Lallemand has treated certain tumors of this description very successfully by exciting inflammation in them by the introduction of pins through them. One of his most interesting cases is that of an infant three months old, which had an erectile tumor over the scapula, three inches in length and two in diameter, with a red granular surface. Compression had been tried in vain. M. Lallemand first introduced a dozen fine pins through the inferior portion of the tumor, and covered the spaces between them with waxed thread variously twisted. Three days afterwards, a similar operation was repeated on the opposite side. The pins were left in their places seven or eight days, till they had excited sufficient inflammation. The rest of the tumor was afterwards attacked, and in the course of two months and a half, after 120 pins had been introduced at successive periods, a cure was affected, without the loss of a spoonful of blood, a uniform glossy cicatrix being left. Long fine pins, such as are used for transfixing insects, are preferable to common sewing needles. (See *Lallemand*, in *Archives Gén. de Méd.* t. viii. sér. 2.) On the same principle of exciting inflammation, and changing the texture of erectile tumors, cures have occasionally been accomplished by passing a couching needle into them and breaking up their structure. Stimulating injections have likewise been thrown into their substance with the same view. (*Lloyd*, in *Med. Gaz. for* 1836-37.) Most of these latter methods seem to me only eligible when the tumor is of limited size, and its base not too deep.

Erectile tumors are more frequently noticed on the lips than any other part of the body, a circumstance ascribed by Dupuytren to their spongy vascular structure. (*Clin. Chir.* t. iv. p. 51.) But they have been met with in the arm, forearm, hand, fingers, thigh, instep, scalp, ear, cheek, labia pudendi, substance of the skin, muscles, periosteum, bones, kidney, liver, &c. In the work last cited, reference is made to an example where the skin, muscles, and bones of the upper extremity, all became affected from the fingers to the shoulder (t. iv. p. 52).

Besides the varieties of aneurism particularly treated of in the foregoing columns, there is another rarer form of the disease, named by Breschet *cirsoid aneurism* (from κιρσός, a varicose vein, and εἶδος, like); and by Dupuytren, *arterial varix*, in consequence of its resemblance to a varicose vein. It consists in the dilatation of an artery in a greater or lesser portion of its extent, and frequently through the whole of an arterial trunk and its branches. In addition to the transverse dilatation, the artery is elongated and tortuous, so as to describe bendings and windings in various degrees.

Independently of these dilatations of the whole arterial tube, nodosities, or small circumscribed aneurismal tumors, present themselves, which are true sacciform aneurisms, and occasionally mixed ones. Most commonly the coats of the vessel are thinned and softened, and, when divided, collapse like those of varicose veins. As Breschet observes, an artery affected in this manner, may easily be mistaken for a varicose vein. The disease has been noticed in the iliac, carotid, brachial, femoral, and tibial arteries, and also in some of less size; such as the occipital, the auricular, radial, ulnar, palmar, plantar, and ophthalmic. This kind of arterial disease, according to Breschet, accompanies an aneurismal varix of long standing. The arterial varix, like the venous aneurismal varix, has been suspected to be attended with some communication between the two orders of vessels, and the passage of a certain quantity of venous blood into the dilated varicose artery. But pathologists have not yet been acquainted with the disease long enough to know its nature perfectly. Some interesting examples of it, illustrated by engravings, are recorded by Breschet. (See *Mém. Chir. &c.*)

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ANKYLOSIS, [from ἀγκύλη, a thong or band, or ἀγκύλος, crooked, a term used to describe the condition of an articulation, which either no longer permits the free exercise of all its movements, or is attended with complete immobility. The first Greek derivation sufficiently well illustrates the nature of the uniting medium between the ends of the bones in the most common form of ankylosis; whilst the second, as M. Cloquet observes, has no doubt been chosen, from the fact that ankylosed limbs are generally found in a state of permanent flexion; a position chosen by the patient as the most easy, being that in which the ligaments are least extended, and the synovial surfaces least compressed during the severity of the joint affection, which usually precedes ankylosis. *True* or *complete* ankylosis signifies the fixed and motionless state of a joint, resulting from any of the conditions hereinafter explained.] *False* or *incomplete* ankylosis denotes the impairment of motion, or very considerable rigidity, in an orbicular, or ginglymoid joint, occasioned by adhesions of one synovial surface to the other, or by a thickening of the soft parts on the outside of the joint. [Perhaps it would be better to adopt the definition of M. Houel, who confines the term *ankylosis* to the completely immovable cases, while the others are grouped together under the term "*articular rigidity.*"] By Mr. Mayo, ankylosis is divided into *osseous*, *cartilaginous*, and *mixed*, according as the articular surfaces happen to be united through the medium of bone, of cartilage, or of both these substances together. (See *Outlines of Human Pathology*, p. 72.) Of course, this last classification is not intended to comprise some of the varieties of false ankylosis. True ankylosis, then, may be said to denote the complete loss of motion, either in the kind of joint termed *diarthrosis*, where the ends of the bones are tipped with cartilage, and furnished with a capsular ligament, or in the other less moveable sort of joint, termed *synarthrosis*, where the bones are united by an intervening layer of fibro-cartilage, and the articulation is strengthened externally by ligamentous bands. The latter kind of joint can hardly be said to be susceptible of false ankylosis; for it naturally has only a very slight degree of motion, which requires a true ankylosis for its interruption.

Ankylosis is more common in the ginglymoid articulations than others; though sometimes met with in every description of joint. In general, only one joint is ankylosed in the same individual; but sometimes several articulations are the seat of ankylosis, and rare instances are recorded, in which every joint in the body was in this state. Thus, Bernard Conner describes an example of a general ankylosis of all the bones of the human body. (*De stupendo Ossium Coalitu.*) The particulars of a child, twenty-three months old, afflicted with universal ankylosis, are given in *L'Hist. de l'Acad. des Sciences*, an. 1716. In old age, ankylosis in certain parts of the skeleton is a natural change; and in this period of life, it is common to find the heads of the ribs ankylosed to the bodies of the vertebræ, or the tubercles to the transverse processes, the vertebræ to one another, the ensiform cartilage to the sternum, &c.

Ankylosis, strictly speaking, is not a disease itself, but only an effect or consequence of other affections, and it may follow all those which destroy any one of the conditions, without which the motion of a joint is necessarily interrupted either permanently or for a very considerable time. The author of the article *Ankylosis*, in the *Encyclopédie Méthodique*, refers to a preparation, in which the femur is so ankylosed with the tibia and patella, that both the compact and spongy substances of these bones appear to be common to all of them, without any line of separation being discernible between them; [and the pathological museums of the present day afford many specimens of the kind]. Eustachius, Columbo, and Cruveilhier, have each seen an ankylosis of the lower jaw. Cruveilhier has given the particulars of an ankylosis of one of the articulations of the lower jaw in a very old woman. It commenced in her childhood, from a blow on the side of the face. From the engraving of the parts, it appears that the condyle and glenoid cavity were completely consolidated and united by osseous matter.

Referring to ankylosis in general, we may observe with M. Sanson, that its causes are numerous; inasmuch as every circumstance capable of impairing the articular surfaces, stopping the synovial secretion, lessening the suppleness of the ligaments, or of the soft parts around the joint, or of interfering with the action of the muscles, or the play of the tendons, may hinder the articular surfaces, more or less, from moving upon one another. One thing, almost essential to the production of ankylosis, is the part being kept motionless; and, as M. Sanson well observes, this condition has such influence, that it will of itself bring on the changes which terminate in a joint becoming incapable of resuming its functions, in consequence of true or false ankylosis. An illustration of this fact is afforded by what happens to the Indian Fakirs, who, by way of religious penance, sometimes condemn themselves to continue motionless in certain attitudes for several years, and whose limbs at the expiration of the term are ankylosed in the posture in which they happen to have been so long maintained. The same fact is exemplified in persons who have met with fractures of their limbs; for, in consequence of the motionless state in which the part is kept to promote union of the broken bones, the synovial secretion is diminished, and the fibrous capsules and ligaments of the joint all acquire a rigidity, in which the surrounding cellular tissue participates. The sheaths of the tendons are also no longer duly lubricated. All these circumstances make opposition to the free action of the muscles, which, being themselves weakened by protracted inactivity, are incapable of overcoming the resistance to the motion of the joint. [The paralytic also afford cases of complete ankylosis, with entire disappearance, in rare instances, of all trace of the former joint, and that without appreciable symptoms of inflammation. On the same principle of a long-continued motionless state of an articulation, ankylosis may be induced as a complication and sequel of the contracted state,—or lesion of some particular muscle, or tendon, or the growth of various tumors near the joint,—exostosis, aneurism, &c.] The contraction of cicatrices after burns, or after a destruction of the soft parts by gangrene or ulceration; and an unyielding state of the cellular tissue and fascia, the effect of extensive and inveterate abscesses in it; and especially inflammation of the synovial membrane, whether acute, or chronic, idiopathic, scrofulous, gouty, or rheumatic, &c., or accidentally excited by mechanical injury of the joints; are all so many circumstances capable of leading to ankylosis. Particular fractures of the joints, or such as are situated near them, if not skilfully treated, are apt to be followed by inflammation of the synovial membrane, absorption of the cartilages, and complete ankylosis. No doubt, in some of these instances, the connection amounts at first only to what authors understand by false ankylosis; but, in the course of time, this becomes converted into complete, or true, characterised by osseous consolidation. On the whole, however, as M. Sanson has remarked, false ankylosis is far more common than the true form of it.

When a bone is fractured near a joint, and this is kept too long motionless, ankylosis is apt to follow. Here the risk is increased by the synovial membrane being likely to inflame; and, indeed, sometimes the accident brings on ulceration of the cartilages. In University College Hospital, I lately saw a case, where the olecranon had been broken across its base, and the detached piece had become completely consolidated to the humerus; yet the patient had considerable power of extending the fore-arm. It is partly in consequence of the risk of inflammation of the synovial membrane and of ankylosis, that fractures of or very near joints are more serious than others differently placed. Wounds and contusions of joints may bring on such changes as terminate in ankylosis. I have already mentioned, that Cruveilhier has seen an instance of ankylosis of the right articulation of the lower jaw. The patient lived to a very advanced age, and, notwithstanding the ankylosis, was able to speak very well, and to masticate by pressing the food with her tongue against the hard substance covering the alveolar processes, where the teeth were deficient. (See *Cruveilhier*, *Anat. Pathologique*, livr. ix. pl. 5, figs. 1 & 2.)

[Although this work is essentially devoted to practical surgery, some explanation, however brief, will necessarily be expected of the pathological condition of the joints in true and false ankylosis. Without entering into more precise narration of the various kinds of ankylosis, for which the reader is referred to Cruveilhier, Houel, Nelaton, &c., it may be stated generally that true and false ankylosis may be the result of,—1st. Complete fusion or consolidation of the ends of the bones forming the articulation, a condition brought about by the absorption or destruction of the articular cartilages (for the various exciting causes see above), and the reciprocal throwing out of granulations from the exposed ends of the bones thus brought into contact. More or less of atrophic deformity usually attends this complete fusion of the spongy tissue of two bones; — 2nd. The formation of a bony sheath or capsule to the joint, or, more commonly, the formation of osseous growths, bridges or stalactites, passing from one bone to the other. Such growths are usually, but by no means invariably, found in the direction of the fibrous tissues, tendons, or ligaments, which surround the joint affected. In a preparation deposited in the Musée Dupuytren, ankylosis of the elbow is produced by ossification of the brachialis anticus muscle, and in another, the hip-joint is fixed by ossification of the psoas muscle. Gouty concretions deposited around joints may also lead to a similar result; in all these circumstances, however, the articular cartilages and fibro-cartilages remain persistent;—3rd. The cartilages being removed, and the ends of the bones becoming united by fibrous bands in a manner similar to the false union of fractured bones by the same tissue. Such a mode of ankylosis is said to follow the suppuration of joints particularly; and such fibrous tissue has never been known to undergo ossification (Houel); — 4th. The formation of fibrous bands within the joint, as the result of synovitis, attended with more or less deformity and absorption of the articular cartilages; — 5th. The arrest of the secretion of synovia, and the different alterations of the tissues around the joints, which take place under the various causes quoted above, and which comprise thickening and rigidity of the ligaments and all the fibrous textures, the muscles becoming shorter, paler, degenerated from fatty deposit, the skin contracting remarkably, the nerves even undergoing shortening, while the blood-vessels become tortuous to a corresponding degree. The effect of the pathological conditions comprised under the first and second heads will necessarily be true ankylosis of the joint implicated, while that of the three other groups will be to render the joint more or less completely immoveable; that is, to induce a state of true or false ankylosis, just as the tissues are more or less dense and rigid. Partial dislocation may also attend any of these conditions. As a guide to treatment, it is important that the surgeon decide whether the case before him be one of true or false ankylosis. The task is not an easy one. Chloroform is of course a valuable aid; but an examination should first be made without it; for if the patient experience much pain under attempts to move the joint, the surgeon will thus be supplied with one of the best evidences that he has to deal with a false ankylosis: if the joint admit of the least motion (unless there be evidence of external bony deposit around the joint), most surgeons are agreed that the case is to be regarded as one of false ankylosis. Care must be taken to fix the bone above the affected joint, either by the aid of an assistant, or, as in the case of scapula and pelvis, by mechanical contrivances. The persistence, or diminution of the rigidity and contraction in the muscles and tendons around the joint, under the subsequent action of chloroform, will of course aid the diagnosis, immobility alone being no sign of true ankylosis. But if the patient, when conscious, and with his attention drawn to or diverted from the joint, permit of free manipulation without pain or flinching, and no motion be obtained, the operator may confidently conclude that the case is one of true ankylosis.]

With regard both to true and false ankylosis, the surgeon may generally render more efficient service in preventing than in endeavouring to cure them. In wounds, contusions, and fractures of or near joints, the best means of prevention consist in the rigorous adoption of antiphlogistic treatment at first, and in a later stage in having timely recourse to passive motion of the joint; and then to combine with this plan friction with camphorated and other liniments. When the bones are carious, as in scrofulous disease of the vertebræ, and in advanced stages of ulceration of the cartilages of the knee, elbow, wrist, &c., the surgeon, instead of endeavouring to prevent ankylosis, should promote its occurrence, as the most favourable result which the case now admits of. In fact, the completion of ankylosis will denote the termination of the disease. One important indication, however, under such circumstances, is to try to let the limb be ankylosed in the posture which will allow it to be of the greatest possible use. Thus, when the elbow is likely to be the seat of ankylosis, the forearm should be kept bent; but when the knee is concerned, the leg should be kept extended; and when the hip, the thigh should be maintained in a similar position. If ankylosis should have taken place to a certain extent, with the limb in a disadvantageous posture, this may often be still very much improved by the application of splints, and other mechanical contrivances. The action of any mechanical apparatus, however, must be at first moderate, though unremitting. Perseverance will here succeed when violence would fail, by bringing on excessive pain and a dangerous degree of inflammation. Indeed, where the attempts to remove a false ankylosis by gentle passive motion, embrocations, and the cautious use of mechanical means, fail, it is better not to employ violence, because such an ankylosis is preferable to inflammation, abscesses, and ulceration of the joint.

As for true ankylosis, where a complete osseous consolidation has taken place, it may be set down, not only as incurable, but as admitting of no improvement or alteration in the position of the limb, and, whatever that may be, the patient must be content with it. Hence, where there is risk of ankylosis, the great importance of placing the limb in good time in the position which will let it be of the greatest service to the patient.

[Here followed, in former editions of this Dictionary, an account of Dr. Rhea Barton's operation on the hip-joint for the cure of ankylosis, by sawing through the femur between the great trochanter and the neck of the bone, for further particulars of which the reader is referred to the last edition, or to the original in the North American Med. and Surg. Journ. for April, 1827, the nature of the present work not admitting of so long a reference to a single case. It may be added, that the opinion of eminent surgeons of the present day seems to confirm that expressed by Cooper, Sanson, and Cloquet, that such an operation is unjustifiable, and that a true ankylosis is to be regarded as incurable, if so startling a word can with propriety be applied to so happy a result of a grave and formidable disease. The only exception I can conceive to this proposition would be, perhaps, in the case of the lower jaw. It is right perhaps to add, that cases are on record of the successful removal of a wedge-shaped piece of bone from the front of the knee-joint, when ankylosed at an inconvenient angle. (See also, *Joints, Excision of.*)

But when all symptoms of local inflammation are subdued, and the general health is good, much may be effected for the cure of ankylosis, even when a serious amount of partial dislocation is present; and this statement applies particularly to the knee-joint. Many cases of false ankylosis admit of rupture of the impediments to the free motion of the joint by the hands of the surgeon unaided, and the operation is unattended by any unpleasant consequences; others may be restored to free and natural motion by the careful application of continued mechanical extension. Louvrier broke down all forms of ankylosis by the aid of a powerful piece of mechanism, but with most sad and terrible results. Scarcely less serious were the consequences of the proceedings of Dieffenbach, Palasciano of Naples, and Langenbeck, who practised tenotomy and the division of muscles and fasciæ in addition to the forcible rupture of the impediments to motion in ankylosed joints. The reader is referred for a good historical account of this point of surgery, to M. Bonnet's work, and to Mr. Brodhurst's papers. The latter gentleman has been very successful in his treatment of these cases, of thirty-two of which he gives the statistics. Mr. Brodhurst lays down the following rules as absolutely necessary to success:—The punctures required for the division of the tendons, cicatrices, fasciæ, &c. to be allowed to heal before extension be made, the limb being kept meanwhile at perfect rest, and in its old position: after six or eight days, the impediments to be broken down by alternate motions of flexion and extension of the joint, under chloroform: the limb to be then carefully placed at its former angle in an extending splint contrived for the purpose: after a few days, extension to be commenced, and when completed to be followed up by passive motion of the joint, at first under chloroform. Additional mechanism is applied to the extending splint in cases of partial dislocation. The reader is referred to M. Bonnet's valuable work for descriptions of admirably conceived mechanical instruments.] *Spencer Smith.*

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ANTHRAX (ἄνθραξ, a burning coal). See Carbuncle.

ANTIMONY. Antimonial medicines are prescribed in a great number of surgical cases, and I may say very commonly in all, where it is desirable to promote the secretions in general, and those of the skin and bowels in particular. Hence, in the treatment of phlegmonous and erysipelatous inflammation, antimony, especially the potassio-tartrate, or tartarised antimony, is a valuable medicine. In this work, there is no occasion to notice the usefulness of tartarised antimony as an emetic. In inflammations of the brain and its membranes, the eye, the testicles, and the synovial tissues, surgeons frequently prescribe it with great advantage to the patient. Rasori, an Italian physician, used to order it in very large doses, as a means of keeping down inflammation of important organs; and the success of this treatment, as compared with that resulting from the free employment of the lancet, excited a great deal of attention. The disturbance of the stomach, which was at first severe, afterwards generally subsided, and that organ seemed to bear the medicine well. In this country, the tartarised antimony is sometimes employed in cases of dislocation, where the muscles make powerful resistance to the reduction: here it is prescribed in doses of half a grain, repeated every five or ten minutes, until a good deal of nausea is excited, or the patient actually vomits. In this state the patient becomes exceedingly faint, and the muscles no longer oppose the efforts of the surgeon to reduce the dislocated bone. [Now, however, that we possess in chloroform so much more effectual an agent for producing muscular relaxation, the use of antimony in dislocations is almost entirely superseded.] (See DISLOCATION.) In doses of one sixth or one fourth of a grain, joined with calomel and opium, tartarised antimony operates as a diaphoretic, and this combination is useful in various cases of inflammation, which are within the province of surgery.

Tartarised antimony, in the proportion of ʒj. to ℥j. of lard, makes what is called the antimonial ointment, which, where it is desirable to keep up counter-irritation on the surface of the body, is rubbed upon the part in the quantity of about a drachm, and for a few minutes at a time. The effect is to bring out pustules, and even ulceration, the degrees of which, and their influence on the complaint, are to determine how often and long the antimonial frictions are to be continued. In some cases, these excite pustules and ulceration in distant parts; a fact deserving to be particularly remembered.

[The pulvis antimonii comp. (Ph. Lond.) and the patent preparation known as Dr. James's powder, are both composed, according to the analysis of Mr. Phillips, of antimoniate of antimony (antimonious acid) and phosphate of lime. Serious doubts have been entertained about the efficacy of both these preparations, and according to Mr. Phillips, the high state of oxidation of the antimony which they contain will fully account for their inactivity. (See *Transl. of Lond. Pharmacop.* 1851, p. 270.)] Dr. Elliotson prescribed the pulvis antim. comp. in doses of 100 grains, and it seemed to have no effect. In general, says Dr. A. T. Thomson, it displays no influence whatever on the system. Its occasional activity may be ascribed to the oxide being accidentally in the state of a *protoxide*. (See *Thomson's Elem. of Mat. Med.* p. 923, ed. 2.) A like uncertainty has also been found to attend the use of Dr. James's powder. (See *Pereira's Mat. Med.* ed. 3, vol. i. p. 680.) Hence, when antimonials are indicated in surgery, for the purpose of promoting the secretions generally, and of the skin in particular, it is best to prescribe the potassio-tartrate of antimony, which is of known and uniform activity. This may be combined with calomel or opium, or both, according to the indications of the case; or it may be given in aqueous solution, or in the form of vinum antim. potass. tart. (P. L.) A quarter of a grain of the salt is contained in each fluid drachm of the latter preparation.

The precipitated sulphuret of antimony is only prescribed as an ingredient in the compound calomel pill.

The muriate of antimony, termed butter of antimony, from its consistence, is a powerful caustic, more frequently employed by foreign than British surgeons, who, in consequence of its deliquescent character, consider it an inconvenient application.

ANTRUM, *Diseases of.* The diseases to which the antrum, or maxillary sinus, is liable, commence either in its mucous lining, the bony laminæ of which it is composed, or the fangs of the teeth, which form projections at the lower part of it. Sometimes the mucous membrane inflames, and, becoming thickened, closes the natural opening by which the antrum communicates with the nasal fossæ, and the consequence is an accumulation of mucus or limpid fluid in it. On other occasions a purulent fluid is secreted; or a fluid is formed, which concretes into small masses, and has the characters of adipocire. The antrum may also be the seat of polypi, sarcomatous tumors of various descriptions, erictile tumors, or aneurism by anastomosis, and scirrhous swellings. Then its bony parietes may be softened, more or less absorbed, or carious, or affected with necrosis or exostosis. (See *Gensoul, Sur quelques Maladies Graves du Sinus Maxillaire, &c.* p. 2, 8vo. Paris, 1833.) Sometimes extraneous bodies, detached portions of bone, a bullet, and even insects, may lodge in the antrum, and cause, for many years, very afflicting pains.

COLLECTION OF MUCUS.

In general, the disease, which is not very common, takes place unpreceded by any causes which are at all manifest. It is alleged mostly to happen in young subjects: of three patients seen by Boyer, the eldest was not more than twenty. (*Traité des Mal. Chir.* t. vi. p. 139.) Sir Benjamin Brodie has seen only two cases: one patient was a lady, whose age is not specified; the other, a boy. A collection of transparent fluid in the antrum is undoubtedly a much rarer occurrence than one of pus. (See *Brodie*, in *London Med. Gaz. for Dec.* 1834.) As Mr. Hunter has noticed, whether the obliteration of the outlet, leading to the nose, be a cause or only an effect of the disease, is not easily determined; but from some of the symptoms, there is great reason to suppose it an attendant. "If it be a cause, we may suppose that the natural mucus of this cavity, accumulating, irritates, and produces inflammation for its own exit, in the same manner as an obstruction to the passage of the tears through the ductus ad nasum produces an abscess of the lachrymal sac." (See *Hunter's Natural Hist. of the Teeth*, p. 174, ed 3.) A most interesting example of the effects of the lodgement of mucus in the antrum, is that recorded by Dubois: a boy, between seven and eight years of age, was observed to have at the base of the ascending nasal process of the upper jaw-bone, on the left side, a small, very hard tumor, of the size of a nut. As it caused no pain, and did not increase, his parents gave themselves no concern about it. When he was about sixteen, however, the swelling began to increase, and to be somewhat painful. Before he was eighteen, its augmentation was so considerable, that the floor of the orbit was raised up by it; the eye thrust upwards, and nearly closed; the arch of the palate pushed down in the form of a tumor; and the nostril almost effaced. Below the orbit, the cheek made a considerable prominence; while the nose was thrown towards the opposite side of the face, and the skin at the upper part of the tumor, below the lower eyelid, was of a purple red colour, and threatening to burst. The upper lip was drawn upwards, and behind it; all the gums of the left side were observed to project much further than those on the opposite side of the face; and, at this point alone, the thinness of the bony parietes of the antrum was perceptible. The patient spoke and breathed with great difficulty; he slept uneasily, and his mastication was painful. The case was at first supposed by Dubois, Sabatier, Pelletan, and Boyer, to be a fungus of the antrum, and an operation was considered advisable. In proceeding to this measure, the first thing, which attracted the notice of Dubois, was a sort of fluctation in the situation of the gum, behind the upper lip; a circumstance which led him to give up the idea of the case being a fungus, though he expected that, on making an opening, merely a small quantity of ichorous matter would escape, affording no kind of information. In this place, however, he determined to make an incision along the alveolar process, whereby a large quantity of a glutinous substance like lymph, or what is found in cases of ranula, was discharged. A probe was now introduced, with which Dubois could feel a cavity equal in extent to the fore part of the tumor; and in moving the instrument about, with the view of learning whether any fungus was present, it struck against a hard substance, which felt like one of the incisor teeth, near the opening that had been made. Five days after this first operation, Dubois extracted two incisors and one grinder, and then removed the corresponding part of the alveolar process. As the hemorrhage was profuse, the wound was now filled with dressings, which in two days came away, and enabled Dubois to see with facility all the interior of the cavity. At its upper part, he perceived a white speck, which he supposed was pus; but, on touching it with a probe, it turned out to be a tooth, which was then extracted, in doing which some force was requisite. The rest of the treatment merely consisted in injecting lotions into the cavity, and applying common dressings. In about six weeks, all the hollow disappeared; but the swelling of the cheek and palate, and the displacement of the nose, still continued. In the course of another year and a half, however, every vestige of deformity was entirely removed. (*Dubois*, *Bulletin de la Faculté de Méd.* an 13, No. 8.)

In the case of the lady attended by Sir Benjamin Brodie, there was no distinct fluctuation, but a kind of crackling sensation communicated to the fingers, like what would be felt in pressing upon very thin horn, or parchment. (*Med. Gaz.* loc. cit.)

With respect to the treatment of collections of mucus, or transparent albuminous fluid, in the antrum, by means of injections thrown into that cavity through the natural opening in it, while the head is inclined to the opposite side, for the purpose of facilitating the escape of the collected fluid, as proposed by Jourdain in 1765 (*Mém. de l'Acad. de Chir.* t. iv. p. 357), I fully agree with Deschamps and Boyer, that the method is a bad one; because long before the disease forms an outward swelling, we may presume that the natural communication between the antrum and the nostril is closed, and will not readily admit of a tube being introduced into it. Some plan, more fraught with promptitude and efficiency, is here demanded. Hence, the practice of opening the tumor in an eligible place, and to an extent sufficient for the discharge of the mucus, and the prevention of another accumulation, is what all surgeons of the present day recommend. (*Deschamps, Traité des Maladies des Fosses Nasales, et de leur Sinus*, p. 231, 8vo. Paris, 1804; *Boyer, Traité des Mal. Chir.* t. vi. p. 145, 8vo. Paris, 1818. Indeed, that Jourdain's proposal was attended with too much difficulty for common practice, was the sentence long ago pronounced upon it by a committee of the Royal Academy of Surgery in France. If the case has not destroyed, or softened the front or lower portion of the bony texture of the antrum, and any bad tooth is situated under it, this should be extracted, and a perforation made into the antrum through the bottom of the socket. This aperture may be preserved as long as necessary, by the introduction of a piece of elastic gum catheter, which is to be fastened to the adjacent teeth, and through which the secretion in the antrum may escape, and lotions be injected. (See *Deschamps, Traité des Mal. des Fosses Nasales, &c.* p. 234.) However, as Hunter remarks, if the forepart of the bone has been destroyed, even though the case be merely a collection of mucus, or pus, an opening may be made on the inside of the lip: but, from a fear that there would be difficulty in maintaining such an aperture, he still inclines to the practice of drawing one of the teeth. (*Natural History of the Teeth*, p. 176, ed. 3.)

In general, I believe that the extraction of one of the molar teeth will not prove very applicable to the present case; first, because the thick albuminous fluid requires a larger opening than can be thus obtained: and secondly, because when the surgeon is called upon to perform an operation, the bony texture of the antrum is already very thin, much softened, or even partially absorbed above or behind the alveoli; consequently, as soon as the surgeon has made an incision above the gum, or in the part of the swelling presenting itself on the roof of the mouth, he finds that a probe will immediately enter the antrum. All that he has to do, therefore, is to enlarge this opening with a small pair of bone-pliers, or a strong knife. Mr. Hunter's apprehension about the difficulty of maintaining the opening, and of the likelihood of a return of the accumulation, does not appear to be confirmed by what happened in the cases under Dubois and Sir Benjamin Brodie. The latter informs us, that, "after dissecting the membrane of the cheek from the jaw, I took a curved scalpel, bent laterally, with a strong sharp point, and introduced the point into what seemed the thin bony parietes, or boundary of the tumor. Immediately there escaped a large quantity of transparent fluid, like very thin mucus, something like what we find in cases of ranula. I then introduced a probe into the cavity of the antrum, and found that it might be passed in any direction. There was neither tumor nor dead bone in it; and the cavity seemed to be in a natural state, except that it was enormously dilated. I next enlarged the opening, cutting out a circular portion of thin bony shell, formed by the expanded parietes of the antrum. After the operation, the tumor subsided, and, in a few weeks, the cheek was not larger than the other. The aperture made by the scalpel has continued pervious to this day, though it is ten years since I performed the operation. The lady wears a plug, which she takes out night and morning, and with her own hand introduces the point of a syringe, and washes out the antrum." (See *Lond. Med. Gaz. for Dec.* 1834.)

Abscesses of the Antrum.

Abscesses are far more common than collections of mucus. Violent blows on the cheek, inflammatory affections of the adjacent parts, and especially of the pituitary membrane lining the nostrils, exposure to cold and damp, and, above all things, bad teeth, may bring on suppuration within the antrum. The first symptom is pain, often imagined to be toothache, particularly if there should be a carious tooth in this part of the jaw. Such pain, however, extends more into the nose, than that usually does which arises from a decayed tooth, and affects the eye, orbit, and frontal sinuses. (See *Hunter, On the Teeth*, p. 175, ed. 3.) But these symptoms are insufficient to characterise the disease, the nature of which is not unequivocally evinced till a much later period. Sir Benjamin Brodie adverts to inflammation of the antrum, independent of local causes; a case more obscure than when some manifest local cause of irritation is present. In one such example, he was led to make a perforation above the second molaris, but no pus escaped. The patient was relieved by taking two grains of calomel and half a grain of extract of opium three times a day till the gums had become rather sore. (*Brodie*, in *Lond. Med. Gaz. for Dec.* 1834.) An inflammation of the antrum, tending to suppuration, is generally of longer duration than one entirely dependent on a caries of a tooth. There is a constant dull pain in the cheek, with frequent paroxysms of lancinating torture, and a great deal more sympathetic febrile disturbance than attends toothache; and the violence of the suffering increases more and more, until, at last, a hard tumor is perceptible below the cheekbone. By degrees the swelling extends over the whole cheek; but it afterwards rises to a point, and forms a circumscribed hardness, perceptible above the back grinders. This symptom is accompanied with œdema, redness, and sometimes with suppuration of the external parts. In some instances, when there is an outward abscess, the matter has made its way into that situation through the bone, and there is consequently a communication between both collections of matter.

The circumscribed elevation of the tumor, above the molares, does not, however, occur in all cases; for sometimes the matter makes its way towards the palate, causing the bones of this part to swell, and, at length, bringing them into a state of caries, or necrosis, unless timely assistance be given. In some other cases, the matter escapes between the fangs and sockets of the teeth, and causes a soft prominent swelling in the gums. Lastly, there are certain examples, in which the matter passes into the nostril of the same side, when the patient is lying with his head on the opposite one. If this mode of evacuation should be frequently repeated, it affords relief, and prevents the tumor both from pointing externally, and bursting, as it would do if the purulent matter could find no other outlet. But this evacuation of pus from the nostril is not so common as might be expected; for, according to Mr. Hunter, the opening between the antrum and cavity of the nose is generally stopped up. He even seems inclined to think, as I have already observed, that the disease may sometimes be occasioned by the impervious state of this opening, in consequence of which the natural mucus of the antrum collects in such quantity as to irritate and inflame the membrane with which it is in contact, just as an obstruction in the ductus nasalis hinders the passage of the tears into the nose and causes an abscess in the lachrymal sac. This is a point, however, on which even Mr. Hunter would not venture to speak with certainty; for it is by no means impossible, that the impervious state of the opening is rather an effect than the cause of the disease, since inflammation in the antrum is often manifestly produced by causes of a different kind, and the opening in question is not invariably closed.

Sir Benjamin Brodie concurs with other surgeons in believing that inflammation of the antrum is mostly dependent on local causes, and more commonly upon the irritation of a bad tooth than any other circumstance. This gives rise to inflammation at the bottom of the alveolus. Here matter forms, and not always being able to escape between the fang and the socket, destroys the periosteum lining the latter part, causes absorption of the bone, and the inflammation is propagated to the lining of the antrum. In many instances, the case becomes complicated with dead as well as carious bone. (See *Brodie*, in *Lond. Med. Gaz. for Dec.* 1834.)

In the early stage of these cases, leeches, fomentations, calomel, opium, and saline purgatives may be employed for the purpose of reducing the inflammation, and preventing its advance to suppuration. But when an abscess has formed, and the matter is confined in the antrum, the indications dictate other treatment. The matter should be discharged, and any source of local irritation which is discoverable removed.

Abscesses in the antrum require a free outlet: and if the surgeon neglects to procure it nature herself ultimately does what is requisite; but not till the patient's agony has been greatly prolonged, and the disease has extended further than ought to have been allowed. At length, however, the pus makes its appearance, either towards the orbit, the alveoli, the palate, or, as is mostly the case, towards the cheek. The matter having thus made its escape from the antrum, bursts through the soft parts, and the opening becomes fistulous.

In all cases, whether the pus be simply confined in the antrum, or whether the case be conjoined with a necrosis, or caries, the principal indication is to discharge the matter.

The ancients seem to have known very little about the treatment of diseases of the antrum. Drake, an English anatomist, is reputed to be the first proposer of a plan for curing abscesses of this cavity. (*Anthropologia Nova.* Londini. 1727.)

However, Meibomius was much earlier in proposing, with the same intention, the extraction of one or more of the teeth, in order that the purulent matter might escape through the sockets.

Drake and, perhaps before him, Cowper, aware that the fangs of the teeth did not reach completely into the antrum, proposed making a perforation through the socket into that cavity, for the purpose of letting out the matter, and injecting such fluids as were judged proper.

In the treatment of abscesses of the antrum, the extraction of one or more teeth, and the perforation of the alveoli, being generally essential steps, the first question is, what tooth ought to be taken out. In general, caries, or even a mere continual aching of any particular tooth, ought to decide the choice. But if all the teeth should be sound, which is not often the case, writers direct us to tap each of them gently, and to extract that which gives most pain on this being done. When no information can thus be obtained, other circumstances ought to guide us. All the molar teeth, and the second bicuspid, correspond with the antrum. They even sometimes extend into this cavity, the fangs being then only covered by the pituitary membrane ; and the bony lamella, which separates the antrum from the alveoli is always very thin towards the back part of the upper jaw. Hence, when the choice is in our power, it is best to extract the first or second molar, as in this situation the alveoli can be more easily perforated. Though, in general, the first bicuspid and canine tooth do not communicate with the antrum, their fangs approach the side of it, and from their sockets an opening may readily be extended into that cavity.

When one or more teeth are carious, they should be removed, because they are both useless and hurtful. The matter frequently makes its escape, as soon as a tooth is extracted, in consequence of the fang having extended into the antrum, or rather in consequence of its bringing away with it a piece of the thin partition between it and the sinus ; or the discharge may follow from the partition itself being carious. If the opening thus produced be sufficiently large to allow the matter to escape, the operation is already completed. But as it can easily be enlarged it ought always to be so when there is the least suspicion of its being too small. However, when no pus makes its appearance after a tooth is extracted, the antrum must be opened by introducing a pointed instrument in the direction of the alveoli. For this purpose a trocar, an awl, or a gimlet, may be employed.

Sir Benjamin Brodie prefers an instrument, formed like a common hydrocele trocar, but a little larger, and of course without a cannular. "It should not be made of the best steel; for (says he) I once used a common trocar, made of steel, and it broke while I was performing the operation. In this case, I extracted the broken portion very easily ; but such an accident might occur, and great difficulty be experienced in extracting the point of the instrument. When the bottom of the alveolus is broken down, the matter will readily escape from the antrum, and you may introduce a probe and explore the cavity, so as to ascertain whether there be in it any dead bone or not. Sometimes there is a piece of dead bone at the bottom of the alveolus, and then you have only to wait patiently until an opportunity occurs for its removal. At other times you will feel the dead bone, after the probe has entered the antrum, and the opening already made may not be sufficient for its extraction. Under these last circumstances, the opening must either be enlarged, or another made in a different place." (*Brodie,* in *Lond. Med. Gaz. for Dec.* 1834.)

For the performance of this operation some recommend that the patient should sit on the ground, in a strong light, resting his head on the surgeon's knee, who is to sit behind him in a chair. Immediately the instrument has reached the cavity, it is to be withdrawn. Its entrance into the antrum is easily known by the cessation of resistance. After the matter is discharged, surgeons advise the opening to be closed with a wooden stopper, in order to prevent the entrance of extraneous substances.

The stopper is to be taken out two or three times a day, to allow the pus to escape. If there be no dead bone present, this plan soon disposes the parts affected to discontinue the suppuration and resume their natural state. The cure may often be accelerated by employing injections of weak brandy and water, lime water, or a solution of the sulphate of zinc. Two or three days after an opening has been made into the antrum, Sir Benjamin Brodie begins to wash out the cavity, one or twice daily, with tepid water, injected by means of a syringe with a slightly curved pipe. The water injected will now generally pass into the nostril, and the cavity can be very completely washed out. If the water does not pass out of the nose, it shows that the natural opening between the two turbinated bones is blocked up. (*Brodie*, op. cit.)

Some surgeons prefer a piece of bougie, or of elastic gum catheter, instead of the wooden stopper. The examples on record where the extraction of a tooth and perforation of the bottom of the antrum were the means of curing abscesses of that cavity are very numerous. (See *Farmer's Select Cases*, No. ix. ; *Gooch's Cases*, p. 63, new ed.; *Palfyn, Anatomie, &c.; Brodie*, op. cit.)

When the bones are diseased, the simple perforation will not accomplish a cure. A probe will generally detect caries or necrosis. The fœtid smell and ichorous appearance of the discharge will also leave little doubt that the bones are diseased.

When there are loose pieces of dead bone or other foreign bodies to be extracted, it may be requisite to make a larger opening in the antrum than can be obtained through the socket of a tooth. Instances also occur where patients have lost all the molar teeth, and the sockets are quite obliterated, so that a perforation from below cannot be effected. Some practitioners object to sacrificing a sound tooth. In these circumstances, a perforation in the antrum may be made above the alveolar processes ; as first suggested by Lamorier. The operation consists in making a transverse incision, below the malar process and above the root of the first molar. Thus the gum and periosteum are divided, and the bone exposed. A perforating instrument is to be conveyed into the middle of this incision, and the opening in the antrum made of the requisite size with a small pair of cutting pliers, or other convenient instrument. In this way an opening can be more conveniently made than with a trephine. The following way of making the opening is recommended by Sir B. Brodie: "Raise up the cheek, so as to expose the membrane covering the gum on the side of the face, and, with a scalpel, make a transverse incision down to the bone. In one case (says he), I did otherwise, thinking the division of the membrane, as a separate part of the operation, was unnecessary; but the consequence was that the blood escaped into the cellular membrane underneath, and there was an immense ecchymosis, rendering the rest of the operation very difficult. Then perforate the thick plate of bone, as nearly as possible to what you suppose to have been the original seat of the disease." The best instrument for this purpose, according to Sir Benjamin Brodie, is a pair of sharp-pointed strong scissors. "Apply them to the bone in their closed state, using them as a chisel, and they will easily penetrate it, and go into the antrum. With these the bone may be broken away to the requisite extent." (See *Mém. de l'Acad. de Chir.* t. iv. p. 351; *Gooch's Obs. Append.* p. 138.) Some examples occur, where it is absolutely necessary to expose a great part of the surface of the bone, and to cut away the dead pieces which are wedged, as it were, in the living ones. In general, however, it is prudent to wait till the dead bone is loose; and, in the meanwhile, to restrict our interference to preventing the lodgment of matter, and maintaining cleanliness.

TUMORS OF THE ANTRUM.

Ruysch, Bordenave, Desault, Abernethy, Weinhold, Gensoul, Liston, Regnoli, Guthrie, and others, have recorded examples of various kinds of tumors affecting the antrum. Surgical writers describe polypi of the antrum; and as growths of the kind have their origin from parts invested by mucous membranes, it is natural to expect that the antrum would occasionally be the situation of them. Yet the disease must here be very rare; and Sir Benjamin Brodie even regards the history and treatment of polypi of the antrum as altogether hypothetical; and he adds, "No polypus, I believe, ever existed in the antrum, around which a surgeon could put a ligature; and I never heard of the operation being performed." (See *Lond. Med. Gaz. for Dec.* 1834, p. 850.) In no hospital, either civil or military, have I had an opportunity of seeing a polypus of the antrum; neither has any case presented itself to me out of an hospital. I join Sir Benjamin Brodie therefore in believing the disease to be exceedingly rare. There are, however, some good authorities in confirmation of the fact that polypi do sometimes grow in the antrum. (*Eichhorn*, *Chelius*, &c.) Certain other tumors, originating within the antrum, are far more common; some of which are of a fibrous, sarcomatous, or osteo-sarcomatous character, free from malignancy; while the others are of a malignant cancerous kind, partaking of the nature of medullary tumors, or of carcinoma, and sometimes of both of these formidable diseases together.

[Non-malignant tumors in the antrum, while in an incipient state, present but few symptoms. The absence of pain at first, and the indolence of their growth, tend to conceal their existence;] but such a disease rarely exists a long while without being accompanied with some affection of the neighbouring parts; and hence its presence may generally be ascertained before it has attained such a size as to have altered in a serious degree the natural shape of the antrum. This information may be acquired, by examining whether any of the teeth have become loose, or have spontaneously fallen out; whether the alveolar processes are sound, and whether there are any fungous excrescences making their appearance at the sockets; whether there is any habitual bleeding from one side of the nose, any sarcomatous tumor at the side of the nostril, or towards the great angle of the eye. When the swelling, however, has attained a certain size, the bony parietes of the antrum are dilated, and an extraordinary swelling of the cheek takes place. [It is principally, if not exclusively, in these cases of non-malignant disease that operations for the removal of a portion or the whole of the superior maxilla are now considered admissible.]

A swelling of the parietes of the antrum, in consequence of an abscess, or a sarcomatous tumor in its cavity, may lead us to suppose the case an enlargement of the bones, or an exostosis. The symptoms of the two first affections have been already detailed. One sign of an exostosis, besides the absence of the symptoms characterising an abscess or a tumor in the antrum, is the thickened parietes of this cavity forming a solid resistance; whereas, in cases of mere expansion, the dimensions of the surface of the bone being increased while its substance is rendered proportionally thinner, the tumor is softer and more yielding.

When such an exostosis depends upon a particular constitutional cause, and especially upon one of a venereal nature, it must be attacked by remedies suited to this affection. But when the disease resists internal remedies, and its magnitude is likely to produce an aggravation of the case, a portion of the bone may be removed with a trephine or other cutting instrument.

Malignant tumors of the antrum are attached to the mucous membrane, and fill up the cavity. At first the patient has but little pain, and the existence of the disease is scarcely indicated by any particular symptoms. But as the disease advances, things are different. The tumor, growing larger, presses upon the inner surface of the antrum, and causes its bony parietes to become dilated. By degrees it forms a projection in the cheek. After a time, there is another projection in the bony palate. Then one occurs at the inferior part of the orbit; and there is still another blocking up the nostril. From the pressure of the tumor, the osseous texture of the antrum is absorbed, the alveoli are destroyed, and the teeth are loosened, or drop out. At length the morbid growth either makes its way into the orbit, displacing the eye, and passes through the orbitar plate of the frontal bone into the skull, and proves fatal, or else it protrudes through the front, or lower part of the antrum: in either of which last situations it presents a large fœtid, bleeding mass, bringing the patient to his doom with equal certainty. In the Museum of University College are three specimens of malignant disease of the antrum; in two, the swelling made its way from the antrum to the brain; in the third, which was taken from an elderly woman, a patient of mine, who died in the hospital, the medullary and scirrhous mass, after entering the orbit, and displacing the eye, caused ulceration and sloughing in the cheek, and a protrusion of some of the tumor in this direction. The woman, who had suffered indescribable agony from the pressure of the tumor, as it continued to enlarge, was at length worn out by the discharge, irritation, and repeated bleedings from the disease. I remember a boy in St. Bartholomew's Hospital, many years ago, in whom a medullary tumor, begining in the antrum, made its way through the orbitar plate of the frontal bone and cribiform plate of the ethmoid into the cranium. He was only comatose about forty-eight hours before he died, though the portion of the swelling projecting into the cranium, and causing a corresponding depression in the anterior lobes of the brain, was equal in size to a small orange.

Mr. Abernethy published an account of a very singular disease of the antrum. The patient, who was thirty-four years of age when the account was written, perceived, when about ten years old, a small tumor on his left cheek, which gradually attained the size of a walnut, and then remained for some time stationary. About a year afterwards, the tumor having again enlarged, a caustic was applied to the integuments, so as to expose the bone. The actual cautery was next applied, and an opening thus made into the antrum. After the exfoliation, the antrum became filled with a fungus, which rose out upon the cheek, and could not be restrained by any applications. Part of the fungus also made its way into the mouth, through the socket of the second bicuspid tooth, the other teeth remaining natural. The disease continued in this state nine years, occasionally bleeding in an alarming way. When the patient was in his twentieth year, the whole fungus sloughed away during a fever, and never returned. After this, the sides of the aperture in the bone began to grow outwards, forming an exostosis, which rapidly attained a great magnitude. A small exostosis took place in the mouth, but became no larger than a horsebean. The exostosis of the maxillary bone was of an irregular figure, and projected from the whole circumference of the aperture a great way directly forward. Mr. Abernethy compared its appearance, when he was writing, with that of a large tea-cup fastened upon the face, the bottom of which may be supposed to communicate with the antrum. The diameter of the cup, formed by the circular edge of the bone, was three inches and a half; the depth two inches and seven eighths. The general height of the sides of the exostosis, from the basis of the face, was two inches; its walls were not thick, and terminated in a thin, cellular edge. The integuments, as they approached this edge, became thinner, and they extended over it into the cavity. The exostosis now reached to the nose in front, and to the masseter muscle behind; above it included the very ridge of the orbit, and below it grew from the edge of the alveolar process. A line that would have separated the diseased from the sound bone would have included the orbit and nose, and indeed one half of the face. Mr. Abernethy saw no means of affording the man relief. (*Trans. of a Society for the Improvement of Med. and Chir. Knowledge*, vol. ii.) See also a case related by Harrison. (*New Lond. Med. Journ.* vol. i. p. 1.)

In a case of fungus, which had distended the antrum, hindered the tears from passing down into the nose, raised the lower part of the orbit, caused a protrusion of the eye, made two of the mola teeth fall out, and occasioned a carious opening in the front of the antrum, through which opening a piece of the fungus projected, Desault operated as follows:—The cheek was first detached from the os maxillare, by dividing the internal membrane of the mouth at the place where it is reflected over this bone. Thus the outer surface of the bone was denuded of all the soft parts. A sharp perforating instrument was applied to the middle of this surface, and an opening made more forward than the one already existing. The plate of bone situated between the two apertures was removed with a little falciform knife, which, being directed from behind forward, made the division without difficulty. The opening thus obtained being insufficient, Desault endeavoured to enlarge it below, by sacrificing the alveolar process. This he endeavoured to accomplish with the same instrument; but finding the resistance too great, he had recourse to a gouge and mallet. A considerable piece of the alveolar arch was thus detached, without any previous extraction of the corresponding teeth, three of which were removed by the same stroke. In this manner an opening was procured in the external and inferior part of the antrum, large enough to admit a walnut. Through this aperture a considerable part of the tumor was cut away with a knife curved sideways, and fixed in its handle. A most profuse hemorrhage took place, but Desault, unalarmed, held a compress in the antrum for a short time; this being removed, the actual cautery was repeatedly applied to the rest of the fungus, and the cavity was filled with charpie dipped in powdered colophony.

On the eighteenth day, the swelling was evidently diminished, the eye less prominent, and the epiphora less visible. But, at this period, a portion of fungus made its appearance again. This was almost entirely destroyed by two applications of the actual cautery. It appeared again, however, on the twenty-fifth day, and required a third and last recourse to the cautery. From this time the progress of the cure went on rapidly. Instead of fungous excrescences, healthy granulations were now formed in the bottom of the sinus. The parietes of the antrum gradually approaching each other, the large opening, made in the operation, was reduced to a small aperture, hardly capable of admitting a probe. Even this little opening closed in the fourth month, at which time no vestiges of the disease remained, except the loss of teeth, and a very obvious depression just where they were situated. (*Œuvres Chir. de Desault, par Bichat*, t. ii.; and *Parisian Chir. Journ.* vols. i. and ii.) See other cases recorded by Acoluthus (*Act. Cur. Natur.*); Garengeot (*Mém de l'Acad. de Chir.*; Dupuytren (*Bulletins de la Faculté de Méd.*); Gensoul (*Sur quelques Mal. du Sinus Maxil.* p. 9); Béclard (*Gensoul*, op. cit. p. 11); Georgi (*Gensoul*, op. et loc. cit.); Velpeau (*Ib.* p. 14); Anderson (*Glasgow Med. Journ.* vol. ii. p. 74); Canolles (*Recueil Périodique de la Soc. de Méd.* t. ii. No. 9); Eichorn (*Diss. de Polypis in Antro Highmori*, Goett. 1814); Sandifort (*Museum Anat.* vol. ii. tab. 30); Leveillé (*Recueil de la Soc. &c.* t. i. p. 24); Weinhold (*Von den Krankheiten der Geischtsknochen*, p. 27, 4to. Halle, 1818.)

In some of these examples, a cure is stated to have been accomplished; in others, the disease returned, and proved fatal. The question then arises, whether all the tumors were malignant, or only a part of them? Those which were permanently cured might have been of a different nature, not partaking of the character of medullary sarcoma, nor of that of carcinoma.

With respect to Desault's operation, and any other performed for a medullary, or cancerous tumor of the antrum, it would have been desirable to know what was the state of the patient some considerable time after the removal of the swelling; for, as Sir Benjamin Brodie correctly observes, a malignant disease may appear to be cured for a twelvemonth, and yet return. The circumstance of Desault's patient seeming to be well four months after an operation of this kind, by no means proves that it produced a permanent cure. (See *Lond. Med. Gaz. for Dec.* 1834, p. 351.) Dr. Anderson, of Glasgow, has furnished information respecting the case in which he extirpated a fungous tumor from the antrum after it had produced complete absorption of the bone. "This patient died of pectoral inflammation, *five years and a half afterwards*, when she had just recovered from the operation of removing nearly the whole of the *lower* jaw. On a minute examination of the antrum, the former disease was found to have been permanently cured by the operation." (*Anderson*, in *Lond. Med. Gaz. for Feb.* 1835.) Hence, Dr. Anderson disapproves of leaving a patient, even with such a tumor, to his fate.

Sir Benjamin Brodie formerly attempted to destroy a malignant tumor of the antrum in its early stage. The bone being absorbed, he cut out a large portion of the membrane, which now constituted the only boundary of the antrum. He now came to a considerable tumor, growing from a broad surface. "The outer part of the tumor, which was of soft consistence, I broke down with my fingers, and I then turned the tumor out, so that the antrum appeared to be perfectly empty. But this was not done without an enormous, and, indeed, frightful hemorrhage." Notwithstanding the free use of caustic and the actual cautery, the disease returned and grew faster than it could be destroyed, and proved fatal. Mr. Liston's observations are to the same purpose. The malignant form of the disease, even in a very early stage, is pronounced by him to be unmanageable: "The tumors, if removed, are speedily reproduced, and the fatal termination may be accelerated by interference. I have removed tumors from the antrum maxillare, and from the frontal sinus; but the parts soon became occupied by morbid growths of a more formidable character than the preceding; the membrane and bone appear to assume a disposition to generate such disease; and the fungous protrusions cannot be kept down with escharotics, nor with the actual cautery. The antrum, when filled with such tumors, is easily laid open. The cheek is divided perpendicularly from over the inferior orbitar foramen to the mouth, and the soft parts are dissected from off the bone. The cavity may then be exposed by means of a small trephine; but this instrument is scarcely ever required, the parietes being so softened as to yield easily to the knife: though pliers, or cutting forceps, may be useful in enlarging the aperture. By the guidance of the finger, the attachments of the morbid growth are separated with a blunt-pointed bistoury; and a scoop is used to turn out the diseased mass. The root of the tumor is then touched with a red-hot iron; and by this implement, or by dossils of lint, the hemorrhage is easily arrested. But *such operations*, considering the result of those which have been practised, *are scarcely justifiable*." (See *Liston's Elem.* part. ii. p. 158.)

Mr. Liston delivers the same judgment on the operation of removing a malignant tumor of the antrum, along with its investment, and every part of the bone to which it is connected. "The disease," says he, "is seldom, if ever, seen by the surgeon early enough to admit of any operation being practised with the least chance of ultimate success. At a sufficiently early period, the removal of the bone of the parietes of the cavity containing, and from which the tumor has grown, must, without doubt, afford a better chance, and is, in every point of view, to be preferred to the old operation of what was called trephining the antrum." The view which I now entertain of this subject, in relation to malignant tumors of the antrum, completely agrees with that taken by Sir Benjamin Brodie and Mr. Liston. If a case were needed to confirm the accuracy of their opinions, I would refer to that in which Mr. Guthrie lately operated in the Westminster Hospital, and who has honestly laid the true result of it before the public, as every other surgeon ought to do who ventures to try the practice. (See *Guthrie*, in *Lond. Med. Gaz. for January* 16, 1836.) The example in which M. Georgi operated, it seems, was followed by a lasting cure; but, as M. Gensoul remarks, there was a double piece of good luck in this instance; viz. that of a necrosis of the bone taking place to a sufficient depth to prevent the return of the disease, and the not less fortunate circumstance of such necrosis being restricted precisely to the half of the face. (See *Gensoul, Sur quelques Mal. Graves du Sinus Maxil.* p. 19.) The case recorded in the *Bulletins de la Faculté de Méd.*, where Baron Dupuytren removed about one third of the alveolary arch and the bony palate, in order to extirpate an osteo-sarcoma, proved successful; but some forms of this disease are not regarded by British pathologists as partaking of the same degree of malignancy, the same unfavourable state of the constitution, and the same disposition to return, as attend medullary sarcoma and a truly cancerous swelling. The operations performed by Acoluthus, of Breslaw, and M. Garengeot, of Paris, are reported to have terminated in cures.

M. Gensoul, lately principal surgeon of the Hôtel Dieu at Lyons, instead of merely opening the antrum, cutting away as much of the tumor as possible, and attacking the rest with caustic or the cautery, proposed and practised another operation, founded on the same principles as are recognised by the best surgeons as applicable to every operation for the removal of a cancerous breast. "Here," says he, "all writers agree in advising amputation to be performed at the base of the disease, so as to make all the incisions in the sound parts; and this is exactly what I recommend to be done in diseases of the maxillary sinus." (*Sur quelques Maladies graves du Sinus Maxillaire*, p. 4.) Gensoul's first operation was executed on the 26th of May, 1827. (Op. cit. p. 18.) Mr. Lizars advocated this operation in the year 1826, but had no opportunity of performing it till the month of December, 1827. This subject I shall have occasion to return to in another place, where a description of the operation of removing the antrum will be given. (See BONES, EXCISION OF.)

As it appears from the foregoing observation, that whatever operation is done, the patient has a fairer prospect of being cured by it when the disease does not partake of a medullary or cancerous nature, and as, likewise, the chances of recovery are so bad in the latter cases that many of the best surgeons pronounce any operation for them unjustifiable; it would be very desirable if the character of the disease could always be determined before the tumor has made its way beyond the limits of the antrum. I remember that Sir Benjamin Brodie once mentioned to me a case in which he was able to ascertain the medullary consistence of the tumor by the introduction of one of his exploratory grooved needles. The plan seems to be one deserving of recollection. In the case here referred to, the antrum was removed by another surgeon, but the disease returned. In a case which was in the University College Hospital, under my care, the disease, which was malignant, had caused ulceration of the cheek, and thrown out a firm fungous bleeding mass in that direction; so that the nature of the case was but too manifest. But if there had been no such protrusion of the disease through the cheek, the projecting part of the tumor in the roof of the mouth admitted of manual examination; and its consistence could be felt to be in some places elastic; in others, firm, like scirrhus, or mammary sarcoma. In fact, the preparation taken from the patient, an aged female, after her death, exemplifies a combination of these two structures; and is placed in the museum of University College. Mr. Mayo, in noticing the importance of discriminating osteo-sarcoma from medullary sarcoma of the antrum remarks,—"The only criterion that I am acquainted with for determining the nature of the swelling is to plunge a lancet into it; when, if the disease is osteo-sarcoma, the peculiar crisp sensation of cutting that texture will be perceived." (See *Mayo's Outlines of Pathology*, p. 278.)

[In the present day a grooved needle or very small trochar is used to procure a particle of the tumor, in order to have its character tested by microscopical inspection.]

A few years ago, Mr. Pattison suggested the expedient of tying the carotid artery, as likely to bring about the dispersion of fungous diseases of the antrum, without the necessity of meddling with the tumor itself. He adverts to three cases, the results of which, according to his account, were favourable to the practice. (See *Burns, On Anat. of the Head, &c. ed. by Pattison.*) However, the ligature of an arterial trunk has been tried by Sir Astley Cooper, to stop the progress of medullary tumors in other situations, but without success (see *Surg. Essays*); and Mr. Liston declares, that the statement of a malignant tumor in the antrum having been arrested by ligature of the common carotid, is not borne out by facts. (*Elem. of Surgery*, part ii. p. 161.) In M. Magendie's *Journ. de Physiologie* is a case, in which this eminent physician tried in vain to stop the progress of a tumor of the antrum by tying the common carotid artery.

Insects in the Antrum.

It is said, that insects in this cavity may sometimes make it necessary for the surgeon to open it. This case, however, must be exceedingly rare; and even what we find in authors (*Pallas, De Insectis Viventibus intra viventia*) appears so little authentic, that I should hardly have mentioned the subject if there were not in a work of repute (*Med. Comm.* vol. i.) a fact which appears entitled to attention. Mr. Heysham, a medical practitioner at Carlisle, relates that a strong woman, aged sixty, in the habit of taking a great deal of snuff, was subject, for several years, to acute pains in the antrum, extending over one side of the head. These pains never entirely ceased, but were more severe in winter than summer, and were always subject to frequent periodical exacerbations. The patient had taken several anodyne medicines, and others, without benefit; and had twice undergone a course of mercury, by which her complaints had been increased. All her teeth on the affected side had been drawn. At length, it was determined to open the antrum with a large trocher, though there were no symptoms of an abscess, nor of any other disease in this cavity. For four days no benefit resulted from the operation. Bark injections, and the elixir of aloes, were introduced into the sinus. On the fifth day, a dead insect was extracted, by means of a pair of forceps, from the mouth of the cavity. It was more than an inch long, and thicker than a common quill. The patient now experienced relief for several hours: but the pains afterwards recurred with their former severity; oil was next injected into the antrum, and two other insects, similar to the former, were extracted. No others appeared, and the wound closed. The pains were not completely removed, but considerably diminished for several months, at the end of which time they became worse than ever, particularly affecting the situation of the frontal sinus.

Bordenave has published, in the twelfth and thirteenth volumes of the *Mém. de l'Acad. de Chir.* edit. 12mo., two excellent papers on diseases of the antrum. In the thirteenth volume he relates a case, in which several small whitish worms, together with a piece of fœtid fungus, were discharged from the antrum, after an opening had been made on account of an abscess of this cavity, attended with caries. (P. 381.) But, in this instance, the worms had probably been generated after the opening had been made in the cavity; for when they made their appearance, the opening had existed nine months. Deschamps refers to another case, in which M. Fortassin, his colleague at La Charité, found in the antrum of a soldier, whom he was dissecting, a worm of the ascaris lumbricus kind, four inches in length. (*Traité des Mal. des Fosses Nasales, &c.* p. 107.) Such an example is also recorded in one of the volume of the *Journ. de Méd.* [The linguatula tænioides, the parasite which infests the frontal sinus, and which somewhat resembles the ascaris lumbricus, is not unlikely to have been the worm described as found in the antrum in the above cases.] Where cases of this description present themselves in a living subject, it would be advisable to inject oil into the cavity of the antrum, and then endeavour to wash out the extraneous substances, by throwing into the sinus warm water, by means of a syringe.

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Superioris, &c., Rintellii, 1750; *Haller*, Disp. Chir. l. 205. *Jourdaine*, in Mém. de l'Acad. de Chir. t. iv. p. 357: also Traité des Dépôts dans le Sinus Maxillaire, &c. 12mo. Paris, 1760; Traité des Mal. de la Bouche, t. ii. Paris, 1778; and Journ. de Méd. t. xxi. p. 57, et t. xxvii. p. 52—157. This author, who, in 1765, suggested to the Royal Academy of surgery the method of injecting fluid into the antrum, through the natural opening, is said to have been anticipated in the practice by Allouel, who first conceived the plan in 1737, and tried it with success in 1739. See *Boyer*, Traité des Mal. Chir. t. vi. p. 149. *Becker*, Diss. de Insolito Maxillæ Superioris tumore aliisque ejusdem morbis, Wirceb. 1776. Remarques et Observations sur les Maladies du Sinus Maxillaire, in Œuvres Chir. de Desault, par *Bichat*, t. ii. p. 156. *Desault's* Parisian Chir. Journal, vol. i. and ii. Medical Communications vol. i. Trans. of a Soc. for the Improvement of Med. and Chir. Knowledge, vol. ii. Natural History of the Human Teeth, by *John Hunter*, p. 174, 175, edit. 3. *Gooche's* Chir. Works, vol. ii. p. 61, and vol. iii. p. 161, edit. 1792. *Callisen's* Systema Chirurgiæ Hodiernæ, t. i. p. 364, &c. *Dubois*, in Bulletin de la Faculté de Médecine, No. 8. *J. L. Deschamps*, Traité des Maladies des Fosses Nasales et de leur Sinus, 8vo. Paris, 1804. *Eichorn*, Diss. de Polypis in Antro Highmori, Göt. 1804. *Liston*, Edin. Med. Journ. No 68. *P. V. Leinicker*, De Sin. Maxillari, ejusdem Morbis, &c. Wirceb, 1809. *C. A. Weinhold*, Ideen über die abnormen Metamorphosen der Higmorshöle. Leipz. 1810; and also, Von den Krankheiten der Gesichtsknochen und ihrer Schleimhaüte, der Ausrottung, eines grossen Polypen in der linken Oberkieferhöhle, dem Verhuten der Einsinkens der Gichtischen und Venerichsen Nase, und der Einsetzung Künstlicher Choanen, 4to. Halle, 1818. Account of a Malignant Tumor removed from the Antrum, by *T. Irving*, in Edin. Med. Journ. Nos. 83 and 84. *J. Gensoul*, Lettre Chir. Sur quelques Maladies graves du Sinus Maxillaire, et de l'Os Maxillaire Inférieur, 8vo. Paris, 1833, avec huit Planches, in folio. *Sir Benjamin C. Brodie*, Bart., in Lond. Med. Gaz. Dec. 1834. *G. J. Guthrie*, in Lond. Med. Gaz. *R. Liston*, in Elem. of Surgery, part ii.; and Med. Chir. Trans. vol. xx. *Scott*, in Lancet for 1831.

ANUS. The lower termination of the intestine, named the rectum, is so called, and its office is to form an outlet for the fæces. It is furnished with muscles, which are peculiar to it; viz. the sphincter, a voluntary muscle, which forms its base and support, and keeps it habitually closed, in order that the loathsome affliction of a continual and involuntary discharge of the fæces may not occur; and the *levator ani*, which serves to draw it up into its natural situation, after the expulsion of the fæces. It is also surrounded, as well as the whole of the neighbouring intestine, with muscular fibres, and a very loose sort of cellular substance. In addition to the levator ani, the proper dilating muscle, the sphincter is antagonised by the diaphragm and muscles forming the anterior parietes of the abdomen. The want of something corresponding to a sphincter is a main source of the annoyance resulting from an artificial anus. The external sphincter is covered by skin, which is abundantly furnished with sebaceous follicles; hairs grow upon it, and it is folded on itself to assume the character of a mucous tissue. At the place of its duplicature it is thrown into many diverging wrinkles, which become effaced whenever the anus is dilated. The common cuticle terminates just within the anus, where it is replaced by the kind of epidermis belonging to mucous textures. In the mucous membrane, are distributed the terminal ramifications of the hæmorrhoidal arteries; from which originate a multitude of tortuous plexiform veins, constituting the lowermost radicles of the vena portæ.

[It is important, however, to remark, that the hæmorrhoidal plexus of veins does not terminate exclusively in the portal vein, but empties itself also partly into the internal iliac veins; so that a communication exists around the termination of the intestine between the *portal* and the *general* venous system. This communication is of great advantage when there is congestion of the liver, or any obstruction to the circulation of the blood through that organ, since it affords the only other channel through which, under such circumstances, the engorged portal system can relieve itself; and this outlet is conveniently provided at the lowest point, where from the weight of the superincumbent column of blood, the congestion is greatest. This provision for relief, however, is often insufficient, and hence, as is well known, hepatic obstructions are very commonly attended by distension and dilatation of the hæmorrhoidal veins.]

The anus receives a large supply of nerves from the sacral nerves and from the hypogastric plexus; and numerous mucous cryptæ lie under the mucous membrane, which their secretion serves at once to lubricate and to protect.

ABSCESSES IN THE NEIGHBOURHOOD OF THE ANUS. — FISTULA IN ANO.

[Abscesses in the neighbourhood of the anus are of very common occurrence; but their especial importance, in a surgical point of view, arises not so much from their frequency, as from the circumstance, that, after the evacuation of the matter, they are rarely found to heal spontaneously, like ordinary abscesses in other situations, but their parietes, after contracting to a certain extent, leave a permanent fistulous channel by the side of the lower part of the bowel. This latter condition, which is an after consequence of the abscess, constitutes the disease commonly known as *fistula in ano.*] Those cases in which the matter has made its escape by one or more openings through the skin only, are called *blind external fistulæ;* those in which the discharge has been made into the cavity of the intestine, without any orifice in the skin, are named *blind internal;* and those which have an opening both through the skin, and into the gut, are called *complete fistulæ.*

Abscesses about the anus, according to Mr. Pott, may present themselves in different forms.

"Sometimes the attack is made with symptoms of high inflammation; with pain, fever, rigor, &c., and the fever ends as soon as the abscess is formed. In this case a part of the buttock, near the anus, is considerably swollen, and has a large circumscribed hardness. In a short time, the middle of this hardness becomes red and inflamed, and in the centre of it matter is formed."

"The pain is sometimes great, the fever high, the tumor large and exquisitely tender; but however disagreeable the appearances may have been, or however high the symptoms may have risen, before suppuration, yet, when that end is fairly and fully accomplished, the patient generally becomes easy and cool; and the matter formed under such circumstances, though it may be plentiful, is good."

"On the other hand, the external parts, after much pain, attended with fever, sickness, &c., are sometimes attacked with considerable inflammation, but without any of that circumscribed hardness which characterises the preceding tumor, instead of which the inflammation is extended largely, and the skin wears an erysipelatous appearance. In this the disease is more superficial, the quantity of matter small, and the cellular membrane sloughy to a considerable extent."

"Sometimes, instead of either of the preceding appearances, a gangrenous suppuration takes place, and the cellular tissue is affected in the same manner as it is in a carbuncle."

"In this case, the skin is of a dusky red or purple colour; and, although harder than in a natural state, it has by no means that degree of tension or resistance which it has either in phlegmon or in erysipelas. The patient has generally at first, a hard, full, jarring pulse, with great thirst and restlessness. If the progress of the disease be not stopped, or the patient relieved by medicine, the pulse soon changes into an unequal, low, faltering one; and the strength and the spirits sink in such a manner as to imply great and immediately impending mischief. The matter formed under the skin, so altered, is small in quantity and bad in quality, and the adipose membrane is gangrenous and sloughy throughout the extent of the discoloration."

"Sometimes the disease makes its first appearance in the induration of the skin, near to the verge of the anus, but without pain or alteration of colour; which hardness gradually softens and suppurates. The matter, when let out in this case, is small in quantity, good in quality; and the sore is superficial, clean, and well-conditioned. On the contrary, it now and then happens, that although the pain is but little, and the inflammation apparently slight, yet the matter is large in quantity bad in quality, extremely offensive, and proceeds from a deep crude hollow."— (*Pott*, *On Fistula in Ano*, Lond. 1765, p. 7—10.)

Abscesses near the rectum happen with particular frequency in persons who are habitually costive, and, according to Sir Benjamin Brodie, in those also who have been troubled with piles. His observations confirm the truth of some cases on record, where abscesses of the rectum are stated to have been produced by foreign bodies penetrating through the mucous membrane of the bowel and sphincter muscle, into the cellular tissue. "I was sent for (he informs us) to a gentleman, who had a very uneasy feeling in the rectum. I thought he laboured under internal piles, and prescribed for him something, which, however, did not relieve him. The next day, as he was no better, I examined the rectum, and found a hard substance sticking in the mucous membrane: with some difficulty I extracted it, and found it to be part of the core of an apple, which the patient had eaten." If this had not been extracted, no doubt an abscess might have been produced by the side of the gut. Sir Benjamin Brodie was sent for to another patient, who had an abscess near the rectum; and, after he had opened it, he detected a long fish-bone sticking across it, which was extracted. The bone had evidently penetrated the mucous membrane of the bowel; and, in all probability, some fæculent matter had passed by the side of it, so as to account for the remarkable putridity of the matter. (See *Lond. Med. Gaz.* for 1835, 1836, p. 27.) The experience of Sir Benjamin Brodie likewise agrees with the remark made by the greater number of writers on this subject, respecting the occasional formation of abscesses near the rectum in persons otherwise healthy, though they take place far more commonly in unhealthy individuals.

"The place where the abscess points," observed Mr. Pott, "and where the matter, if let alone, would burst its way out, is various and uncertain. Sometimes it is in the buttock, at a distance from the anus; at other times near its verge, or in the perineum; and this discharge is made sometimes from one orifice only, sometimes from several. In some cases there is not only an opening through the skin, externally, but another through the intestine into its cavity; in others, there is only one orifice, and that either external or internal.

"Sometimes the matter is formed at a considerable distance from the rectum, which is not even laid bare by it; at others, it is laid bare also, and not perforated: it is also sometimes not only denuded, but pierced; and that in more places than one."

"All consideration of preventing suppuration is generally out of the question: and our business, if called at the beginning, must be to moderate the symptoms; to forward the suppuration; when the matter is formed, to let it out; and to treat the sore in such a manner as shall be most likely to produce a speedy and lasting cure."

"When no symptoms require particular attention, and all that we have to do is to assist the maturation of the tumor, a soft poultice is the best application." When the disease was of the phlegmonous kind, Mr. Pott preferred letting the skin become very thin before an opening was made in it; but, at the present day, abscesses near the anus and rectum are commonly opened directly the matter has formed. "This kind of tumor is generally found in people of full sanguine habits: and who, therefore, if the pain be great, and the fever high, will bear evacuation, both by phlebotomy and gentle cathartics."

"When the inflammation is erysipelatous, the quantity of matter formed is small, compared with the size and extent of the tumor; the disease is rather a sloughy, putrid state of the cellular membrane, than a single abscess, and therefore the sooner it is opened the better; if we wait for the matter to point, we shall wait for what will not happen; at least not till after a considerable length of time, during which the disease will extend itself."

"When, instead of either of the preceding appearances, the skin wears a dusky purplish-red colour; has a doughy, unresisting feel, and very little sensibility: when these circumstances are joined with an unequal faltering kind of pulse, irregular shiverings, a great failure of strength and spirits, and inclination to doze, the case is formidable, and the event generally fatal."

"The habit, in these circumstances, is always bad; sometimes from nature, but much more frequently from gluttony and intemperance. What assistance art can lend must be administered speedily; for if the disease be not stopped, the patient will sink. Here is no need for evacuation of any kind; recourse must be immediately had to medical assistance; the part affected should be frequently fomented; a large and deep incision should be made into the diseased part, and the applications made to it should be of the warmest, most antiseptic kind."

"Strangury, dysury, and even total retention of urine, are no very uncommon attendants upon abscesses in the neighbourhood of the rectum and bladder; more especially if the seat of them be near the neck of the latter organ. They sometimes continue from the first attack of the inflammation until the matter is formed, and has made its way outward, and sometimes last a few hours only." (*Pott*, op. cit. p. 11—22.)

If these symptoms are not very urgent, they may commonly be relieved by a gentle cathartic, accompanied by diluent and diuretic medicine, but if they amount to a complete retention, the use of the catheter will occasionally become necessary. This practice, however, was condemned by Pott, who observed that the retention here is spasmodic, and arises from irritation, notwithstanding the participation of the neck of the bladder, in some degree, in the inflammation.

The most effectual means of relief seemed to him to be the warm bath, or semicupium ; the application of bladders with hot water to the pubes and perineum ; and, above all other remedies, the injection of a glyster, consisting of warm water, oil, and opium. (Op. cit. p. 22.)

"A painful tenesmus is no uncommon attendant upon an inflammation of the parts about the rectum. If a dose of rhubarb, joined with the confect. opii, does not remove it, the injection of thin starch and opium, or tinct. thebaic., is almost infallible."

"The bearing down in females, as it proceeds, in this case, from the same cause (viz. irritation), admits of relief from the same means as the tenesmus."

"In some habits, an obstinate costiveness attends this kind of inflammation, accompanied, not unfrequently, with a painful distention and enlargement of the hæmorrhoidal vessels, both internally and externally. While a large quantity of hard fæces is detained within the large intestines the whole habit must be disordered ; and the symptomatic fever, which necessarily accompanies the formation of matter, must be considerably heightened. And while the vessels surrounding the rectum (which are large and numerous) are distended, all the ills proceeding from pressure, inflammation, and irritation, must be increased." (p. 23.) Here we must agree with Pott, that antiphlogistic treatment and a low cool regimen must be the remedies : while laxative glysters and a soft cataplasm applied externally, will serve to relax and mollify the parts, at the same time that it hastens the suppuration.

[In the present day it is the custom to open freely *all* abscesses about the anus immediately the matter is formed and fluctuation can be detected. An early and free incision is the best means of preventing burrowing of the matter, and affords the patient the best chance of the immediate closure of the abscess without the formation of a fistula.]

"In making the opening, the knife or lancet should be passed in deep enough to reach the fluid: and when it is in, the incision should be continued upward and downward, in such manner as to divide all the skin covering the matter. By these means, the contents of the abscess will be discharged at once and future lodgment of matter will be prevented." (*Pott*, op. cit. p. 29.)

[After the matter has been discharged, a piece of soft lint or wool should be lightly inserted between the lips of the incision, to prevent its closing too rapidly ; and attention should be paid to the state of the wound from day to day while the cavity of the abscess is contracting, as it is important to maintain a free and depending outlet for the matter which continues to be secreted ; but all stuffing and distention of the cavity should be carefully avoided.]

"Upon discharge of the matter, the external swelling subsides, and the inflamed colour of the skin disappears ; the orifice, which at first was sloughy and foul, after a day or two are past becomes clean, and contracts in size ; but the discharge, by fretting the parts about, renders the patient still uneasy."

"As this kind of opening seldom proves sufficient for a cure (though it sometimes does), induration, in some degree, remains ; and if the orifice happens not to be a depending one, some part of the matter lodges, and is discharged by intervals, or may be pressed out by the fingers of an examiner. The disease, in this state, is not very painful ; but it is troublesome, nasty, and offensive : the continual discharge of a thin fluid from it creates heat, and causes excoriation in the parts about ; it daubs the linen of the patient, and is at times very fetid : the orifice also sometimes contracts so as not to be sufficient for the discharge ; and the lodgment of the matter then occasions fresh disturbance." (*Pott*, op. cit. p. 51.)

The reason of abscesses near the rectum less frequently healing up than others, is referred by Sir B. Brodie to the sinus, or passage for the matter, running through the sphincter muscle. "The sphincter muscle is constantly in motion, contracting and dilating, and consequently there is not the repose which is necessary for the cure of the abscess." (Op. et vol. cit. p. 27.) Sir B. Brodie acknowledges that an abscess sometimes forms high up by the side of the rectum, above the sphincter ; but this he regards as an occurrence comparatively rare. "These abscesses," he observes, "attain a very large size before the patient suffers much pain or inconvenience. There is at first merely a sense of bearing down of the rectum, occasioned by the pressure of the abscess on it ; but as the abscess increases in size, the patient has violent painful spasms, and a constant feeling as if he wanted to pass a motion, while there are no fæces in the bowel. His sufferings are now excessive. You examine the external parts, and you see nothing ; you introduce your finger into the rectum, and there you perceive the abscess pressing on one side of the gut, and very much diminishing its diameter. Having thus ascertained the position of the abscess, if you examine the external parts again, although you could discover nothing in the first instance, you will probably be able to detect it, deep seated as it is, at the side of the anus. More resistance will be offered to the pressure of the finger here than elsewhere ; and if you introduce two fingers of the left hand into the rectum, and press on the abscess from within, you will make it actually bulge a little externally." Sir B. Brodie then proceeds to explain, that abscesses, formed high up by the side of the rectum, if left to themselves, generally burst into it.

When the intestine is found to be separated from the surrounding parts by the matter, the operation of dividing it should be performed at the time the abscess is first opened, and not be deferred—"For," said Mr. Pott, "if it be done properly, it will add so little to the pain which the patient must feel by opening the abscess, that he will seldom be able to distinguish the one from the other, either with regard to time or sensation ; whereas, if it be deferred, he must either be in continual expectation of a second cutting, or feel one at a time when he does not expect it."

" The intention in this operation is to divide the intestine, from the verge of the anus, up as high as the top of the hollow in which the matter was formed; thereby to lay the two cavities of the gut and abscess into one, and by means of an open wound, instead of a hollow or sinuous sore, which serves for the lodgment of matter, to obtain a firm and lasting cure." (*Pott*, op. cit. p. 38.) The operation, however, is effectual partly on another principle, first particularly explained by Sir Benjamin Brodie. The division of the sphincter muscle had indeed been insisted upon by others (see *Chelius, Handb. der Chir.* b. i.); but the principle of its utility had not been duly pointed out. " When the abscess is laid open, the fibres between it and the bowel must be divided; and the sphincter muscle being thus set at liberty, not only is there a free and ready escape for the matter, but the action of the muscle, *which prevents the healing of the abscess*, is put an end to. This then is the mode of curing the abscess: lay it open into the bowel, dividing at the same time the fibres of the sphincter muscle, which lie over it." (*Brodie.*)

When a discharge of the matter by incision is too long delayed or neglected, the abscess makes its own way out, by bursting somewhere near to the fundament, or through the intestine into its cavity; or sometimes in both directions. In either case the discharge is made sometimes by one orifice only, and sometimes by more.

It is seldom that there is more than one orifice communicating with the interior of the bowel, although there may be several openings externally upon the integuments; but commonly these openings are only so many distinct burstings of the skin covering the matter, and all, be they few or many, lead and open immediately into the one single abscess.

Authorities differ as to the mode in which these abscesses originate :—

In 1820, some interesting remarks on this subject were published in France by M. Ribes, deduced from the dissection of not less than seventy-five persons, who had died with fistulæ. The doctrine started by M. Ribes was that a fistula is formed by the bursting of an internal pile into the rectum, and the consequent passage of a portion of the contents of the bowel into the orifice. Now this is not the common mode in which an abscess near the anus is occasioned; yet it sometimes happens as an exception to the common course of things. According to M. Ribes, the orifice is *always* within five or six lines above the junction of the internal membrane of the bowel with the external skin, and may usually be seen if the patient forces the gut gently down, as in going to stool. This account of the common situation of the internal opening, when the abscess communicates with the bowel, agrees with the observations of Sabatier, Larrey, and Chelius. (See *Recherches sur la situation de l'Orifice interne de la Fistule de l'Anus, &c.; Quarterly Journ. of Foreign Med.* No. 8, *Oct.* 1820; *Larrey*, in *Mém. de Chir. Mil.* t. iii. p. 415; *Chelius, Handb. der Chir.* b. i. p. 577. 8vo. Heidelb. 1826.)

[Sir B. Brodie believes that "the disease is originally an ulcer of the mucous membrane of the bowel, extending through the muscular tunic into the cellular membrane external to the intestine. It is admitted," he observes, " by every one, that in the greater number of cases of fistulæ in ano, there is an inner opening to the gut, as well as the outer opening; and I am satisfied that the inner opening always exists, because I scarcely ever fail to find it, now that I look for it in the proper place, and seek it carefully. I have, in a dead body, examined the parts where fistulæ had existed, several times, and in every instance I have found an inner opening to it. This affords a very reasonable explanation of the formation of these abscesses; it is almost impossible to understand, on any other ground, why suppuration should take place in the vicinity of the rectum, more than in any other part of the body, and why the cellular membrane there should suppurate more than cellular membrane elsewhere."

Sir B. Brodie thinks that the most common cause of abscess of this kind, is the lodgment of hard fæces in the bowels: by the straining that takes place to expel them, the mucous membrane gets torn or abraded at one part, and then the passage of the fæces causes ulceration. Some time afterwards straining again occurs, and the muscular tunic gives way, and the fæces escape into the cellular texture. He believes the inner orifice is always situated immediately above the sphincter muscle, just the part where the fæces are liable to be stopped, and where an ulcer is most likely to extend through both the tunics. (See *Lancet*, vol. i. 1843—44, p. 530.)

Mr. Syme, on the other hand, affirms positively, that " the mucous membrane always remains entire in the first instance, and is never perforated until after suppuration has taken place." He thinks that, in the first place, a collection of matter is formed between the integuments near the anus and the mucous coat of the rectum, but that " the contents of the abscess by far most frequently escape by an aperture through the external integument. This opening is usually very small, often hardly perceptible : and if the cavity be examined after the contents have been discharged, the mucous membrane will be found completely denuded, to more or less extent, at the distance of an inch, or a little further, from the anus. As the matter, in order to get into this situation, would, if originally deposited externally to the sphincter, have to penetrate between the muscular fibres, its formation probably takes place in connection with the inner coat of the bowel whence it proceeds outwards, overcoming the obstacles opposed to its progress in this direction, instead of pursuing an inward course, in opposition to the general tendency which leads to the external surface of the body."— " If the disease be still permitted to pursue its course unchecked, a small aperture is, sooner or later, formed also through the thin denuded part of the mucous membrane of the rectum. It may seem surprising that this second opening should be formed after the matter has procured vent elsewhere; but there can be no doubt as to the fact; and it agrees completely with what is observed to happen in the case of abscesses situated in the neighbourhood of the urethra, which, after their evacuation, whether spontaneous or artificial, often discharge purulent matter alone for a time, and then urine also. The true explanation, in both cases, probably is, that the matter, from not escaping with perfect freedom, accumulates in the cavity, so as to cause sufficient pressure for inducing ulceration of the denuded membrane. It is very seldom that a fistula of more than two months' standing will be found not to have an internal aperture." (*On Diseases of the Rectum*, edit. 3, 1854, p. 20.)

The statements just quoted are somewhat perplexing and contradictory, but, the fact is, these abscesses really originate in a variety of ways, and may commence by any one of the foregoing methods. *In the first place*, small circumscribed superficial abscesses immediately beneath the integument of the verge of the anus are very frequently met with. These may arise, as M. Ribes has stated, from the suppuration and bursting of an internal pile into the rectum; but they may also be produced independently of hæmorrhoidal disease, from constipation, or any other irritating cause. The fistulæ resulting from these abscesses are usually of small extent, are altogether superficial to the sphincter muscle, and seldom give rise to burrowing of matter in different directions. *A second class of cases* consists of those described by Sir B. Brodie, as the result of ulceration of the proper coats of the bowel, and escape of fæcal matter into the surrounding cellular tissue. Analogous to these are the cases where the coats of the rectum have been perforated by some hard substance, such as fish bones, &c., which have been swallowed with the food. These abscesses usually extend outwards into the ischio rectal fossa, and unless they are speedily relieved by incision, or the skin happens to give way, the matter is likely to burrow in various directions. The fistulæ resulting from these are generally deeper than the sphincter muscle. *A third class of cases* corresponds to those described by Mr. Syme, and take their origin external to the mucous membrane, the opening through which is of subsequent occurrence. These cases are, in the writer's opinion, more frequent than those arising from ulceration of the mucous membrane; at all events it is very common to find, upon opening an abscess, and for some time subsequently, that the mucous membrane is denuded for a considerable extent, but the most careful search will fail to discover any opening into the intestine; whereas in fistulæ of long standing the internal communication is generally met with. This kind of abscess may commence in immediate connection with the coats of the bowel, and thence make its way outward, which Mr. Syme believes to be the usual mode; or it may commence as a phlegmonous abscess in the ischio rectal fossa, and extend inwards through the fibres of the levator and the proper fibres of the bowel, until the mucous membrane is denuded. This latter kind of abscess often arises from some direct local injury, such as a fall or blow upon the perineum, and it is in these cases that an early incision, before denudation of the mucous membrane has taken place, is especially called for, and is likely to be followed by permanent closure of the cavity, which will hardly occur if the abscess commenced in connection with the coats of the bowel. An excellent account of the different kinds of abscesses near the anus has been given by M. Velpeau. See *Dict. de Méd.* ed. 2, 1833, t. iii. p. 304, Art. *Abcès de l'Anus.*

The situation of the internal orifice of fistula in ano was also further investigated by M. Velpeau. In thirty-five cases examined by him, he found that a great majority opened at the entrance of the anus, or a few lines within, in accordance with the statement of M. Ribes. Three, however, had their orifice outside the villous membrane of the anus, whilst on the other hand there were four, in which the opening was as high as an inch and a half, two inches, or two inches and a half, and a fifth even as high as three inches, and only just within reach of the finger. (*Dict. de Méd.* t. iii. p. 321.)]

The complete fistula is the most frequent form, but whether the case be a complete fistula, or a blind external one, that is, whether there be an opening in the skin only, or one there and another in the intestine, the appearance to the eye is much the same.

The method by which each of these states may be known is, by introducing a probe into the sinus by the orifice in the skin, while the forefinger is within the rectum.

[The internal orifice being then carefully sought for in the proper situation, *i. e.* just above the sphincter muscle, it may, in most instances, be discovered; but as it was formerly supposed to be situated at the upper extremity of the sinus, surgeons frequently failed to find it, and hence arose the opinion, that the blind external fistula was the most frequent variety of the disease. Sir B. Brodie maintains, that the internal opening is *always* present, and therefore does not admit the existence of an external blind fistula at all; but, as has been already explained, cases are sometimes met with, especially when the disease is not of long standing, in which no internal orifice can be discovered after the most careful search; and in addition to this, as Mr. Curling remarks, preparations may be met with in museums, which prove beyond all doubt that such a state of things is occasionally found.

The track of the sinus may often be felt as a hard cord under the skin, and by careful examination, the course which it takes, and the existence of other sinuses branching from it, may be made out. Some inequality of surface, a projecting papilla, or slight excavation of the mucous membrane distinguishable by the finger in the rectum, will often indicate the situation of an internal aperture, and will afford a useful guide for the direction of the probe. The absence of this, however, must not be taken as a proof that a communication does not exist, for sometimes, after a fruitless search with the probe and finger, a little water injected along the sinus with a small syringe will be found to make its way into the rectum, and will thus demonstrate the existence of a communication.]

Sometimes the matter of an abscess, formed near the anus, instead of making its way out through the skin externally, near the verge of the anus, or in the buttock, pierces through the intestine only. This is what is called a *blind internal fistula.* In this case, after the discharge has been made, the greater part of the tumefaction subsides, and the patient becomes easier. If this does not produce a cure, which sometimes, though very seldom, happens, some small degree of induration generally remains in the place where the original tumor was; upon pressure on this hardness, a small discharge of matter is frequently made per anum; and sometimes the expulsion of air from the cavity of the abscess into that of the intestine may very palpably be felt, and clearly heard; the stools, particularly if hard, and requiring force to be expelled, are sometimes smeared with matter; and although the patient, by the bursting of the abscess, is relieved from the acute pain which the collection occasioned, yet he is seldom perfectly free from a dull kind of uneasiness, especially if he sits for any considerable length of time in one posture. (*Pott*, op. cit. p. 96.)

Treatment of Fistula.

The methods of cure proposed and practised by our ancestors were three: viz. caustic, ligature, and incision.

The intention in each of these is the same: viz. to form one cavity of the sinus and intestine, by laying the former into the latter. The two first are now completely, and most properly, exploded.

For the treatment by incision, "the curved probe-pointed knife, with a narrow blade, is the most useful and handy instrument of any. This, introduced into the sinus, while the surgeon's fore-finger is in the intestine, will enable him to divide all that can ever require division; and that with less pain to the patient, with more facility to the operator, as well as with more certainty and expedition, than any other instrument whatever. If there be no opening in the intestine, the smallest degree of force will thrust the point of the knife through, and thereby make one; if there be one already, the same point will pass through it. In either case it will be received by the finger in ano; will thereby be prevented from deviating; and being brought out by the same finger, must necessarily divide all that is between the edge of the knife and the verge of the anus." (*Pott*, op. cit. p. 39.)

Besides the operation with the probe-pointed bistoury, as described by Pott, surgeons often practise another with a silver director and sharp-pointed bistoury. The director is introduced into the sinus, and then into the rectum, either through the internal opening, if one already exists, or by making it gradually penetrate through the coats of the bowel if no internal opening can be discovered. Then the director is to be bent, so as to make one extremity of it project through the anus; and the soft parts which lie over it divided, by passing the sharp-pointed bistoury along its groove. (See *Brodie*, in *Lond. Med. Gaz.* for 1835—36, p. 184.) When there are several sinuses, and any of them are left undivided, the operation will probably not bring about a cure; hence the common maxim, that every sinus must be laid open.

[Whenever it can be found, the internal orifice should be included in the incision. Mr. Syme attaches great importance to this, and he thinks, that "in complete fistulæ the most extensive incisions will fail to afford permanent relief unless they include the internal opening;" and "that the repetition of operations for this disease, which are so frequently heard of in practice, are, with few exceptions, referable to this mistake." (*On Dis. of the Rectum*, ed. 3, p. 38.) Sir B. Brodie also says, "if you make an artificial opening, and fail to find the real original opening, in three cases out of four you will be plagued afterwards. You have made an artificial opening, but the original one remains, and you go on dressing the sore, but there is a little infiltration of fæces and mucus into it that prevents it being healed. When you have made an artificial opening in the way I have stated, I advise you to do something more. Having made the artificial opening, and laid the fistula open into the gut, take a straight probe-pointed bistoury, introduce it into the rectum, turn its cutting edge outwards, divide the sphincter muscle, and set that completely at liberty. This is better than merely laying open the sinus into the gut, where you cannot find the internal orifice; but it is not so good as the operation where you can find it, because you have more bleeding, you give your patient more pain, and there is a larger wound to heal. (See *Lancet*, vol. i. 1843—44, p. 562.)]

The following remarks by Sir Benjamin Brodie deserve to be remembered:—"The advantage of the division of the sphincter is not merely theoretical. There are few cases, in which it will not greatly facilitate the ultimate cure, preventing the burrowing of matter, and the formation of fresh sinuses, and rendering the subsequent dressings more easy to the surgeon, and less painful to the patient. It is, however, to the more complicated cases of fistulæ that the division of the sphincter is especially applicable; as, for example, where the sinus is of unusual extent, or where there are several sinuses, or where you are not certain that you have been able to detect the whole of them, or where the neighbouring parts are extensively indurated. It is quite a mistake to suppose, that there is any well-founded objection to even the most free division of the sphincter; even in the first instance it scarcely interferes with the retention of the fæces, except they are actually liquid; and the muscle never fails to become perfectly united, and afterwards perform its functions as well as ever. Nor have I ever known any hæmorrhage arise, which was not readily commanded by a dossil of lint introduced into the wound, and the pressure of the finger continued for a short space of time. If there be any considerable bleeding vessel, it is not difficult to secure it with the tenaculum and ligature; but this is seldom necessary." (*Lond. Med. Gaz.* 1835—6, p. 184.)

[At St. Mark's Hospital for Fistula, &c., Mr. Salmon practises this free division of the sphincter *in all cases*, believing that it more effectually prevents any lodgment of matter, and thus renders the success of the operation a much greater certainty.

The treatment of *blind internal fistula* is to be conducted on the same principle as that of a blind external one; that is, it must be converted into a complete fistula, and then be laid freely open into the bowel. If the situation of the cavity is distinguishable externally, it may be opened at once by an incision through the tissues which cover it; if it is not sufficiently evident, it may be made so by the introduction of a bent probe from the rectum through the internal orifice of the fistula; the point of the probe being made to project towards the integument, can then be cut down upon from without.]

The real difference, therefore, as Mr. Pott observed, "between this kind of case and that in which there is an external opening (with regard to method of cure), is very immaterial; for an external opening must be made, and then all difference ceases. In this, as in the former, no cure can reasonably be expected, until the cavity of the abscess and that of the rectum are made one; and the only difference is, that in the one case we have an orifice at or near the verge of the anus, by which we are immediately enabled to perform the necessary operation; in the other, we must make one." (Op. cit. p. 96.)

Immediately after the operation, a soft dossil o fine lint should be introduced (from the rectum) between the divided lips of the incision; as well to repress any slight hæmorrhage, as to prevent the immediate reunion of the said lips; and the rest of the sore should be lightly dressed with the same. Cramming the sinuses with lint, besides causing great pain, would prevent the free escape of purulent matter, and promote the formation of new sinuses. Sometimes it is advantageous to give a few drops of laudanum after the operation, on the principle specified by Sir Benjamin Brodie, namely, not with the view of relieving pain, but of occasioning costiveness, which will allow the dressings to remain undisturbed for two or three days. After this, a gentle aperient may be administered, which will prevent the ill effects of too long continued constipation, and, at the same time, bring away the first dressings. Instead of immediately applying dressings again, Sir Benjamin Brodie prefers a poultice for three or four days, until the first inflammation consequent on the operation has subsided. After this, he dresses the sinuses daily, either with dry lint, or with lint spread with some stimulating ointment, or soaked in a stimulating lotion; always observing the rule to dress lightly. The first dressing should be permitted to continue until suppuration renders it loose enough to come away easily; and all the future ones should be as light, soft, and easy as possible.

If a loose fungous kind of flesh has taken possession of the inside of the sinus, a slight touch of the lunar caustic will reduce it sooner, and with better effect on the sore, than any other escharotic whatever.

Modern writers also speak of a smooth adventitious membrane, which is found to line old fistulæ, and frequently to hinder the success of the operation. (See *Quarterly Journ. of Foreign Medicine, &c.*, No. 8.) But my own belief is, that a case hindered from getting well by this cause is very rare in comparison with others in which the cure is prevented by the matter being still more or less confined, and not having as free an outlet as circumstances demand.

Sometimes in attempting to cure what seems to be a common fistula, we find that it does not get well; and in the end a copious abscess is discovered higher up, which prevents the closing of the smaller sinus below. (See *Brodie*, in *Lond. Med. Gaz.* vol. for 1835, 1836, p. 28.) I have had opportunities of seeing several cases corresponding to this accurate description. In another place, Sir Benjamin Brodie, in adverting to a few cases which are met with, and kept from healing by some undetected sinus, relates the particulars of one instance, in which a lady had several sinuses near the rectum. Sir Benjamin Brodie laid open all he could find; but she continued uncured a considerable time, during all which she complained of uneasy sensations, which could not be accounted for. After repeated examinations, a sinus was detected high up, not more than an inch in length, and seemingly involving the levator ani. This having been laid open, a cure soon followed. See *Lond. Med. Gaz.* for 1835, 1836, p. 185.)

Fistulous sores, sinuses, and indurations about the anus, which are consequences of diseases of the neck of the bladder and urethra, called fistulæ in perinæo, require separate and particular consideration. (See FISTULA IN PERINÆO.)

Abscesses are frequently formed about the lumbar vertebræ, under the psoas muscle, and near the sacrum; in which cases, the bones are probably carious, and sinuses may run down by the side of the rectum, and burst near the fundament. The treatment of such sores and sinuses can have little influence on the remote situation where the collection of matter is originally formed. (See LUMBAR ABSCESS.)

Some years ago, M. Roux published a critique on the preference which English surgeons invariably give to Pott's method of operating for fistula in ano. The plan which he prefers, consists in the use of a kind of director, called a gorget, which is usually made of ebony or box-wood, and intended to be introduced within the rectum, with its concavity turned towards the fistula. A steel director, slightly pointed, and without a *cul-de-sac*, is then passed through the fistula, till the point comes into contact with the wooden gorget. A long, narrow, sharp-pointed straight bistoury is now introduced along the groove of the steel director, till its point meets the groove of the ebony gorget, by cutting upon which all the parts are divided which lie between the internal opening of the fistula and the anus. It may be objected to this method, that it is not always easy to make a director pass at once through the fistula into the rectum. This is acknowledged by Richerand, who adds, that, in this circumstance, the point of the director may be forced into the rectum, without lessening the chance of the success of the operation. (*Nosogr. Chir.* t. iii. p. 463, 464, ed. 4.) A flexible silver director will be more likely to follow the track of the fistula completely into the rectum than a steel one; and the finger of the surgeon will always do the office of the wooden gorget with greater convenience. The only purpose which such a contrivance answers, seems to Sir Benjamin Brodie to be that of saving the surgeon's fore-finger; but, in using it, an advantage is lost, that of the sense of touch; "and (says he) in my own practice, I have found that I could complete the operation better with my fore-finger than the wooden gorget." (Op. et vol. cit. p. 184.) M. Roux censures us for not *cramming* the wound with charpie; for he is not content with merely introducing into it a dossil of lint. (See *Parallèle de la Chir. Angloise, &c.*, p. 296, &c.) His countryman, Pouteau, however, long ago expressed his decided conviction of the inutility of cramming the wound with dressings to its very bottom, after the third day, when superficial dressings, and the renewal of them as often as cleanliness requires, will be fully sufficient. After the sinuses are healed, there is always a sort of fissure or chink left by the side of the anus. If the sinus has been deep, this chink will be deep in proportion; and then an inconvenience will follow, which may lead the patient to fear he is not cured, though he is so in reality. "The mucus of the rectum, sometimes stained with the fæces, will flow through it and stain the linen. But (as Sir Benjamin Brodie adds) this is only temporary; the chink, however deep, will gradually close, and the mucus will ultimately be retained as well as ever."

Operations for fistula in ano may be followed by very troublesome hæmorrhage; but this happens, I believe, chiefly in patients whose hæmorrhoidal vessels are enlarged, or where the surgeon deviates from the prudent advice delivered by

Sir Benjamin Brodie, with reference to such abscesses as are formed high up by the side of the rectum, and above the sphincter. In such cases, in opening the abscess in the first instance, he directs the lancet to be carried through the skin, by the side of the anus, until the matter flows. Then a probe-pointed bistoury is to be introduced, and the rectum divided at the lower part of the abscess, and the incision carried through the sphincter. It is quite unnecessary to lay the whole abscess open into the rectum, and it might give rise to dangerous hæmorrhage from vessels beyond the reach of the finger. (*Brodie*, op. et vol. cit. p. 186.)

[In like manner, when the fistula extends upwards by the side of the rectum, the internal orifice being in the usual situation, it will be sufficient to lay open the lower part of the fistula through the internal orifice into the bowel without interfering with the upper portion. It will be better, however, in such a case, to carry the knife freely through the sphincter, in order that there may be a ready outlet at once for any matter that continues to be secreted.]

Like all other mechanical injuries, operations for fistula may give rise to erysipelas, and in some rare examples, to traumatic tetanus. With respect to erysipelas, Sir Benjamin Brodie notices its occasional extension in a few instances up the mucous membrane of the rectum into other parts of the intestinal canal; a formidable disease, the symptoms of which are peculiar, but not described by any other writer. "The pulse (says Sir Benjamin Brodie) becomes very rapid, and, at the same time, weak; then it is irregular and intermitting. The abdomen is tympanitic, hiccough takes place; there is a great prostration of strength, and the patient often dies in the course of three or four days, sometimes sooner." On one lady, the attack began when the wound of the operation was nearly healed up, and she died in less than forty-eight hours. He considers that, in consequence of the great prostration attendant on it, the disease demands the free exhibition of cordials and stimulants. (See *Lond. Med. Gaz.* for 1835, 1836, p. 185.)

Abscesses near the rectum frequently occur in patients who are labouring under tubercles and abscesses of the lungs. Hence, Sir Benjamin Brodie very properly recommends surgeons, before they operate on a patient for fistula, to ascertain whether the lungs are sound. "Persons with diseased liver, and other visceral diseases (he observes), are also liable to the formation of these abscesses. The distinction of these cases from others, which occur in otherwise healthy subjects, is very important, inasmuch as the practice, which is proper in the one case, is quite improper in the other." (See *Lond. Med. Gaz.* vol. cit. p. 28.) He adds, if the patient labour under visceral disease, it is seldom that the abscess will heal; but if it should, the visceral disease will make increased progress, and the patient die sooner if the operation be performed than if it were let alone. (p. 29.) Every well-informed surgeon will likewise coincide in the prudence of not operating for a fistula, if stricture or carcinoma of the rectum exist; for, under these circumstances, the sinus will not heal, even if it be laid open.

Le Dran's Operations; *Sharp's* Operations; *La Faye's* Notes on Dionis. *H. Bass*, D. Fistula Ani feliciter curanda, in Halleri Disp. Chir. 4, 453. *J. L. Petit*, Traité des Mal. Chir. t. i. and ii. p. 113. *Kirkland's* Medical Surgery, vol. ii. Some of the best practical remarks ever published are contained in *Pott's* Treatise on the Fistula in Ano, in which he has offered also an excellent critique on the opinions of Le Dran, De La Faye, and Cheselden. *Sabatier*, Méd. Opératoire, t. ii. *J. Howship*, Practical Obs. on the Diseases of the Lower Intestines, &c. chap. 6, ed. 3, Lond. 1824. *T. Whately*, Cases of Polypi, &c.; with an Appendix, describing an improved instrument for the Fistula in Ano, 8vo. Lond. 1805. *J. T. Oetzmann*, De Fistula Ani, 4to. Jenæ, 1812. *Roux*, Voyage fait à Londres en 1814, ou Parallèle de la Chirurgie Angloise avec la Chirurgie Françoise, p. 296, &c. Paris, 1815. *Schreger*, Chirurgische Versüche, b. ii. Ueber die Unterbindung der Mastdarmfisteln, p. 1, 131. 8vo. Nürnberg, 1818. *Kothe*, Darstellung, &c. der Afterfisteln, in Rust's Mag. b. i. s. 259. *T. Ribes*, Recherches sur la Situation de l'Orifice interne de la Fistule de l'Anus, et sur les parties dans l'épaisseur desquelles ces ulcères ont leur siége, in Revue Méd. His. et Phil. Paris, 1823, livr. i. p. 174. *Fr. Reisinger*, Darstellung eines neuenn Verfahrens die Mastdarmfistel zu unterbinden, &c. 8vo. Augsb. 1816. *Sir Benjamin C. Brodie*, in Lond. Med. Gaz. for 1835 and 1836; and Lancet 1843—44. *Velpeau*, in Dict. de Méd. ed. 2, 1833. *Art.* Abcès de l'Anus. *Bushe*, on Dis. of Rectum and Anus. New York, 1837. *Syme*, on Diseases of the Rectum, ed. 3rd, 1854.

Fissures of the Anus,

As they are termed, consist of longish superficial ulcerations near the anus, between the converging folds of the fine skin and mucous membrane. When the sides of the anus are separated, and the patient is desired to strain, a narrow fissure is seen, the bottom of which is red, and the margins somewhat swollen and callous. But, as Dupuytren observed, it is frequently necessary, for the purpose of ascertaining how high it reaches, to introduce the finger into the rectum. It is more commonly situated at the sides and back of the anus than at the fore part of it; a favourable circumstance in relation to an operation, particularly in women, in whom this opening is divided from the posterior commissure of the vulva only by a thin partition. The ulceration rarely affects the whole thickness of the mucous membrane. (See *Dupuytren*, *Clinique Chir.* t. iii. p. 283.) Fissure of the anus is usually productive of violent lancinating or burning pain, which gradually augments, and lasts a considerable time after the patient has had a motion. In some cases, indeed, so extreme is the suffering, that the patient, from a dread of obeying the call of nature, refuses to do so as long as possible, or even nearly starves himself, to render the occasions for emptying the rectum less frequent. The severity of the case arises chiefly from a painful spasm of the sphincter muscle.

Baron Dupuytren makes a very useful and practical division of fissures of the anus into three kinds. *Some are below the sphincter*, affecting hardly any texture but the skin, and not the mucous membrane. These excite more or less pruritus, but cause little obstruction to the passage of the fæces. *Fissures above the sphincter*, involving the mucous membrane, can only be seen with the aid of a speculum. When the finger is passed into the rectum, a knotty hard cord is felt, and pressure on it creates acute pain. When the patient goes to stool, such fissures give rise to an indescribable sort of tenesmus, which ceases directly after the evacuation; and the excrement on the side nearest the disease, is covered with puriform or mucous, bloody fluid. Such fissures were found by Dupuytren to be commonly produced by the ulceration of internal piles, excited by the passage of indurated fæcal matter. Lastly, fissures *on a level with the sphincter*, are the worst, being attended with agonising contraction of the sphincter, and other symptoms already specified.

Constipation and the spasm which it excites are amongst the predisposing causes of fissure of the anus. The indurated fæcal matter, either by causing ulceration of the mucous membrane, or by immoderate distension of the passage, may bring on the complaint. The unskilful administration of clysters, especially with pointed rough pipes, is often the cause. Fissures of the anus are frequently met with in persons who have piles; and according to Dupuytren, the lodgment of venereal matter near the anus, as happens in many women, may lead to the complaint. Perhaps it would be more correct to say, that the contact of any irritating matter, or secretion, may have this effect.

The two first descriptions of fissure described by Dupuytren, may mostly be cured without any operation; some by dressing them with simple cerate, or ointment containing opium, mercurial preparations, &c.; others by emollient anodyne lotions or applications. But where the fissure was of the third description, he considered the operation first introduced by Boyer the quickest and surest means of cure. This consists in dividing the anus and sphincter with a probe-pointed bistoury, passed into the rectum, and cutting directly through the fissure, except when it lies forward towards the vagina in the female, or urethra in the male subject. [In these latter cases, he did not cut through the fissure, but divided the sphincter in the lateral direction. He did not consider it absolutely necessary to include the fissure in the incision, because he believed the spasmodic contraction to be the essential part of the disease, and thought that the ulcer would always heal if it were allowed to remain at rest a sufficient length of time, which is effectually secured by the division of the sphincter muscle.] When several fissures existed, Dupuytren sometimes made several cuts in different directions, from three to four lines deep. (See *Clin. Chir.* t. iii. art. 10.)

According to Boyer and Dupuytren, the spasmodic contraction of the sphincter is the real disorder, and the fissure is only a secondary effect. By putting a stop to this contraction, the disease is cured. With this view, Dupuytren tried what good could be done by the following application: ℞. Axungiæ ʒvj., extr. belladonnæ, plumbi acetatis ā ā ʒj. Misc. A tent of linen or charpie, or a soft rectum bougie, of moderate size, smeared with this ointment, is introduced, and its diameter gradually increased to that of the forefinger. Dupuytren states, that the continuance of this treatment for a few days frequently relieves the pain entirely, and obviates all necessity either for caustic, or the division of the sphincter. Even when the plan does not cure, it always palliates, and therefore should be tried before the latter methods are resorted to.

Sir Benjamin Brodie has also spoken of the contraction of the sphincter as a distinct affection; and describes it as occurring chiefly in women disposed to hysteria; though sometimes in the male sex. He observes, however, that very often a small ulcer of the mucous membrane of the rectum accompanies the spasmodic contraction of the sphincter, and is always situated at the posterior part, opposite the point of the os coccygis. When the suffering is not excessive, relief may sometimes be derived from purgatives, given to prevent the evacuations from being hard and figured, from an opiate suppository at night, and from the introduction of a bougie into the anus just before the patient has a motion. In worse cases, Sir Benjamin Brodie recommends the division of the sphincter with a straight probe-pointed bistoury. The forefinger is passed into the rectum, quite above the sphincter, as a guide to the bistoury. The fibres of this muscle are thick, and will require two or three strokes for their complete division. An opiate may be given to keep the bowels quiet for two or three days afterwards. Then a dose of castor oil may be exhibited. Simple dressings will suffice to heal the wound. (See *Lond. Med. Gaz.* 1834—35, p. 26.)

In females, the incision should never be made towards the vagina, for it will never heal properly in this situation, and the sphincter will not become perfect again; so that the patient will be left with an incontinence of fæces. In neither sex should the incision be directed towards the coccyx; because in this way only the inner or circular fibres of the sphincter can be divided, and not the outer layer which is attached to the apex of the os coccygis. The knife passes between the two lateral portions of this outer layer and simply splits or separates them; and the contractile power of the muscle remains, and interferes with the cicatrisation of the wound. (*Brodie*, op. cit. 1836, p. 187.)

[Many surgeons do not believe with Boyer, that spasm of the sphincter is the primary cause of the disease, but consider the opposite explanation as the true one, namely, that the ulcer is the primary disease, and that the spasm is caused by the pain and irritation produced by the passage of the stools over the ulcerated surface. This latter view of the question has the support of M. Velpeau (see *Op. Surg.* translated by Mott, vol. iii. p. 1109), and it is also strongly urged by Mr. Quain, (*On Dis. of the Rectum*, p. 176.)

In support of this view may be mentioned the fact, that cases are not unfrequently met with in which spasm of the sphincter does not exist, or, at any rate, does not form a prominent symptom; it cannot therefore *always* be the cause of the disease; it would seem more correct, therefore, instead of subdividing the complaint, as Boyer did, into contraction with fissure and contraction without fissure, to speak of fissure with contraction and fissure without contraction.

Of late years many surgeons have advocated less extensive incisions than those originally recommended by Boyer. Mr. Copeland states, that in a simple ulcer the mere setting the mucous membrane at liberty by dividing it longitudinally so as to include the ulcer in the incision, is sufficient to effect a cure. Mr. Syme and, subsequently, many other surgeons, have inculcated a similar practice, and state that it has been attended with complete success in their hands; a further proof that the complaint does not depend altogether on the contraction of the muscle, or it would not be relieved by the mere scarification of the mucous membrane forming the base of the ulcer.

The milder plan of treatment just alluded to is now very frequently practised. It is doubtful, nevertheless, whether it can be depended upon to give such complete relief, and to effect so permanent a cure *in all cases*, as the incision through the sphincter. Mr. Salmon states, that he has repeatedly seen cases in which the slighter incision has failed to cure the disease, and he therefore still practises the free division of the muscle in all cases in which an operation is required.

It seems reasonable to suppose that the division of the muscular fibres becomes *essential* in proportion to the extent to which they are found spasmodically contracted.

Some of the French surgeons have lately practised *forcible dilatation* of the sphincter muscle. " The operator introduces his two thumbs into the rectum, and after having obtained a *point-d'appui* for his fingers against the tuberosities of the ischia, he forcibly separates his thumbs until they come in contact with the internal surface of the tuberosities. He experiences at first a resistance, then a sensation of internal laceration, and his two thumbs touch the bones." M. Nélaton " does not hesitate to say that this is certainly the best mode of treating fissures of the anus" (see *Elém. de Pathol. Chir.* tom. v. p. 80, 1858), a remark in which the majority of English surgeons are not very likely to coincide.]

EXCRESCENCES OF THE ANUS.

These cases are frequent, the growths receiving a variety of names, according to their supposed resemblance to things, as condylomata, mariscæ, and fici. Some are much firmer than others ; some of them grow, in consequence of irritation of the skin of the anus, by the contact of rancid secretions, or purulent matter. Others are originally piles ; for, as Sir Benjamin Brodie observes, when the cavities of external piles become obliterated, they generally form flaps of skin, which gradually waste ; but sometimes diseased action takes place in them, and they become converted into excrescences, similar to those which grow from the nymphæ of women. Many excrescences about the anus and perineum are of middling consistence, between that of a wart and that of a polypus. I have cured a great number by stimulating applications, as the nitrate of silver, the tinc. ferri mur., the acetic acid, and the powder of savine, blended with subacetate of copper, or a solution of the sulphate of copper. But, in general, I remove the larger kinds with a bistoury. The bleeding, which may be at first copious, does not generally require a ligature, as it stops as soon as lint or linen dipped in cold water and a T bandage have been applied. (See HÆMORRHOIDS and RECTUM.)

PROLAPSUS ANI.

See *Rectum, Prolapsus of.*

IMPERFORATE ANUS.

As it is of the utmost consequence that this and other malformations should not remain long unknown, one of the earliest duties of an accoucheur, after delivery, is the examination of all the natural outlets of new-born infants.

The place in which the extremity of the rectum, or the anus, ought to be, may be entirely, or partly, shut up by a membrane, or fleshy adhesion. In other instances, no vestige of the intestine can be found, as the skin retains its natural colour over the whole space between the parts of generation and the os coccygis, without being more elevated in one place than another. In these cases, the intestine sometimes terminates in one or two *culs-de-sac,* about an inch upward from the ordinary situation of the anus. (See *Baillie's Engravings,* fasc. iv. tab. v.) Sometimes it does not descend lower than the upper part of the sacrum; sometimes it opens into the bladder or vagina. Dr. Palmer dissected a case, where the colon, after reaching the vicinity of the left kidney, began, as it descended, to form a sigmoid flexure ; but previously to its arrival at the concavity of the left ilium, made a sudden turn to the right, and, crossing the psoas muscle, reached the projection of the sacrum, where it terminated, *without entering the pelvis at all.* With this malformation was combined an imperforate meatus urinarius, and other considerable deviations of the genital organs from their natural structure. (See *Medico-Chir. Journ.* vol. i. 8vo. Lond. 1816.)

Sometimes the colon terminates in a sac, and the rectum is entirely deficient. (See *Beauregard,* in *Journ. de Méd.* i. 66.)

[Dr. Bushe records a case in which the rectum terminated by *two* extremities, both in the median line, one being a little anterior than natural, the other about an inch further back. The posterior was the smaller of the two, and did not discharge more than one third of the fæces. (*On Diseases of the Rectum,* p. 44. New York, 1837.)]

In cases of imperforate anus, if a speedy opening be not made for the fæces, the infants soon perish, with symptoms similar to those of a strangulated hernia. Mr. A. C. Hutchinson thinks it advantageous, however, not to operate till the expiration of from twenty-four to sixty hours after birth, as he conceives that, within this period, no great inconvenience will arise, and the distension of the rectum with meconium will be a guidance to the surgeon in making the incisions. (See *Obs. in Surgery,* ed. 2.) After ascertaining the complaint, which is an easy matter, the surgeon should endeavour to learn, whether the anus is merely shut by portions of skin, a membrane, or a fleshy adhesion; or whether the anus is altogether wanting, in consequence of the lower portion of the cavity of the gut being obliterated, or the rectum not extending sufficiently far down.

When merely a thin production of the skin closes the opening of the rectum, the part producing the obstruction is somewhat different in colour from the neighbouring integuments, being usually of a bluish or livid hue, in consequence of the accumulation of the meconium under it. The meconium, propelled downward by the viscera above, forms a small roundish prominence, which yields like dough to the pressure of the fingers, but immediately projects again when the pressure is removed. When a fleshy adhesion closes the intestine, the circumstance is obvious to the eye, if the part protrude, as is generally the case ; greater hardness and resistance are felt than when there is merely a membrane ; and the livid colour of the meconium cannot be seen through the obstructing substance.

These last circumstances are of themselves enough to convince the surgeon of the necessity of an operation ; but they do not clearly show, whether the intestine descends as far as it ought, in order to form a proper kind of anus. Complete information on this point can only be acquired after the obstructing substance has been divided, or else after the child's death, when the operation has proved ineffectual. Though there be no mark to denote where the anus ought to be situated, and no degree of prominence, yielding, like soft dough, to the pressure of the fingers, and rising again when such pressure is removed; yet the rectum may still exist, and have a cavity, as far as the membrane, or adhesion, closing it.

When the anus is simply covered with skin, and its place indicated by a prominence, arising from the contents of the rectum, we have only to make an opening with a knife, sufficient to let out the meconium. Another cut may then be made across the first, and the four angles removed. About two years ago, I performed this operation, and the little patient was saved. A piece of bougie, or what is better, a portion of elastic gum catheter, is afterwards to be introduced, in order to keep the opening from closing. If the anus be only partly closed by a membrane, the opening may be dilated with tents or bougies; but, if the aperture be small, it is preferable to use the bistoury for its enlargement.

When no external appearance denotes where the situation of the anus ought to be, the case is more serious and embarrassing; and this, whether the intestine be stopped up by a fleshy adhesion, or the coalescence of its sides, or whether a part of the gut be wanting.

However, it is the surgeon's duty to do everything in his power to afford relief. For this purpose, an incision an inch long, or rather more, is to be made in the situation where the anus ought to be, and the wound is to be carried more and more deeply in the natural direction of the rectum. The cuts are not to be made directly upwards, nor in the axis of the pelvis; for the vagina or bladder might thus be wounded. On the contrary, the operator should cut backward, along the centre of the concavity of the os coccygis, where there is no danger of wounding any part of importance. In all cases of this kind, the surgeon's finger is the best director. The operator, guided by the index finger of his left hand, introduced within the os coccygis, is to dissect in the direction above recommended, until he reaches the meconium or has cut as far as he can safely reach with his finger. If he should fail in finding the meconium, as death must unavoidably follow, one more attempt ought to be made, by introducing, upon the finger, a middle-sized trocar, in the direction best calculated to reach the rectum, without danger to other parts, viz. upwards and backwards in the median line. Should this attempt prove successful, the canula may be left in the puncture and secured there with tapes, so as to afford an outlet for the fæces. In some observations on this subject, addressed to the Medical and Chirurgical Society by Mr. A. Copland Hutchison, he recommends an elastic gum catheter to be substituted for the canula, after a week; and, when the tube can be dispensed with, a sponge tent, or piece of bougie, to be worn twelve out of the twenty-four hours. (See *Obs. in Surgery*, ed. 2, 1826.)

In an interesting case, recorded in Langenbeck's Surgical Bibliotheca, the imperforate state of the anus was not discovered till the evening of the twelfth day from the child's birth, when hiccough and convulsions had come on. M. Wolff found the abdomen protuberant, hard, and painful when handled, and the child was suffering from nausea, vomiting, and great depression of strength. Next day, he introduced a lancet a few lines in front of the os coccygis, to the depth of an inch, without finding the rectum. The puncture was then carried to the depth of two inches, but without effect. With a pharyngotomus, however, he now succeeded in piercing the rectum; and a glyster was administered, which brought away some meconium. Under the use of glysters and tents, the child soon recovered.

By such proceedings, many infants have been preserved, which would otherwise have been devoted to certain death. Hildanus, La Motte, Roonhuysen, Mr. A. Copland Hutchison, and others, have successfully adopted the practice. Mr. B. Bell met with two cases in which the intestine was very distant from the integuments, yet he succeeded in forming an anus, which fulfilled its office tolerably well for several years; though he found it difficult to keep it pervious. As soon as he removed the dossils of lint and other kinds of tents used for maintaining the necessary dilatation, such a degree of contraction speedily followed, that the evacuation of the intestinal matter became difficult. He employed, at different times, tents made of sponge, gentian root, and other substances which swell on being moistened. But they always produced such pain and irritation that it was impossible to persevere in their use. Tents of soft lint dipped in oil, or rolls of bougie-plaster, were found to cause less irritation than those composed of any other materials.

Though keeping the opening dilated may seem simple and easy to those who have had no opportunities of seeing cases of this description, it is far otherwise in practice. Mr. B. Bell assures us that he never met with any disease that gave him so much trouble and embarrassment, as he experienced in the two cases of this sort which occurred in his practice. Although, in both instances, he made the openings at first sufficiently large, it was only by very assiduous attention for eight or ten months that the necessity for another operation, and even repeated operations, was prevented. When only the skin has been divided, the rest of the treatment is, doubtless, more simple; for then nothing more is requisite than keeping a piece of lint, for a few days, in the opening made with the knife. But, when the extremity of the rectum is at a certain distance, though we may generally hope to effect a cure, after having succeeded in giving vent to the intestinal matter; yet the treatment, after the operation, will always demand, for a long while, a great deal of attention and care on the part of the surgeon. In a highly interesting example, recorded by Mr. Miller of Methven, such was the tendency to closure of the new opening, that he was obliged to repeat the operation ten times before the child was eight months old. (See *Edin. Med. Journ.* No. 98, p. 62.) Notwithstanding all these operations, and another one of two hours and three quarters' duration performed several years afterwards for the extraction of an alvine concretion, equal in size to a turkey's egg, the power of the sphincter was perfect.

[The cause of this contraction may be thus explained. The lost portion of the intestine can never be restored; it is a fistula which is substituted in place of the natural tube, and the species of mucous surface, which ultimately becomes developed but very imperfectly, represents the natural lining of the bowel. (See *Velpeau, Op. Surg.* Mott's Trans. vol. iii. p. 1090.) To obviate this inconvenience from subsequent contraction, and also to prevent the irritation caused by the passage of fæcal matters over the raw surface, Amussat advised that the edge of the mucous membrane should be drawn down and stitched to the edges of the opening in the integument. As Mr. Erichsen remarks, however, this very desirable suggestion can only be carried into effect when the intestine terminates at a short distance from the surface. If the perineal incision were two or three inches in depth, there would be little probability of the surgeon being able to bring down the intestine to such an extent. In a case in which he attempted to do so, he found the gut too firmly fixed to be moved by any traction that it would have been safe to have employed. (See *Erichsen, Science and Art of Surgery*, p. 790.)]

The probability of success in these cases may be considered as, in some measure, proportioned to the depth of the necessary incision. An infant was brought to University College Hospital with an imperforate anus; Mr. Liston, after carrying the incisions to the depth of three inches, made a small opening into the intestinal canal, as indicated by the discharge of fetid gas, and a small quantity of meconium. A piece of bougie was introduced to maintain the opening; but the child died in a very short time, and there was no opportunity of ascertaining the state of the parts. In a case like that recorded by Dr. Palmer, to which I have above adverted, the inutility of any attempt to discharge the fæces by an operation, in the usual site of the anus, must be sufficiently obvious. (*Medico-Chir. Journ.* vol. i. p. 181.)

Sometimes, while the anus appears pervious and well-formed, the infant suffers the same symptoms as if there were no anus at all. The reason of this depends upon the intestine being occasionally closed by a membranous partition, situated more or less upward, above the aperture of the anus. This case is in fact an imperforate rectum, rather than an imperforate anus. (*Courtial, Nouvelles Obs. sur les Os*, p. 147; *John Wayte*, in *Edin. Med. and Surgical Journ. April*, 1821; and *Cases in Hutchison's Obs. in Surgery*, ed. 2.)

[Dr. Bushe mentions a case in which he found *two* partitions, one about half an inch from the anus, and the other three-quarters of an inch higher up. (*On Dis. of the Rectum*, p. 40.)]

Sometimes the symptoms are owing not simply to an interruption of the cavity of the intestine, but even of its parietes; and thus the colon may be separated entirely from the rectum. (*Andral. Précis, d'Anat. Pathol.* t. ii. p. 143.) Such erroneous formations may be suspected, when an infant, whose anus is externally open, does not void any excrement for two or three days after its birth, and especially when urgent symptoms arise, such as swelling of the belly, vomiting, &c. We are now to endeavour to ascertain, whether the rectum is impervious above the anus, by attempting to inject glysters, or introducing a probe. If the gut be shut up, there is nothing to be done but having recourse to the method described above, and forming a communication by means of a bistoury guided on the finger, or else with a pharyngotomus. If the obstacle should only consist of a transverse membrane, the operation will be easy, and its success highly probable; but if there should be an internal obstruction of the intestinal canal, from total deficiency of some part of its parietes, the case is infinitely more serious.

In the case recorded by Mr. Wayte, the membranous septum was felt by the finger, about an inch from the verge of the anus. It was pierced with a pointed probe, which was followed by a hydrocele trocar, and afterwards by a bougie of larger dimensions. On withdrawing the latter much meconium, mixed with fæces, escaped, and continued to be frequently discharged. In a week, however, the opening closed, and a fresh puncture was made, which was maintained by the frequent introduction of bougies. The child proceeded tolerably well until the end of another week, when the passage was again much contracted, and the abdomen proportionably distended. On the twentieth day from birth, a full-sized trocar was used for restoring the opening, which, however, again had a tendency to close, but was afterwards dilated by introducing, twice a day, bougies, which were increased in size, until a rectum bougie of middling size could be passed. The boy now rapidly improved, and every hope of perfect recovery was entertained, but disease of the os coccygis ensued; and at the end of six months, the little patient died hectic. (See *Edin. Med. and Surg. Journ.* vol. xvii.)

When the anus is imperforate, the intestine sometimes opens into the vagina in the female; or into the bladder, or urethra, in the male; there being, as Andral expresses himself, a tendency in the terminal orifices of the digestive, urinary, and genital organs to be confounded together, and to form a common cavity more or less analogous to the cloaca of birds. (*Précis d'Anat. Pathol.* t. ii. p. 144; *Dumas*, in *Recueil Périodique de la Soc. de Méd.* t. iii. No. 13; *Leveillé, Rapport des Travaux de la Soc. Philom.* vol. i. p. 145; *Murray Diss. Atresi Ani vesicalis,* Ups. 1794; *Act. Nat. Cur.* vol. viii. Obs. 24; vol. ix. Obs. 11; *Rœstel*, in *Mursinna's Journ. für die Chir.* br. i. p. 547; *Obs. Med.* Decad. ii. No. 2; *Velpeau, Nouv. Elém.* t. iii. p. 977.) The first case is the least dangerous of such malformations. The intestine may terminate at two places at the same time, viz. at the usual place, so as to form a proper anus, more or less perfect; and also in the vagina. If the rectum were to terminate at the lower and posterior part of the vulva, of which M. Brachet has lately published an example, the making of a new anus in the proper situation would be unattended with difficulty. A director should be passed into the rectum through the opening already existing, and an incision made, under the guidance of this instrument, from the perineum towards the coccyx in the natural situation of the anus, through all the textures covering the extremity of the rectum. A canula is then to be fixed in the bowel, at the posterior part of the wound, by which means the front of the incision would have an opportunity of healing, and the fæces take their right course. This operation was recommended by Vicq d'Azyr. M. Velpeau sees no occasion for the suture advised by M. Martin for the union of the anterior part of the wound, and suggests that sometimes it may be advantageous not to divide the recto-vaginal septum at all, but to pass a blunt curved instrument from the vaginal fistula to the lower end of the bowel, and then make a puncture into the latter through the skin. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 979.)

When the two openings are exceedingly small, and the fæces cannot readily pass out, even with the aid of glysters, the opening of the anus ought to be enlarged with a knife, and kept dilated with a canula. The communication with the vagina will then gradually close.

For the most part, the intestine has but one opening in the vagina. In this circumstance, the surgeon should make an incision in the place which the anus ought to occupy. The natural channel of the fæces being thus opened, less excrement will pass out of the vagina; and by the introduction of a tube into the new anus, the communication between the rectum and vagina will be obliterated and a perfect cure accomplished; an instance of which is recorded by M. Lépine. (See *Dict. de Méd. et de Chir. Prat.* t. iii. p. 121.) The opening between the intestine and vagina is sometimes too small for the due evacuation of the fæces, and the infant is then exposed to the same sort of dangerous symptoms as if the rectum had no opening at all.

In male infants, the rectum sometimes opens into the bladder; and, in these circumstances there is generally no anus. The case is easily known, by the meconium being blended with the urine, which acquires a thick greenish appearance, and is voided almost continually, though in small quantities. Only the most fluid part of the meconium is thus discharged. The thicker part, not getting from the rectum into the bladder, nor from the bladder into the urethra, greatly distends the intestines and irritates the bladder, producing in the end fatal symptoms. For a few days, however, the meconium may be diluted, and voided with the urine. An infant, whose meconium came away through the urethra, seen by M. Velpeau, lived nearly a week. (*Nouv. Elém. de Méd. Opér.* t. iii. p. 977.) In all such cases one thing is certain, viz. that without the speedy interference of art to form an anus, capable of serving as an outlet to the fæces, with which the urinary organs cannot remain obstructed, the infant will inevitably die. This case must, therefore, be treated on the same principles which apply to the foregoing examples. Though we can hardly hope to prevent altogether the inconveniences resulting from the rectum opening into the bladder, since even a new passage will not completely hinder the fæces from following the other course; yet we shall thus afford the child the only chance of preservation which its condition will allow.

Instances are also upon record, where the rectum opened into the urethra (*Bresl. Samml.* 1718, p. 702; *Hist. de l'Acad. Royale des Sciences*, 1752, p. 113 ; *Hochstetter*, in *Med. Wochenblatt*, 1780, No. 18; 1783, No. 19 ; *Kretschmar*, in *Horn's Archiv.* b. i. p. 350.)

[These cases may perhaps be distinguished from each other by the fact that, when the opening is urethral, a small jet of meconium will generally precede the passage of the urine, whereas when it is vesical, the meconium and urine will be mixed. (*Bushe, On Dis. of the Rectum*, p. 42.)

Mr. Fergusson operated successfully on a case in which the rectum terminated in the membranous part of the urethra. The child lived till he was six years old, when he died of disease of the lungs. Occasionally when his bowels were loose, a few drops of fæces would come by the urethra, and he was wont also to discharge part of his urine by the artificial opening into the rectum. In the operation, the rectum was first sought for in its natural situation, but without success. Some meconium being then observed to escape by the urethra, it was thought that the rectum terminated in the bladder, and an incision was made, as it was believed at the time, in the neck of the bladder, through which the meconium escaped. On examination of the parts, after death, however, this was found not to have been the case, but the bowel terminated in the membranous portion of the urethra by an aperture about the size of a lancet puncture. (See *Ed. Med. and Surg. Journal*, vol. xxxvi. p. 363, and *Op. Surg.* ed. 3, p. 740.]

Cruveilhier saw an infant in which the rectum opened under the glans penis, through a canal formed in the substance of the raphè of the scrotum. (*Anat. Pathol.* pl. vi. 1re livr.)

[Mr. South met with a somewhat similar case. There was no anal orifice in the usual situation, but in front of the scrotum, and in the track of the raphè, there was a small opening, just large enough to admit a probe, and through this, when the child cried, a small quantity of meconium passed. There was a slight protrusion in the natural position of the anus when the child cried ; Mr. South therefore made an incision at this part, and succeeded in finding the rectum at the depth of an inch from the surface. The child recovered from the operation, and lived till adult age, but the unnatural canal under the penis always remained pervious, and small quantities of stool occasionally escaped from it. (See *South's Trans. of Chelius*, vol. ii. p. 329.)

There are no satisfactory data to enable us to estimate the proportion of mortality in cases of imperforate anus, but it is unquestionably very great; probably of the whole number of children born with this malformation the survivors do not amount to more than one tenth.]

In cases in which an outlet for the fæces cannot be procured by any of the methods pointed out above, Littre proposed, in 1720, to make an opening in the sigmoid flexure of the colon, above the left groin, and thus form an artificial anus. In 1788, Dumas tried the plan on an infant, which died on the tenth day. In 1793, it was practised with complete success, by M. Duret, of Brest; and M. Pilore, of Rouen, had an equally fortunate case. But the infant, on whom Desault operated in 1794, lived but four days afterwards. M. Ouvrard, of Angers, and M. Roux, of Paris, lost also the two children on whom they made the experiment. (*Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 983.) M. Duret cut into the abdomen at the lower part of the left iliac region: and, having opened the sigmoid flexure of the colon, he fixed it near the wound. The child was saved by the formation of an artificial anus ; but at the age of twenty-five months, it continued to be troubled with a prolapsus of the lining of the bowel. (See *Recueil Périodique de la Soc. de Méd.* t. iv. No. 19; and *Sabatier*, *Méd. Opératoire*, t. iii. p. 836, ed. 2.)

Callisen conceived, that the descending colon might be most easily got at by making an incision in the left lumbar region, along the edge of the quadratus lumborum muscle, and opening that intestine between the two layers of peritoneum, which fix it in its situation. Thus he calculated that all necessity for cutting into the cavity of the peritoneum itself would be obviated. (*Syst. Chir. Hodiernæ*, t. ii. p. 688, 689, ed. 1800.) The operation was tried in one case by M. Roux, but in two hours the infant perished. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 984.)

[Callisen's proceeding has been modified by Amussat, who made the incision in the transverse instead of the vertical direction. For a further description of these operations, the reader is referred to the article on *Intestinal Obstructions.* The mortality which has attended their performance, in cases of imperforate anus, is very great. It is stated by Amussat, that of twenty-one children thus operated upon, only four ultimately recovered.]

Artificial Anus.

Anus Anormale, Dupuytren; Intestinal Fistula, Teale; Fæcal Fistula. — Artificial anus signifies an accidental opening in the parietes of the abdomen, to which opening some part of the intestinal canal tends, and through which a variable quantity, or even the whole of the intestinal matter or of the fæces, is involuntarily discharged.

[It may be the result of injury to some part of the intestinal canal, from penetrating wounds, mortification, or other causes; or it may be produced intentionally by the surgeon for the purpose of saving life, in cases of otherwise irremediable obstruction. In the present article, the first class of cases only will be treated of; and the reader is referred to the article on *Intestinal Obstructions* for a description of the operation to form an artificial outlet for the fæces. Mr. Teale gives the name of Intestinal Fistula to those cases in which the preternatural opening is the result of injury, and restricts the term Artificial Anus to those in which it is really produced *artificially* by the surgeon. Others distinguish by the name of *fæcal fistula* those cases in which a small proportion only of the contents of the bowel makes its escape by the unnatural opening, and apply the term *artificial anus* to those in which the whole, or nearly the whole, of the intestinal matter is so discharged.]

Of all the infirmities which assail the human race, none is more annoying and disgusting than an artificial anus; and, as a modern writer exclaims, what a wretched spectacle does a person exhibit, from whom the bilious alimentary matter and excrement are every instant involuntarily discharged! In vain is the aid of pouches, reservoirs, and boxes, for the palliation of his dreadful affliction; to him society is lost; and he is for ever doomed to live a solitary and miserable life. Such, at all events, was the sentence pronounced by science, until the genius of Dupuytren came to reform, and restore to the world the unfortunate individuals, who seemed to be for ever banished from it. (*Leçons Orales de Clinique Chir.* t. iii. p. 193.)

Excepting in those cases where the preternatural opening is purposely made by the surgeon, an artificial anus is always preceded by an injury of the intestinal canal, either by a penetrating wound, or by ulceration of the bowel, and the bursting of an abscess externally; or by an accidental wound of the gut in the operation for hernia; or, lastly, and most commonly, by mortification of the bowel, the effect of the long continuance of the strangulation of the part.

Foreign bodies, swallowed by mistake, have sometimes irritated the bowel, and caused it to become adherent to the peritoneum lining the parietes of the abdomen; then ulcerative inflammation ensued, followed by fæcal abscess, and a fistulous opening, or true artificial anus. In a few uncommon instances worms, of the lumbrici kind, have caused the same consequences.

All these cases are further divisible into such as are attended with a destruction of a portion of the intestinal tube; and into those which are not accompanied with any such loss of substance.

When once an artificial anus has been formed, it is a solution of continuity produced in the bowel and parietes of the abdomen, which are completely adherent to one another. The opening, in whatever way occasioned, is most commonly roundish, but sometimes of an irregular shape. Its diameter varies from a few lines to an inch or more. In the majority of persons, its edges are thick, depressed, adherent to the subjacent parts, inclined towards the abdominal cavity, and immediately continuous with the mucous membrane of the bowel. A reddish circle denotes the place of their junction. The neighbouring integuments have radiating furrows in them, *en cul de poule*, analogous to what is observed near cicatrices in general; and notwithstanding the most minute attention to cleanliness, the matter evacuated irritates the skin, bringing on an erysipelatous redness, or excoriations of variable depth. (*Dupuytren, Clin. Chir.* t. ii. p. 196.)

Whatever may be the kind of injury which the bowel has sustained, one thing here invariably happens, viz. the adhesion of the two divided portions of the intestine to the edge of the opening in the parietes of the abdomen. This occurrence, which has the most salutary effect in preventing extravasation of the contents of the bowel into the cavity of the abdomen, is produced by the inflammation which precedes gangrene and follows wounds. (See *Œuvres Chir. de Desault,* t. ii. p. 352—354.) In hernia, the adhesions *precede* the destruction of the parts; in wounds, they *follow* the division of the bowel; and hence, in these last cases, the solution of continuity frequently brings on a fatal effusion. The adhesions never ascend far along the extremities of the bowel; which, being only contiguous, and covered by a smooth membrane, as in other parts of them, leave between them a sort of *cul-de-sac,* the entrance of which is towards the belly, while the apex is directed towards the skin. It is into this *cul-de-sac* that, in certain individuals, the abdominal viscera protrude, so as to occasion herniæ; which push the artificial anus outwards, compress, displace, and otherwise complicate it. (See *Dupuytren, Clinique Chir.* t. ii. p. 198.)

When, in strangulated hernia, the case is not relieved by the usual means, or when the necessary operation has not been practised in time, the protruded bowel sloughs; the adjoining part of it adheres to the neck of the hernial sac; and the gangrenous mischief spreads from within outwards. If the patient live long enough, and an incision in the tumor be not now practised, one or more openings soon form in the integuments, and through these apertures the fæces are discharged until the separation of the sloughs gives a freer vent to the excrement. But when an incision is made, the fæces are more readily discharged; and, as Mr. Travers has related, this is sometimes the best mode of relief. "In the ordinary situation of hernia, the portions of intestine, embraced by the stricture, occupy a position nearly parallel. Their contiguous sides mutually adhere; in the remainder of their circumference they adhere to the peritoneum, lining or forming the stricture. The existing adhesion of the contiguous sides, strengthened by the adhesion of the parts in contact, ensures a partial continuity upon the separation of the sphacelated part. The line of separation is the line of stricture. It commences on that side of the gut which is in direct contact with the stricture. As the separation advances, the opposite adhering sides may perhaps recede somewhat, and a little enlarge the angle of union. But, it is ever afterwards an angle; and where the peritoneum is deficient, the canal is simply covered in by granulations from the cellular membrane of the parietes, coalescing with those of the external or cellular surface of the peritoneum." (*On the Process of Nature in repairing Injuries of the Intestines*, p. 360.) It must be confessed, that few surgeons have entertained sufficiently accurate ideas of the changes which happen around the wounded or mortified portion of intestine, when an artificial anus is produced; and though Desault's account was excellent, so far as it went, it was not until the year 1809, when Scarpa published his valuable work on Hernia, that the whole process of nature on such occasions was completely elucidated. The hernial sac (says he) does not always partake of gangrene with the viscera contained in a hernia; and even when it does slough, since the separation of the dead parts happens on the outside of the abdominal ring, there almost always remains in this situation a portion of the neck of the hernial sac perfectly sound. It may be said, therefore, that, in all cases, immediately after the detachment of the mortified intestine, whether it happen within, or on the outside of the ring, the two orifices of the gut are enveloped in the neck of the hernial sac, which soon becoming adherent to them by the effect of inflammation, serves for a certain time to direct the fæces towards the external wound, and to prevent their effusion into the abdomen. In proportion as the outer wound diminishes, the external portion of the neck of the hernial sac also contracts; but *that part, which embraces the orifices of the intestine, gradually becomes larger, and at length forms a kind of membranous, funnel-shaped, intermediate cavity, which makes the communication between the two parts of the bowel.* However, according to Scarpa's investigations, this adhesion of the neck of the hernial sac round the two orifices of the gut, does not hinder the latter from gradually quitting the ring, and becoming more and more deeply placed in the cavity of the abdomen. The base of the above-described funnel-shaped membranous cavity corresponds to the bowel, and its apex tends towards the wound, or fistula.

But, in relation to this part of the subject, there are some other circumstances which every surgeon should well understand. I allude to the exact position of the two portions of the bowel, with respect to each other, the direction of their orifices, the angle or ridge between them, and the difference in their diameters. The first of these circumstances, viz. the position of the two parts of the bowel, was correctly described by Saviard, Morand, and Desault; and, as we have seen, is pointed out by Mr. Travers, who represents them as occupying a position nearly parallel, and cites an interesting observation recorded by Pipelet. The patient was a woman fifty-six years old; the loop of spoiled gut was from five to six inches long: the contents of the bowel were discharged through the wound for a considerable time, and an artificial anus was established. Some accidental obstruction occurred; a purgative was given, which operated in the natural way, and in fifteen days the wound was healed. She lived in perfect health to the age of eighty-two, when she died of a disease not connected with this malady. Pipelet examined the body, and has given a figure representing the union. The line of the intestine formed an acute angle, where it adhered to the peritoneum, opposite to the crural arch. The cylinder is evidently much contracted. Pipelet particularly dwells upon the angular position, and constriction of the tube at the point of union. The lower continuation of the intestinal tube was also remarked to be more contracted than the upper portion; a circumstance correctly referred, by Mr. Travers, to the undilated state of the bowels, situated between the artificial and the natural anus. (See *Mém. de l'Acad. de Chir.* t. iv. p. 164; and *Travers, On Injuries of the Intestines*, p. 364.) The two ends of the bowel, as Scarpa has observed, are found lying in a more or less parallel manner by the side of each other; the upper with its orifice open, and directed towards the external wound by the fæces, which issue from it; while the lower, which gives passage to nothing, becomes less capacious, and is retracted further into the abdomen; or, as Dupuytren observes, the two terminating portions of bowel pass into the abdomen, sometimes crossing, sometimes coiling over one another; in other instances, running parallel; but most frequently diverging at a more or less acute angle. (See *Dupuytren, Clinique Chir.* t. ii. p. 202.) According to Scarpa, the breach in the intestinal canal is never repaired by the orifices of the upper and lower portions of the bowels reuniting, coalescing, and running as it were into each other. Indeed, they meet at a very acute angle; the axis of one does not correspond to that of the other; and their orifices never lie exactly opposite each other. It is, in short, by means of the funnel-shaped cavity, formed by the remains of the hernial sac, that the two parts of the bowel communicate; and the fæces, in order to get from the upper into the lower continuation of the intestine, must first pass in a semicircular track through that funnel-shaped cavity, there being between the orifices of the bowel, *a considerable projection, or jutting angle, forming a material additional obstacle to the direct passage of the fæces from the upper into the lower portion of the intestinal tube.* (*Scarpa sull' Ernie Memorie, Nat. Chirurgische*, Milano, 1809.)

This promontorio, as it was called by Scarpa, or éperon, as it is named by the French, was mentioned both by Saviard and Morand. It consists, in fact, of the part of the bowel which has been spared by gangrene, or a wound, in the direction towards the mesentery; and it advances more or less towards the skin, in proportion as the bowel has experienced a greater or lesser loss of substance, or a greater or lesser change of direction. When the bowel has only been wounded, or the seat of a small slough, and it pursues its natural course, the projection is trivial and concealed; but very large, reaching the level of the skin, when the whole circumference of the bowel has been destroyed; and, in consequence of the loss of substance, its two ends meet at an acute angle, or run parallel to one another. In the first case, there is between the two orifices of the bowel a cylindrical channel, more or less deep, which may still convey matters from the upper to the lower end. This case is most easy of cure. In the other, no trace of such a channel is discoverable; and the jutting angle, the éperon, between the two orifices of the intestine, forms a barrier which the intestinal matter cannot pass. Thus the difficulties are greater, and the resources of surgery less certain. (See *Dupuytren, Clin. Chir.* t. ii. p. 203.) Whatever may have been the original state of this projecting angle, after a certain time it does not divide the bottom of the funnel-shaped tube, where the orifices of the intestine are, into two equal parts; because it is propelled towards the lower portion of the bowel, by the pressure of the matters passing through the orifice of the upper end. By degrees the orifice of the lower end becomes covered by it as by a valve, and is detected with difficulty.

Towards the interior of the bowel, Dupuytren found that the éperon had constantly the shape of a crescent, while towards the cavity of the abdomen the two equal halves of it diverged from one another to receive the mesentery in the interspace. The éperon, therefore, is composed of a single wall only at its sharp edge, and everywhere else it consists of two parietes, leaving between them a triangular interval, which becomes greater as the two portions of the bowel recede from one another in their course into the abdomen. From this latter disposition, says Dupuytren, a fact of the highest importance arises; viz. that the cavities of the two ends of the intestine are separated from one another by a double septum, the surfaces of which, on the side towards the belly, are smooth, and free from all adhesion together. To get, therefore, from one of these cavities into the other, through their parietes, the cavity of the peritoneum must of necessity be pervaded: hence the difficulty and danger in trying to form a communication between the two ends of the bowel by attacking the septum between them. (See *Dupuytren, Clinique Chir.* t. ii. p. 204.)

Another interesting circumstance, explained by Dupuytren, is, that the jutting angle, and double septum, the continuation of it, are not invariably so fixed as to be totally incapable of advancing or receding; but, being connected with the mesentery, they are, in a certain degree, obliged to follow the movements communicated by it to them. Sometimes, when hernia is combined with adhesions, the mesentery, which becomes elongated, and forms a cord between the spine and the displaced bowel, keeps the trunk immutably bent forwards. In cases of artificial anus, the end of this cord, corresponding to the intestine, is attached to the bottom of its angle on the side towards the belly, precisely at the base of the éperon interposed between the two orifices. Hence the éperon, and the bowel terminating at it, must be continually drawn towards the cavity of the abdomen by the mesentery: and thus we may discern how the motion and posture of the trunk backward should have a favourable influence in promoting a spontaneous cure. Sometimes, however, the tension of the mesenteric cord ruptures the adhesions of the ends of the bowel to the parietes of the abdomen, and causes a fatal effusion of intestinal matter within the peritoneum. Long after the spontaneous cure of an artificial anus, the effect of this action of the mesentery may be to separate the bowel completely from the parietes of the abdomen, and restore it to its free and floating condition again. Dupuytren ascertained this fact by *post mortem* examinations; a fact, which he would have had difficulty in crediting, if he had not been perfectly certain of the identity of the individuals, and had not detected in each of them a fibrous cord extending from the point of the parietes of the abdomen, corresponding to the former artificial anus, to the bowel. (See *Clinique Chir.* t. ii. p. 206.)

It is then in the deeper part of the funnel-shaped tube, which, as we have seen, lies between the opening in the skin and the bottom of the artificial anus, that the most remarkable and important dispositions of an artificial anus are placed. Here are situated the orifices of the two ends of the intestinal canal, and the septum between them. Of these two orifices, one belongs to the upper part of the bowel; and, being always pervaded by alimentary matter, or fæces, is the freer and larger; the other is continuous with the lower portion of the bowel; and since it transmits no alimentary nor fæcal matter, or only trivial quantities, it is usually narrow, contracted, and not readily detected.

[The intermediate funnel-shaped cavity, described by Scarpa, being formed by the remains of the hernial sac, is of course only met with in those cases of artificial anus which result from strangulated hernia. When the affection is produced in any other way, there is no cavity of this kind, and consequently, the two orifices of the bowel and the projecting septum are then much nearer the surface, and the contents pass more directly from the upper orifice at once out at the wound. The presence of the intermediate cavity is, in many instances, of great utility in promoting a spontaneous cure; for if the intestinal matters, after they have passed from the upper portion of the bowel into this cavity, can re-enter its lower portion more readily than they can escape by the fistulous opening on the surface, the latter may gradually contract and close, and a natural cure be effected. In such a case the lost portion of intestine is in fact replaced by the remains of the hernial sac. It may be stated, therefore, that, *cæteris paribus*, there is a greater probability of the intestinal matters resuming their natural course without surgical interference, in artificial anus from hernia, than in artificial anus from other causes.]

Desault, after noticing the efficiency of the adhesions, between the injured part of the bowel and the edge of the opening in the parietes of the abdomen, in preventing extravasation, remarks, that if such adhesions were entire, the abdominal parietes would form a substitute for the portion of the canal which has been destroyed, and the contents of the bowel would continue to pass, as usual, towards the anus, were it not that the portions of the intestine separated and adherent to the neighbouring parts, form such an acute angle as obstructs the passage of the intestinal matter. The more acute this angle is, the greater is the obstruction; when the two parts of the bowel lie nearly parallel, the entrance into the lower portion of the canal is completely prevented; but if they meet at a right angle, then more or less of the contents of the upper portion may be transmitted into the lower. The first disposition chiefly happens when a considerable part of the intestinal canal has been destroyed, or when the tube has been completely divided; while the second is principally remarked in cases where the injury has been less extensive. And it is plain that the possibility of a cure depends materially on the kind of angle at which the two portions of bowel meet, and that the projection of the internal frænum, or jutting membranous ridge between the two orifices, is always a greater or lesser obstacle to the cure.

With respect to the diminution which occurs in the diameter of the part of the intestinal canal, between the artificial opening and the natural anus, Desault admits the correctness of the observation, but entirely dissents from such authors as have spoken of the change as sometimes proceeding so far that an obliteration of that portion of the intestinal tube is the consequence. The mucus secreted within it suffices for preventing this obliteration ; a secretion which, in these cases, is copious, and is partly voided from the rectum in the form of white flakes. And, if any further proof were needed that the bowels between the artificial and natural anus remain pervious, it is furnished by the fact, that, in cases of artificial anus, the lower continuation of the tube frequently becomes inverted, and protrudes. On the other hand, the kind of obliteration above spoken of has never been demonstrated by dissection: it was not observed by Lecat, in the examination of the body of a person, who died twelve years after the entire cessation of the passage of fæces *per anum;* nor was it found to exist by Desault, when he opened a patient who died of marasmus in the Hôtel Dieu, in consequence of an artificial anus, which communicated with the ileum, and had lasted two years. (*Œuvr. de Desault*, t. ii. p. 354—356.

It is true, then, that the lower portion of the intestinal canal undergoes a kind of atrophy, but, perhaps, is never obliterated or rendered quite impervious. Such atrophy, according to Dupuytren, extends to the corresponding part of the mesentery and mesenteric glands ; and after some years, such is the difference between the upper and lower parts of the intestinal tube, that while the former seems to be that of an adult, the other looks as if it belonged to a new-born infant. (*Clinique Chir.* t. ii. p. 210.)

I believe the only case, forming an exception to the assertion of Desault, that the lower portion of the intestinal canal is never obliterated, is that met with by M. Bégin, in the Val de Grace. It was that of a man, eighty years of age, who, for forty years before he died, had been afflicted with artificial anus, communicating with the transverse arch of the colon. The intestine below the artificial anus was transformed into a solid cord, not larger than a quill, until it approached the anus, when its diameter increased, and its solidity lessened. Here it contained also a whitish mucus ; and in other parts was only capable of admitting a small probe, except for the space of six or eight inches towards the artificial anus, where its cavity was totally obliterated. (See *Dict. de Méd. et de Chir. Pratiques*, t. iii. p. 133.)

However proper the formation of an artificial anus may be in many cases in which the patient's life depends upon the event, it must be confessed that the consequence is a most afflicting and disgusting infirmity. This truth cannot be denied, though the fæces which are discharged, from not having been so long retained in the bowels, may not be so fetid as those which are evacuated in the ordinary way. As the opening which gives vent to the excrement, is not endowed with the same organisation as the lower end of the rectum, and as, in particular, it is not furnished with any sphincter capable of contracting and relaxing itself, as occasion requires, the fæces are continually escaping without any knowledge of the circumstance on the part of the patient. Hence the uncleanly state of the parts around the external opening, and their frequently excoriated fungous state. Some persons in this state, among the number of those whose histories are on record, made use of a metal box, in which their excrement was received. Schenckius relates the case of an officer who was wounded in the belly, and who allowed his fæces to escape into a vessel made for the purpose. Dionis mentions a similar case. Moscati also communicated to the Academy of Surgery the history of a wounded man, in whom an artificial anus took place in consequence of a wound in the abdomen below the right hypochondrium. His excrement used to be received in a tin box, fastened to him with a belt. The wound received a leaden canula, to which the tin box was accommodated.

Uncleanliness is not the only inconvenience of an artificial anus. Persons have been known to be quite debilitated by the affliction, and even ultimately to die in consequence of it. This is liable to happen, whenever the intestinal canal is opened very high up, so that the aliment escapes before chylification is completed, and the nutritious part of the food has been taken up by the lacteals. In this circumstance the patient becomes emaciated and sometimes perishes, as Desault had an opportunity of observing ; and examples of which are also on record by Hoin and Le Blanc. In cases of this description, the matter voided has little fœtor, and is frequently sourish. In all instances, the matter is evacuated involuntarily, because there is nothing like a sphincter. But when the opening only communicates with the lower convolutions of the ileum, or, what is more frequent, with the large intestines, the danger is less serious, and patients in this state are often noticed performing all their functions very well ; and, with the exception of colic, to which they are subject, enjoying as good health as they did previously to their having the present disease. In such examples, the matter voided is more fetid, its discharge does not follow so quickly its introduction into the stomach, and it is retained for a longer time.

On this part of the subject, the investigations of Dupuytren led to some interesting information, which was, that the upper or stomachic portion of the intestinal canal not only preserves its calibre, motion, and natural appearance, but, in consequence of having an increased duty to perform, it acquires an increase of capacity, and becomes the seat of a more energetic circulation, as well as of more active secretion and absorption. This excess of life, says he, is propagated even to the mesentery and its glands.

In cases of artificial anus, the regular convolution of the bowels, so favourable for the advance of their contents, are immediately affected at some point or another. A noose of intestine is elongated, and drawn towards the breach in the parietes of the abdomen ; it assumes the form of a triangle, the base of which is the mesentery, while one side is the stomachic portion, the other the anal continuation of the intestine. In every simple hernia, we see the difficulty occasioned to the free course of the intestinal matter, by the deviation of the bowel from its regular and uniform curve, and its assuming an angular direction. Besides, as Dupuytren has admirably explained, the bowel being, in cases of artificial anus, fixed by adhesions to the parietes of the abdomen, this state not only resists the motions of the digestive tube, but it makes the adherent portion of the bowel a fixed point, towards which all the efforts of the intestinal canal are concentrated, and towards which its contents are incessantly directed: whence a true acceleration of them from the stomach to the artificial anus. A still more serious inconvenience is the shortening of the track which they have to pass. Their lodgment in the intestinal canal being abridged, their digestion remains incomplete, and the absorption of their nutritive principles is performed with less precision. Then nutrition is impaired, and the exhaustion threatens to render the continuance of all the organic functions impossible. (See *Dupuytren, Clinique Chir.* t. ii. p. 213.)

Many patients, afflicted with an artificial anus, void no fæces at all from the rectum; but, occasionally, a thick whitish substance, which is the mucous secretion of the portion of the large intestines nearest to the anus. Under certain circumstances, the quantity of this mucous discharge is more copious. (*Desault*, vol. cit. p. 359.)

Another disagreeable occurrence, to which persons with an artificial anus are exposed, is a prolapsus of the bowel, similar to what sometimes happens through the anus with respect to the rectum. The descent of the bowel is sometimes simple, only affecting a portion of the intestinal canal just above, or below, the opening. On other occasions, the complaint is double, the bowel both above and below the opening being prolapsed. This descent of the intestine forms a tumor, the dimensions of which vary considerably in different subjects. Instances have been known of its attaining the length of sixteen or eighteen inches, or even two feet. (*Dupuytren, Clinique Chir.* t. ii. p. 200.) The surface of the prolapsus is reddish, like that of the inside of the intestine, though discoloured by the irritation of exposure to the air. When it has been of long continuance, the mucous membrane becomes dense and solid, covered with a thin dry cuticle, and assumes the characters of cutaneous texture. (See *Dupuytren,* vol. cit.) When the protrusion is caused by the upper part of the intestinal canal, the fæces are voided at the extremity of the tumor; and when the swelling consists of the lower portion of the bowel, the excrement is evacuated at the base of the prolapsed part. By observing this evacuation, when the tumor is double, it is easy to know to which end of the intestinal canal each protruded portion belongs. This consequence of an artificial anus is very serious, because it greatly increases the inconvenience which the patient suffers. Sometimes the tumor is exquisitely sensitive; and, occasionally, when the eversion of the intestine is considerable, a strangulation is produced, which puts the patient's life in danger.

An artificial anus, particularly that formed by the destruction of the whole calibre of the bowel, rarely continues a simple fistulous opening, but almost always becomes complicated with a prolapsus of the intestine, the interior of which becomes everted as well as protruded. This happens with greater facility, in proportion as the intestine is less fixed in the cavity of the abdomen. The protrusion is more considerable, in proportion as the efforts of the patient at stool are greater; and it is the more afflicting, the older the artificial anus is. The prolapsus, or protrusion of the lower end of the bowel, is less common than that of the upper; it is not so voluminous; and seems to be occasioned by the antiperistaltic movements which propel the mucous secretion of the lower part of the intestinal canal towards the artificial anus. (See *Dupuytren, Clinique Chir.* t. ii. p. 199.) These tumors are usually of an elongated conical shape, with the apex in the integuments, and a depressed aperture in the base, whence is discharged stercoraceous matter, if the prolapsus be connected with the upper portion of the bowel; and mucus, or even the fluid of clysters, if connected with the lower.

The following interesting case of artificial anus, complicated with prolapsus, is recorded by Mr. Lawrence.

"The patient, sixty years of age, has voided all his stools through the groin for about seventeen years, and still retains the external appearances of health and activity. His complaint was a scrotal hernia of the size of a pigeon's egg, before the occurrence of the strangulation which ended in mortification. The testis of the same side, and a large portion of the surrounding integuments, were involved in destruction with the hernia. He had never worn a truss, nor taken any measures to obviate the inconveniences arising from the discharge of his fæces, except that of keeping always a quantity of tow in his breeches."

"A prolapsus of the intestine has taken place through the artificial opening. The projecting part varies in length and size at different times. It was four inches long when I saw it; and the basis, which is the largest part, measured nearly six inches in circumference. This prolapsus never recedes entirely, but is sometimes considerably smaller. It has occasionally protruded to the length of eight or ten inches, being at the same time equal in size to the forearm, and bleeding copiously. This is attended with great pain, and only happens when the bowels are much disordered. Warm fomentations and a recumbent position relieve in this case, by causing the gut to return."

"The prolapsus is of a uniform red colour, similar to that of florid and healthy granulations. The surface, although wrinkled and irregular, is smooth and lubricated by a mucous secretion. It feels firm and fleshy, and can be squeezed and handled without exciting pain: it approaches on the whole to a cylindrical form, and its anterior loose extremity, which is of circular figure, contains a roundish depressed opening, through which the stools are voided. The basis of the swelling is continuous on all sides with the integuments, and I could discover no opening of the lower end of the gut. This person does not possess the slightest power of holding the stools. They are often voided suddenly and without giving him any notice. When the fæces are fluid, which is generally the case, they come away repeatedly in the day, and are discharged with considerable force; but when they are of a more firm consistence, there is not more than one stool in two or three days, and their expulsion requires much straining. At these times their size is not greater than the little finger."

"Whenever he retains his urine, after feeling an inclination to void it, a quantity of clear inoffensive mucus, like the white of an egg, amounting to about four ounces, is expelled from the anus; and this may occur two or three times in the day."

"When he is purged, the food frequently passes with little alteration; this he has noticed particularly of cucumber. He experiences great weakness at such times. Ale will sometimes pass off in five minutes from the time of drinking, having apparently undergone little or no alteration. The bowels are strongly affected by slight doses of purgatives." (*Treatise on Hernia,* 5th ed. p. 416.)

Should the protruded intestine become strangulated, an operation may be necessary for the removal of the stricture. (*Schmucker, Vermischte Chirurgische Schriften,* t. ii.) Two cases, which terminated fatally from this cause, are mentioned by Sabatier, in a memoir in the 5th tome de l'Acad. de Chir. Mr. Lawrence also refers to Le Blanc. (*Précis d'Opérations de Chir.* tom. ii. p. 445.) We should always endeavour to prevent such protrusions, when a disposition to their formation seems to exist, by the use of a steel truss, which should, indeed, be worn by the patient, independently of this circumstance. If the tumor has become irreducible by the hand, an attempt may be made to replace it by keeping up a constant pressure on the part, the patient being at the same time confined to bed. (*Lawrence,* op. cit. p. 421.)

By these means, Desault returned a very large prolapsus; and by pressure on the opening, the fæces were made to pass entirely by the anus, although for four years they had been voided only through the wound. (*Parisian Journ.* vol. i. p. 178.)

In cases of artificial anus, the appearance of the mucous coat of the bowel undergoes some change, in consequence of exposure to the air on the contact of extraneous bodies; it becomes redder and less villous; but does not cease to secrete a great quantity of mucus: this is one of the principal reasons why it is so difficult to close the fistulous opening, even when the passage for the fæces has been restored. The skin around an artificial anus is also generally very irritable, and rendered exceedingly painful by the contact of the excrement. (*Breschet,* in *Graefe's Journ.* b. ii. p. 303.)

With respect to the prognosis, it is universally agreed, that *cæteris paribus,* an artificial anus is more dangerous the nearer it is to the stomach, for reasons already explained. An opening produced by injuries of the cæcum, colon, or rectum, has scarcely any effect on that part of the digestive function termed assimilation. The risk is also in some measure greater, in proportion as the quantity of intestinal matter voided from it is more considerable. The prognosis is more favourable, when the two orifices of the bowel are readily found at the bottom of the artificial anus, than when only the orifice of the upper end is discoverable. Lastly, the more free an artificial anus is from complications and accidental ill consequences, the less is the patient the subject of annoyance and danger. (See *Dupuytren, Clin. Chir.* t. ii. p. 223.)

Treatment.—The treatment of an artificial anus is either palliative or radical. The first consists in obviating the habitual uncleanliness produced by the involuntary discharge of the intestinal matter, and in relieving any unpleasant symptoms present.

The first indication is fulfilled by the employment of silver, or tin machines, which are either kept applied to the external opening by means of a spring, or form receptacles placed more or less distant from the artificial anus, from which the intestinal matter is transmitted through a tube, kept constantly in the opening. In general, says Desault, as elastic gum is supple, light, and capable of taking any shape, it is the best material for the construction of such instruments, which, however, rarely answer their purpose completely.

An instrument of this kind, the construction of which appears very perfect, is delineated by Juville. (*Traité des Band. Herniaires,* sect. viii. pl. vii. and viii.) An ordinary inguinal truss is made with an ivory pad, perforated in its middle, so as to fit the opening. A tube of elastic gum, furnished with a valve opening downwards, leads from this perforation to a receiver of silver, which is attached by a screw to the lower end of the tube, and lies against the inside of the thigh. The silver vessel may be unscrewed and emptied without disturbing the rest of the instrument. It has been found, in some instances, that a common elastic truss, with a compress of lint under the pad, has been more serviceable than any complicated instrument in preventing the continual flow of fæculent matter from the artificial opening. (*Treatise on Hernia,* 5th ed. p. 388.)

Richter, with the view of hindering the too quick escape of the intestinal matter, and the death of the patient from this cause, proposed covering the opening for a certain time with a piece of sponge, supported by an elastic bandage, or truss. But Loeffler found this method objectionable, as it was apt to bring on colic, constipation, and an inflamed excoriated state of the skin.

When the outer opening is disposed to contract too much, and *inconveniences arise from this change,* Sabatier is an advocate for preventing such closure by means of a tent, or skein of silk, introduced into the aperture, and changed very often for the sake of cleanliness; while others prefer a ring of ivory for the purpose. But the irritation produced by the matter imbibed by this sort of tent, and in particular the liability of the bowel to protrude, and be strangulated in the opening of the ivory ring, are found strong objections to these practices. Desault preferred a linen tent, compress, and bandage.

The investigations of Scarpa and Dupuytren fully prove, that the causes of the discharge of the intestinal matters through an artificial anus, and the obstacles to their resuming their natural course, and to a radical cure, depend, — 1st, Upon the adhesion, angular direction, and fixed condition of the bowel. 2nd, Upon the loss of substance which it has sustained, and the consequent contraction of it. 3rd, Upon the jutting angle (*éperon*) and the double septum between its two orifices. These obstacles, great as they may be, are sometimes overcome by nature and art. Loss of substance is indeed irreparable; but amends for it may be made in certain cases by a dilatation of the calibre of the bowel. Its adhesion to the parietes of the abdomen may also become less close, or even so loosened as to let the bowel assume a position and direction more favourable for the re-establishment of the course of its contents. The projection, formed by the *éperon* and double septum, may also be lessened by being continually dragged by the mesentery, and subjected to the effort of the intestinal matter to get from the upper into the lower portion of the bowel. A rich full diet is recommended by M. Louis, for the purpose of gradually enlarging the communication between the two portions of bowel: purgatives, administered with the view of forcing the obstacles to a free communication ; the introduction of tents, the size of which is gradually increased, in order to dilate the contraction between the two parts of the intestine: the movement and position of the trunk backward, advised by Dupuytren to render the mesentery tense, and to efface the projecting angle and the septum continued from it ; compression of the external opening, practised from time immemorial, to hinder the intestinal contents from escaping outwards, and obliging them to pass by the natural way, — are all, as Dupuytren observes, so many resources, which, employed singly or unitedly, have accomplished many cures. (See *Clinique Chir.* t. ii. p. 225.)

But everybody must agree with this distinguished practitioner, that, previously to attempting to cure the principal disease, all accidental complications should be removed ; as an indurated or inflamed state of the skin, extensive sinuses, or a prolapsus of the intestine. The latter, according to Dupuytren, is easily obviated by keeping the patient a few days on his back, and having recourse to the taxis with gentleness, and moderate steady compression. Almost all artificial ani, attended with a simple perforation of some point of the circumference of the bowel, are set down by Dupuytren as curable. These cases are in reality but stercoraceous fistulæ, behind which the intestinal canal is almost entire, without loss of substance, or any manifest contraction, or material change of direction. Here nature is disposed to close the accidental opening, and her efforts, assisted by moderate compression, are mostly successful. But Dupuytren explains that this simple treatment will not answer when the artificial anus has been produced by the destruction of a third or a half of the circumference of the bowel, for an extent varying from a few lines to an inch. Yet here, the loss of substance, the changed direction of the intestine, and the jutting angle between the two portions of it, are not so considerable as to prevent the restoration of the natural passage for the intestinal matter from being brought about by suitable treatment. Nay, he adds, that cases are not absolutely incurable by the plans above adverted to, even when the artificial anus was the consequence of a loss of substance, involving two-thirds or three-quarters of the circumference of the bowel, with a proportionate length of it. But when the loss of the substance amounts to four-fifths, or the whole of the circumference, with or without the inclusion of a piece of the mesentery, such methods will not avail. Here the diminished calibre of the bowel, its altered direction, the jutting angle, and the double septum, present themselves in the strongest manner as invincible impediments to the re-establishment of the natural course of the alimentary matter ; and, as Dupuytren further remarks, pressure, which, when made with precision, is the most effectual means of closing the outlet, immediately brings on colic, nausea, hiccough, vomiting, and all the symptoms of strangulated hernia.

When, therefore, the whole, or the greater part, of the stools is discharged by an artificial anus no attempt must be made to stop up the opening, without a great deal of consideration; for any effort of this kind, made under circumstances which do not justify it, may be the means of exposing the patient's life to the most alarming danger. Sometimes, indeed, without any interference of the surgeon, the outward opening contracts, and, the issue of the intestinal matter being obstructed, pain and tenesmus are excited ; and the same consequences may be produced by any swelling and enlargement of the projecting ridge situated between the two portions of the bowel. In two cases, Puy found this swelling take place in such a degree, that the patients fell victims to the complete stoppage of the intestinal contents. The symptoms which arise are then similar to those which happen in strangulated hernia. Hoin, Le Blanc, and Sabatier, also cite instances, in which the patients lost their lives by gangrene, brought on by this species of strangulation. (*Desault*, vol. cit. p. 360.)

There is a period (says Mr. Travers) at which the function of the lower portion of the canal, with a little assistance, may be restored. The natural order of events, connected with this recovery, has been mistaken and inverted. Practitioners have closed the wound, instead of conducting the matter by purgatives and clysters into the large intestines. Now, the wound will never fail to heal, when the matter recovers its accustomed route ; but this condition cannot be reversed. The restoration is safest when most gradual; when there is evidence of an existing sympathy between the repair of structure and the return of function. According to the same gentleman, there is reason to believe that the well-timed exhibition of a single purgative might often prove effectual. "If the food is rapid, and little changed in its passage, it should be pultaceous and nutritive, and given in moderate quantity at short intervals ; while injections of the same kind should be administered at least twice in twenty-four hours, and retained as long as possible." He states, that by such means patients may be nourished for many weeks. If the discharge is sparing, and does not readily escape, he recommends an occasional purgative in less than ordinary quantity. He disapproves of other medicines, especially stimulants, and all such food as is difficult of digestion, giving a general preference to animal food in a gelatinous form. He bestows just praise on strict attention to cleanliness ; and, in opposition to Desault and Sabatier, condemns the employment of tents and sponges. (Op. cit. p. 371, 373.)

Numerous cases on record furnish abundance of proofs that the fæces, after being voided for several months from the wound produced by the operation for hernia, frequently resume their natural course. Facts of this kind, which, in general, may be said to be common when the intestine is without loss of substance, are not very rare even when more or less of the bowel has been destroyed by gangrene ; and many illustrations of this remark may be found in the writings of De la Peyronie, Louis, Petit, Pott, Le Dran, &c. Several such cases have fallen under my own observation. The greater number of these instances of success, as already stated, were the result of the most simple unofficious treatment, or rather of the undisturbed and very little assisted efforts of nature.

[In an excellent article in the *Cyclopædia of*

Practical Surgery, by Mr. T. P. Teale, headed *Intestinal Fistula*, this statement is fully corroborated. Mr. Teale gives a table exhibiting eleven cases, taken indiscriminately, in which the fæculent discharge following gangrenous hernia spontaneously ceased. In eight of these cases, the time when the cessation occurred is specified, and is found to vary from thirteen to seventy days; or on the average to be thirty-nine days. The quantity of intestine destroyed is not in all the cases noted; but in some of them the gangrene must have implicated a few inches of the tube; and in an instance related by Scarpa, a long loop of intestine was lost. (*Cyclop. of Pract. Surg.* vol. ii. p. 194.)

Mr. Teale gives further tables, showing thirteen cases of penetrating wounds of the abdomen, attended by fæcal discharge, only two of which were followed by permanent intestinal fistulæ; the remaining eleven closed spontaneously: also ten cases of gun-shot injury of the intestine, in eight of which a perfect cure took place without interference. The remaining two were followed by permanent fistulæ, but in each of these the loss of substance was considerable, and in consequence of the absence of the membranous funnel, formed by the sac in cases of mortified hernia and the retraction of the divided extremities of the intestine which this structure has been shown to promote, the natural powers of nature were inadequate to restore the continuity of the canal. Both these cases, however, were cured by the introduction of linen tents, after the manner of Desault, which will be next referred to.]

According to Desault, the most frequent impediment to the restoration of the natural course of the intestinal contents, is the angle formed by the two portions of the intestine; and, says he, it must be enlarged, and rendered less acute, in order that the fæces may continue their route. This desirable change he recommends to be effected by introducing long dossils of charpie into the two ends of the bowel, and gradually altering their direction so as to bring it into a straight line. When the dilatation is sufficient, and the inner angle, or ridge, is effaced, the long dossils need not be continued. The linen tent, with the precaution of not introducing it too deeply, lest it obstruct the course of the fæces, will then suffice. When this plan is skilfully managed, Desault says, there will be a great chance of its succeeding, and its beneficial effect will be denoted by a rumbling in the bowels, and frequently by slight colics. At first, wind is discharged from the rectum, and, soon afterwards, the fæces begin to come away. On the contrary, if they should not pass with facility, the colic be violent, and an accumulation happen in the upper portion of the intestinal canal, the tent must be withdrawn, and any other cause of obstruction be considered, and, if possible, removed. (Vol. cit. p. 365, &c.)

[By this method Desault succeeded perfectly in a very unpromising case, which has been already alluded to, accompanied by a prolapsus nine inches in length, although no fæces had passed per anum for more than four years. After four days he succeeded in returning the prolapsus; the linen tent was then introduced, and in a few hours fluid fæcal matter passed by the rectum. The evacuations were very numerous during the night and for the three following days; but they gradually became thicker and diminished in number. The linen tent was discontinued on the eighth day, and the opening was closed by lint and compresses supported by a truss with a broad and flat pad. This plan entirely prevented the escape of fæcal matter by the wound. The fistulous opening remained, but a very trivial serous exudation could scarcely be said to stain a small piece of lint placed upon it. (*Œuvr. Chir.* tom. ii. p. 370, and *Parisian Journ.* vol. i. p. 178, also quoted at length by Lawrence, 5th ed. p. 390. For a somewhat similar case from Scarpa, see also Lawrence, p. 422).]

From a calculation made by Dupuytren, it appears that artificial ani, capable of spontaneous cure, or of one produced by the means already specified, are, in comparison with the examples which obstinately resist such treatment, as three to one. (See *Clin. Chir.* t. ii. p. 223, 229.) It was for these latter cases that Dupuytren devised a method of cure which reflected upon him the highest credit, and which I shall now proceed to describe.

In the preceding columns, I have given a full explanation of the impediment made to the passage of the fæces into the lower orifice of the intestinal canal, by the projecting septum, or ridge between the two parts of the bowel, and the matter having sometimes to traverse the funnel-shaped membranous cavity in quite a semicircular track. A representation of this septum may be seen in Scarpa's work, tab. 9, fig. 1; and in the sixth plate of Mr. Travers's Inquiry. (See also *Bourgéry, Med. Opér.* tom. ii. pl. 33.) In one example in which this septum was plainly visible in the wound, Dupuytren introduced into the orifice of the upper part of the bowel a curved needle; and, passing it through the projecting septum, brought it out again through the orifice of the lower portion of the gut. Thus, he included a considerable part of the septum in a ligature, which was daily made tighter, with a view of first exciting inflammation in the two layers of this septum, and thus ensuring their adhesion together; and his next plan consisted in making a division through the part embraced by the ligature, whereby the passage for the fæces into the lower portion of the bowel was made quite free. But, as the section made by the ligature was too superficial, Dupuytren completed the division of the septum with a knife; but peritonitis and the death of the patient ensued. According to Dr. Breschet, the ligature also proved ineffectual; because its operation was so slow, that adhesions and cicatrisation took place behind it as fast as it made its way through the rest of the septum. Hence, the expectation that the fæces would sufficiently pass through the aperture made by the ligature was not realised; and in one case quoted by Breschet, though some amendment followed the operation, still the cure was far from being accomplished, as only some of the fæces passed out of the natural anus, while the remaining and greater part of them still came through the fistula. (See *Graefe's Journ.* b. ii. p. 300; also *Clinique Chir.* t. ii. p. 233.) In another case Dupuytren tried to render the layers of the septum adherent by compressing them between the blades of a pair of forceps of particular construction; and afterwards he effected the division of the part by augmenting the compression, by means of a screw traversing the handles of the instrument. In a case which followed the operation for bubonocele attended with mortification of the bowel, Dupuytren began with dilating the outer opening with a bistoury; and after ascertaining the position of the septum between the two orifices of the bowel, he introduced one of the blades of the forceps into each portion of the gut, and closed the instrument with the screw. The part of the instrument situated externally to the ridge, or septum, he covered with charpie and a compress. The constriction was soon followed by colic pains, and tendency to vomit, complaints which were quickly removed by fomenting the belly. They recurred, however, the instrument became loose, and some discharge ensued. On examination, the septum was found to be partially divided. After the breadth of the instrument had been lessened it was applied again; but when the screw was turned the patient began to suffer such violent pain over the whole of the abdomen, that it was necessary to diminish the pressure; and as the instrument was afterwards separated from the parts in a fit of vomiting it was withdrawn. A trial was now made to determine the fæces towards the rectum by pressure on the external opening; but the plan could not be endured, and the hindrance to the egress of the intestinal matter was so oppressive that it was discontinued. As the forceps used on the foregoing occasion did not take sufficient hold of the septum, nor divide it properly, the instrument was somewhat altered. A particular description of its improved make has been inserted by Breschet in *Graefe's Journal*, b. ii. p. 302; and likewise in t. ii. of *Dupuytren's Clinique Chir.* p. 248, where it is termed *enterotome.* Dr. Reisinger published three cases in which it was successfully employed by Dupuytren. In the first of these examples, when the instrument had been applied, it embraced the septum so well, that it could not be displaced from it. The colic attacks, vomiting, thirst, furred tongue, and loss of appetite, which ensued, soon gave way after the belly had been fomented; the constriction was then increased, and found to produce less and less indisposition. After a few days very little of the fæces came out of the artificial anus; and five natural evacuations took place. The blades of the instrument were now completely closed, and on taking it out a slough of membrane was found between the blades; a proof that the septum was destroyed. On the next day the patient's health was undisturbed. Clysters were now administered, with the view of promoting evacuations in the natural manner; and the next day the patient had a proper motion, without any assistance, and a very small quantity of the fæces passed out of the fistulous opening. This aperture was now merely covered with charpie; but, as some high granulations were rising, the powder of colophonium was sprinkled upon them, and compresses and a bandage were applied. The use of clysters was also daily continued, though the patient voided his fæces in the natural way. On discontinuing the external pressure, the quantity of discharge from the fistulous opening increased; and, therefore, on the 1st of October, the compresses were again applied, and kept on the part with a spring truss. The treatment ended in a perfect cure.

In another case, Dupuytren enlarged the lower angle of the outer opening with a bistoury; and after feeling with his finger that both orifices of the bowel were close to that opening, he applied the forceps. In the evening, the constriction was increased, which was followed by severe colic pains over the whole abdomen. They subsided, however, the following day. From the outer opening, a great deal of slimy excrement was discharged. The constriction was not augmented. On the fifth day, the patient was attacked in the night with pain and vomiting. The following night he was also very restless. Though the belly was not tense, it could not bear to be touched. On the eleventh and twelfth days, the patient was free from pain; and, by means of clysters, two natural motions were procured; and on the fourteenth, as the patient was easy, Dupuytren began to make pressure on the fistulous opening. On the twenty-sixth, the edges of the aperture were touched with lunar caustic; and on the twenty-eighth a compress supported by a spring truss was applied. The patient was kept constantly in the horizontal posture; the fæces began to be voided the natural way regularly, and the opening contracted in the most favourable manner.

I think the generality of surgeons will agree with Dr. Reisinger, that the foregoing treatment cannot be indiscriminately adopted, in all descriptions of patients, without danger. It should never be tried too soon after the formation of an artificial anus; but time should be allowed for the irritability and sensibility of the gut, and especially of the septum, to be lessened by the effect of the air and the pressure of the fæces. Nor should the trial ever be made ere it has been fully ascertained that nature cannot herself bring about the cure. Breschet mentions an example, in which the foregoing method could not have been practised, in consequence of the mouth of the lower portion of the bowel having been obliterated by the pressure of a large tent, three inches long, which had been worn by the patient two years, and the projecting ridge could not be detected. (See *Graefe's Journ. de Chir.* b. ii. p. 298.) Many other interesting observations on this proposal may be perused in the memoir by Dr. Breschet, in Dr. Reisinger's tract, the title of which is given in the list of works at the end of the present article, and in *Dupuytren's Leçons Orales,* &c. t. ii. In order not to incur the risk of extravasation of the fæces in the abdomen, the constriction of the septum should never be increased with imprudent haste, before the adhesive inflammation has had time to be produced between the two layers, of which that part is composed.

The following general directions were given by Dupuytren for the management of these cases:— 1. The two ends of the bowel must be detected. 2. The septum between them divided. 3. The external opening healed up.

The lower end of the intestine he frequently found very difficult to make out. In old cases very often neither the angle (éperon), nor th lower portion of the bowel, can be discovered and it seems as if there was only one passag leading to the fistula. The other, partly obliterated and retracted within the belly, has an orifice s concealed, that, unless accidentally entered by probe, its detection is almost impossible. The the relation of the two portions of intestines t one another, Dupuytren found remarkably ir constant. The stomachic portion, according t the kind of case, may be superior or inferior, external or internal. When the artificial anus communicates with the great intestine, he considers clysters amongst the best means of discovering the orifice of the lower continuation of the intestinal canal. In very difficult cases, he sanctions the use of a plug, purgative clysters, and a very full diet. (See *Clinique Chir.* t. ii. p. 265.)

The two ends of the bowel being ascertained, the operation must not be performed if the mucous coat of the bowels, the peritoneum, or other organs be the seat of acute or chronic inflammation. The patient is to be prepared by a suitable, mild, antiphlogistic plan.

In the operation the patient is to lie upon his back. The surgeon takes one of the branches of the *enterotome* in the right hand, and guides it, if requisite, with the left forefinger, to one of the orifices of the bowel, to the depth of one, two, three, or four inches, according to circumstances. An assistant then takes charge of this first part of the instrument. The other branch is then introduced into the other end of the bowel in the same manner. Both branches are then brought together, and joined like a pair of forceps. The blades are then made to grasp the bowel by pressing the handles together. The pressure is next regulated and maintained by means of a screw. Before the expiration of the first day, the pressure is to be increased sufficiently to kill the portion of intestinal tunics embraced by the instrument; and the pressure is to be again augmented every second day, to render its destruction still more certain. In the cases under Dupuytren, the instrument was detached between the seventh and tenth day, bringing away with it the destroyed jutting angle and septum, which prevented the upper portion of bowel from communicating with the lower. Frequently the first signs of the re-establishment of the natural passage precede the detachment of the enterotome. In all cases, slight colic occurs, the evacuations are at first white and albuminous from the lower bowels, and these are followed by stercoraceous matter from the upper ones. At first they are numerous and liquid, and attended with gripings; but they soon become of proper quality, and all uneasiness subsides. (See *Dupuytren*, in *Clin. Chir.* t. ii. p. 264, &c.)

If, after the destruction of the septum, and the re-establishment of a free communication between the two portions of the bowel, the external fistula were not to admit of being healed by pressure and other ordinary means, no doubt could be entertained of the propriety of resorting to the plan of attempting to cure it by paring off the edges and bringing them together with sutures, as was sometimes done by Dupuytren; or on Taliacotian principles, as successfully exemplified by Mr. G. F. Collier. (See *Med. and Physical Journ. for June*, 1820.) Dupuytren, for the purpose of making the sides of the fistula remain in contact, or making them approach each other, occasionally applied an ingenious little instrument, consisting of two pads, which, by means of a screw, can be made to embrace the part. An engraving of it may be seen in *Graefe's Journ.* b. iii. taf. 3, fig. 9. For the closure of the fistula, Dupuytren also sometimes had recourse to a truss, and now and then to the actual cautery.

If after the contraction, or perfect closure of the external opening, the patient should be attacked with colic, nausea, vomiting, and other symptoms of retention of the intestinal matter; and these complaints were not to yield to diluent drinks, aperient injections, and fomentations, Dupuytren recommends making a prompt incision through the cicatrix, and forming a free outlet for the matter accumulated above it. (See *Clinique Chir.* t. ii. p 272.)

[Several modifications of the enterotome have been devised, the object of which has been to give to the new communication a more circular form, instead of being a mere longitudinal fissure, as is the case when Dupuytren's instrument is used. Liotard contrived an instrument to remove a portion of the septum in shape like the segment of a circle, and this has been advantageously modified by Bourgéry for its more easy introduction into the bowel. (See *Bourgéry, Op. Surg.* vol. ii. pl. 33, and *Teale*, op cit. p. 210.) It is doubtful however, whether any material advantage is thus obtained, since the opening made by the original instrument has always been found sufficient for the passage of the fæces, and probably after a time always becomes of a more or less circular form, as it was found to be in one of Dupuytren's cases, which was examined by Lallemand seven years after the operation.

The following is Dupuytren's statement of the results of this operation: "Forty-one operations have been performed, twenty-one by myself, and twenty by other practitioners. The bowel had mortified from strangulation in three-fourths of the cases; in the other fourth there had been wounds with loss of substance. Three cases terminated fatally; one from supposed fæcal effusion into the abdomen; another from indigestion; the third from the peritonitis excited by the operation. Of the remaining thirty-eight, the greater number had no unpleasant symptoms; some indeed had colic, nausea, and vomiting, but these symptoms yielded to drinks containing carbonic acid, to leeches round the anus and fomentations of the abdomen."

"The cure was not equally complete in all. Fistulæ, more or less extensive, remained in nine, rendering the constant use of a truss necessary, in order to prevent the involuntary escape of air, mucus, bile and even fæcal matters. Twenty-nine patients were completely and radically cured in periods varying from two to six months." (*Mem. de l'Acad. Royale de Méd.* tome i. and *Lawrence* op. cit. p. 411.)

Mr. Lawrence remarks: "cases of artificial anus must be much more common in Paris than in London. Dupuytren employed his method in between twenty and thirty instances within a short time. No opportunity has occurred to me of putting it into practice either at St. Bartholomew's Hospital or elsewhere, for several years; and I believe that it has hardly been employed at all in this country." It appears from the observations of M. Jobert, that the representations of Dupuytren respecting the mild nature and successful results of his operation should be received with some allowance. He states that in the cases observed by him, very serious inflammatory symptoms resulted from the application of the enterotome. He adds that a patient in the Hôtel Dieu of Amiens, died of entero peritonitis after its application, and that several other fatal cases have been recorded. (*Traité des Mal. Chir. du Canal Intest.* tome ii. p. 125.) M. Velpeau adverts to the risk that the adhesive inflammation may not always take place at the periphery of the enterotome, even after it has been applied in the most judicious manner; also, that in some cases it is impossible not to include between the branches of the instrument a portion of some important organ at the same time with the abnormal septum. (*Op. Surg.* Mott's transl. vol. ii. p. 632.)

A very ingenious instrument has been contrived by Mr. Trant of Dublin, to effect a cure on Desault's principles, *i. e.* to restore the canal by pressing back the septum, but without the division or removal of any portion of it. One part of the instrument is made to press back the éperon towards the spine, while another part retains the anterior wall of the intestine in close contact with the posterior surface of the abdominial parietes, by which the danger of separating the delicate adhesions in this situation is prevented, which might otherwise cause a fatal extravasation into the cavity of the abdomen. (See *Dublin Med. Press*, 1845, p. 305).] (*James R. Lane.*)

J. R. Tieffenbach, Vulnerum in intestinis lethalitas occasione casus rarissimi, quo colon vulneratum, inversum per 14 annos ex abdomine propendens exhibetur. *Halleri*, Disp. Chir. 5, 61. *Desault*, in Parisian Chir. Journal, vol. i.; or Œuvres Chirurg. par *Bichat*, t. ii. p. 352, &c. *Schmucker's* Chir. Schriften, vol. ii. *Smulkalden*, Nova Methodus Intestina uniendi. Viteb. 1798. *Callisen*, Systema Chirurgiæ Hodiernæ, t. ii. p. 710, &c. Sull' Ernie Memorie Anatomico-Chirurgiche, fol. Milano, 1809. *B. Travers*, Inquiry into the Process of Nature in repairing Injuries of the Intestines, chap. viii. 8vo. Lond 1812. *Dorsey's* Elem. of Surgery. Philad. 1823. *F. Reisinger*, Anzeige einer von dem H. Professor Dupuytren erfundenen, und mit dem glücklichsten Erfolge ausgeführten Operationsweise zur Heilung des Anus Artificialis, nebst Bemerkungen, Augsburg, 1817. *Baron Dupuytren*, Mém. sur une Méthode Nouvelle pour traiter les Anus accidentels, lu à l'Acad. des Sciences en Janvier 1824; Dans la Collect. des Mém. de l'Acad. Roy. de Méd. 4to. Paris, 1828; also, in Leçons Orales de Clin. Chir. t. ii. 8vo. 1832; also, in Dict. de Méd. et de Chir. Pratiques, t. iii. art. "Anus contre Nature." Professor Delpech invented forceps which first took hold of the septum, between the two portions of the bowel, and then divided it by means of two little knives, which, on touching a spring, glided along the interior of the blades, and met towards their end. A representation of it may be seen in *Froriep's* 268th plate, fig. 4. The plan of cutting the septum, however, is abandoned, as likely to cause effusion of the contents of the intestinal canal, and peritonitis. *Lallemand*, in Répertoire Gén. d'Anat. &c. rédigé, par G. Breschet, t. vii. 1823. *Casamajor*, Obs. d'un Anus contre Nature ouvert dans la Vagin; Journ. Hebdom. de Méd. t. iv. p. 163. 1829. *Sabatier*, in Mém. de l'Acad. de Chirurgie, t. v. 4to.; and Médecine Opératoire, t. ii. ed. par MM. Breschet, Sanson, et Béguin. *Brosse*, in Rust's Magazine, b. vi. p. 239. *Liotard*, Dis. sur le Traitment de l'Anus contre Nature, Paris, 1819. *Hennen's* Military Surgery, p. 407, &c. ed. 2, Edin. 1820. Three cases from gunshot wounds; the cure effected by aiding nature occasionally with the exhibition of laxatives and clysters. *Breschet*, in Journ. der Chirurgie von C. F. Graefe, und Ph. von Walther, b. ii. p. 273, 479. Berlin, 1821. Treatise on Hernia, *Lawrence*, Lond. 1810, and 3rd ed. 1838. *Teale*, on Intestinal Fistula, in Cyclop. of Pract. Surg. Lond. 1843.

AORTA. ἀορτὴ, the principal systemic artery. Aneurisms of this vessel have already been treated of: but some other particulars relating to it merit notice in a dictionary of surgery.

WOUNDS OF THE AORTA.

[The general opinion of surgeons is that wounds of this vessel are necessarily and instantly fatal. If the wound be of a size to permit the escape rapidly of a large quantity of blood, this result would of course be inevitable. Cases are recorded however in which patients have survived small punctured wounds of the aorta for weeks, or even months. In one case related by Guattani the patient recovered from the wound, a false aneurism, however, followed at the point of puncture, as discovered by a post-mortem examination several years afterwards. In the *Journ. de Med.* t. xlvi. p. 435, a case is described where a patient was wounded in the aorta just at its origin from the left ventricle, and where death followed on the sixth day. Another case is recorded by Lerouge, in which the wound passed through the right auricle and the aorta, notwithstanding which the patient lived till the eleventh day. (*Recueil d'Observations Chirurgicales de Saviard.*)]

The following case is recorded by M. Pelletan. In the month of May, 1802, a young man was brought to the Hôtel Dieu. In a duel, he had been run through with a foil, which penetrated above the right nipple, and came out at the left side of the chest. The most alarming symptoms were apprehended; but several days elapsed without any serious complaints taking place. The patient was bled twice, and kept on a very low regimen. Everything went on quietly for a fortnight. He now complained of severe pains in his loins, and he was relieved by the warm bath. He seemed to be recovering, got up, and went to walk in the garden allotted for the sick; but the pain in his loins quickly returned, attended with difficulty of breathing, constipation, and wakefulness. He now became very impatient, and out of temper with the surgeons for not relieving him. On the 15th of July, two months after the accident, a deformity of the spine was remarked, about the eighth dorsal vertebra. The patient grew rapidly worse, and died in the utmost agony, saying that he felt suffocated; and tearing off his shirt that his chest might be free from the pressure of all kind of clothing. On the body being opened, the right side of the chest was found full of blood, coagulated in various degrees; and an opening, the diameter of which was equal to that of a writing pen, was detected in the aorta above the crura of the diaphragm. All the adjacent cellular substance was injected with blood, and three of the dorsal vertebræ were found carious. No mark of injury was perceptible in any of the thoracic or abdominal viscera. (*Pelletan, Clinique Chir.* t. i. p. 92—94.)

THICKENING AND CONSTRICTION OF THE AORTA.

Meckel met with two cases in which the aorta was thickened and considerably constricted, just below its arch; yet, in both subjects, there was every reason to believe that the abdominal viscera and lower extremities had been duly supplied with blood. This fluid, which could only pass from the heart with great difficulty, and in small quantities, had, by regurgitating, lacerated the semilunar valves. (*Mém. de l'Acad. Royale de Berlin*, 1756, Obs. 17 and 18.) A similar example is recorded by Stoerck. (*Ann. Méd.* xi. p. 171.) An instance, in which a stricture was met with in the aorta, opposite to the termination of the ductus arteriosus, is described by Sir Astley Cooper. The little finger could hardly pass through the constriction, which impeded the course of the blood through the heart and lungs, and was attended with a considerable dilatation of the right ventricle. (*Surgical Essays*, vol. i. p. 103, 8vo. Lond. 1818. For other facts of this kind, see *Bertin et Bouil-*

land, *Traité des Mal. du Cœur et des Gros Vaisseaux; Reynaud*, in *Journ. Hebdom. de Méd.* t. i. &c.) Gangræna senilis is sometimes connected with disease and morbid deposits within the aorta. (See *Carswell's Illustrations of the Elem. Forms of Dis.* fasc. 7, pl. 3, fig. 2.) See MORTIFICATION.

Obliteration of the Cavity of the Aorta.

It is observed by Professor Scarpa, that the whole body may be regarded as an anastomosis of vessels, a vascular circle; and he contends that this remark is so true, that even an obliteration of the aorta itself, immediately below its arch, may take place, without the general circulation of the blood in the body being stopped. Such a disease of the aorta was seen by M. Paris in the body of a woman. While she lived, the blood, which was expelled from the heart, was transmitted into the trunk of the aorta, below the constriction; and it got there by passing, through the subclavian, axillary, and cervical arteries, into the mammary, intercostal, diaphragmatic, and epigastric arteries. From these latter arteries, the blood passed into the vessels of the thoracic and abdominal viscera, and into those of the lower extremities. (See *Desault, Journal*, t. ii. p. 107; *Brasdor*, in *Recueil Périodique de la Soc. de Méd.* t. iii. No. 18.) Another instance of complete obstruction of the aorta was met with by Monro. (See *Obs. on Aneur. of Aorta*, p. 5.) Dr. Graham, of Glasgow, published another example, in which the aorta was completely obstructed just below the canalis arteriosus. (See *Med. Chir. Trans.* vol. v. p. 287.)

Dr. Goodison, of Wicklow, in examining the dead body of a woman, in the Hospice de la Pitié at Paris, and endeavouring to trace the origin of the inferior mesenteric artery, discovered a hard tumor placed upon the aorta, and accompanied with an obliteration of that vessel from the origin of the inferior mesenteric artery downwards the remainder of its length; the left iliac being also rendered impervious down to its bifurcation, and the right for more than one half of its length. The corpora sesamoida of the semilunar valves of the aorta were considerably enlarged, and the mitral and tricuspid valves presented the appearances termed by Corvisart "vegetations." The arch of the aorta was greatly enlarged, and internally was studded with patches of bone. The vessels given off from the aorta, and especially the lumbar arteries, were all noticed to be considerably increased in size. At the obliterated part of the abdominal aorta, there was a firm bony sheath, covering the vessel for about two inches, and filled with a hard fleshy substance, which extended further upwards, and was firmly adherent to the coat of the artery. It was the inner coat itself which was ossified. For a particular account of the vessels which were chiefly enlarged for the purpose of continuing the circulation, I must refer to Dr. Goodison's description. The general appearance of the body was not unhealthy; and the lower extremities, which were not emaciated, must have been well supplied with blood. The history of the case could not be traced. Mr. Crampton, having carefully compared Dr. Goodison's narrative with the preparation taken from this subject, refers the obliteration of the aorta to the effects of the process by which an aneurism had been spontaneously cured; in which particular, this case is quite different from those reported by M. Paris and Dr. Graham. (See *Dublin Hospital Reports*, vol. ii. p. 193, &c. 8vo. 1813.)

The foregoing cases proved that the obliteration of the canal of the aorta, at any one part, is not incompatible with the continuance of life; and suggested the possibility of the application of a ligature to it being the means of sometimes saving the patient from the doom of certain death.

The next case which I shall notice, is one of the most memorable in the annals of surgery, since it was nothing less than an operation in which a ligature was applied, for the first time, to the aorta of a living subject, under circumstances which, at a time when the successful repetition of Brasdor's operation had not been made (see *Wardrop, On Aneurism*, 1829), perhaps warranted even this desperate attempt to preserve life. Sir Astley Cooper had often placed ligatures round the aorta in dogs, and found that the blood was readily carried by the anastomoses to their posterior extremities (see *Med. Chir. Trans.* vol. ii. p. 158); and he came to the conclusion, that if the aortic plexus be tied with the artery, the lower extremities are rendered paralytic, and the animal ultimately dies; but if care be taken to include only the vessel in the ligature, these consequences do not take place. (See *Lancet*, vol. ii. p. 47.)

A porter, aged thirty-eight, was admitted into Guy's Hospital, April 9, 1817, for an aneurism in the left groin, situated partly above, and partly below, Poupart's ligament. The swelling was considerably diffused, and pressure upon it gave a great deal of pain. On the third day from his entrance into the hospital, the tumor increased to double its former size, and the pulsation became less distinct. The blood could be felt in a fluid state within the sac, which was so large that no operation was practicable without opening the peritoneum. Sir Astley Cooper therefore waited, in order to let the man have a chance of a spontaneous cure. Notwithstanding the practice of venesection and compression, the swelling continued to increase, and on the 20th of June a bleeding took place from a point of the tumor where a slough had formed. The bleeding recurred from time to time; and on the 25th he was so much exhausted by loss of blood that his fæces passed involuntarily, and his immediate death was only prevented by pressure on the opening. At nine o'clock in the evening, this experienced surgeon made a small incision into the sac above Poupart's ligament, and introducing his finger tried if it were practicable to pass a ligature round the external iliac artery within the cavity; but the thing was found impossible, as, instead of the vessel, "only a chaos of broken coagula" could be perceived. At the moment of withdrawing the finger, two students compressed the aorta against the spine, and the incision was then closed with a dossil of lint. Sir A. Cooper now determined to apply a ligature to the aorta itself. "I made (says he) an incision, three inches long, into the linea alba, giving it a slight curve to avoid the umbilicus. One inch and a half was above, and the remainder below the navel," the cut being inclined towards the left side. "Having divided the linea alba, I made a small aperture into the peritoneum, and introduced my finger into the abdomen; and then with a probe-pointed bistoury, enlarged the opening in the peritoneum to nearly the same extent as that of the external wound. Neither the omentum nor the intestines protruded; and during the progress of the operation, only one small convolution projected beyond the wound." With his finger-nail he scratched through the peritoneum, on the left side of the aorta; and then gently moving his finger from side to side, he gradually passed it between the aorta and spine, and again penetrated the peritoneum on the right side of the aorta. A blunt aneurismal needle, armed with a single ligature, was next conveyed under that vessel; care was required in tying the ligature to exclude the intestines from the noose. The wound was then closed by means of the quilled suture and adhesive plaster. During the operation, the fæces were discharged involuntarily, and the pulse, both immediately and for an hour after the operation, was 144. An opiate was given, and the involuntary passage of fæces soon ceased. The sensibility of the right leg was very imperfect. In the night the patient complained of heat in the abdomen; but he felt no pain upon pressure; and the lower extremities, which had been cold a little while after the operation, were regaining their heat, but their sensibility was very indistinct. At six o'clock the following morning, the sensibility of the limbs was still imperfect; but at eight o'clock the right one was warmer than the left, and its sensibility returning. At noon, the temperature of the right limb was ninety-four; that of the left, or aneurismal one, eighty-seven and a half. At three o'clock, an enema was ordered. The heat of the right leg was now ninety-six; that of the left or diseased limb eighty-seven and a half. It is unnecessary here to detail all the various circumstances which preceded the patient's death. Vomiting, pain in the abdomen and loins, involuntary discharge of urine and fæces, a weak pulse, cold sweats, &c., were some of the most remarkable symptoms. At eight o'clock on the second morning after the operation, the aneurismal limb appeared livid and cold, more particularly round the aneurism; but the right leg was warm; and between one and two o'clock the same day, the patient died. On opening the abdomen, there was not the least appearance of peritoneal inflammation except at the edges of the wound; and the omentum and intestines were of their natural colour. The ligature, which included no portion of intestine or omentum, was placed round the aorta, about three quarters of an inch above its bifurcation. When the vessel was opened, a clot, of more than an inch in extent, filled it above the ligature; and below the bifurcation another clot, an inch in extent, occupied the right iliac artery, while the left contained a third, which extended as far as the aneurism. The neck of the thigh-bone was also found broken within the capsular ligament, and not united; an accidental complication. As there were no appearances of inflammation of the viscera, Sir Astley Cooper refers the cause of the man's death to the want of circulation in the aneurismal limb, which never recovered its natural heat, nor any degree of sensibility, though the right leg was not prevented from doing so; hence, says this experienced surgeon, "in an aneurism similarly situated, the ligature must be applied before the swelling has acquired any very considerable magnitude." (*Surgical Essays*, vol. i. p. 114, &c.)

Indeed, the most important conclusions from this case are: — First, that where no other impediments exist, the circulation will continue in the lower extremities, though the abdominal aorta be tied, or suddenly obstructed. Secondly, that suffering aneurismal swellings to become very large, before the operation is done, exposes the patient to considerable disadvantage, on account of the pressure of the disease upon the surrounding anastomoses, whereby the continuance of the circulation is rendered less certain than it would be were the operation done at an earlier period.

Sir Astley Cooper mentions, that if he were to perform the operation again, he would cut off the two portions of the ligature close to the knot on the vessel; because the irritation of the bowels by them seems to him a source of considerable danger. He has also said, that if a case like the foregoing should again occur to him, he would seek the aorta behind the peritoneum. (See *Guthrie, On Dis. of the Arteries*, p. 363.) Whoever has practised the operation of tying the common iliac artery on the dead subject must be fully aware of the practicableness of this last method: in my friend Mr. James's case, however, which I am about to notice, he found the peritoneum so firmly adherent to the aneurismal sac that he says that it would have been absolutely impossible to have detached them from one another; and the method of operating, therefore, without opening the peritoneum, could not have been followed. (*James*, in *Med. Chir. Trans.* vol. xvi. p. 15.) In a third example, however, of ligature of the aorta, when Dr. Murray was the operator, the latter plan was executed, "without more difficulty than was to be anticipated." The patient died twenty-three hours after the operation. (See *Lond. Med. Gaz. for* 1833, 1834, p. 68.)

[Mr. James's case was one of aneurism of the external iliac artery, situated too high to allow of a ligature being applied to that vessel above the tumor. Brasdor's operation was consequently first performed—the ligature was applied to the common femoral artery, half an inch below its origin. This operation failed, however, to arrest the progress of the aneurism. After an interval of three weeks, it was therefore decided, on consultation, to tie the aorta itself.] Mr. James began the external incision an inch above the umbilicus, and extended it down to two inches below it. After the peritoneum had been opened, great embarrassment was occasioned by the protrusion of the distended bowels. The handle of the aneurism-needle broke at the moment the instrument was passed under the aorta. "The broken part was so sharp," says Mr. James, "that I was obliged to withdraw it for fear of injuring the intestines. With some additional difficulty I got my finger, with Weiss's instrument upon it, under the artery; but, even after this had been effected, it was by no means easy, with the best assistance of my colleagues, to extricate the short needle bearing the ligature, so much did the intestines interfere with every kind of manipulation. When the ligature was underneath, I kept the intestines out of the way with the fingers of both my hands, and placed one of my thumbs on the vessel, whilst Mr. Luscombe drew it (the ligature) first on my thumb, and then on the artery." The tumor immediately became flaccid, and a deadness in the lower extremities was complained of. We shall only add, that the patient afterwards suffered severe pain in the lower limbs, which never ceased till he died, which event took place three hours and a half after the operation. During this short time, the temperature of the lower limbs was equal to that of the trunk; but it fell in every part of the body. The particulars of the post mortem examination are interesting; but I can only state here, with reference to Brasdor's operation, that "the external iliac artery did not terminate in the femoral, as usual, but gave off two trunks of nearly equal size; and from the inner, which corresponded with the profunda, the epigastric was given off." Mr. James does not regard then the result of his attempt as unfavourable to Brasdor's method; "for a considerable and satisfactory alteration was produced by tying only one of the trunks which led from the iliac, and had the distribution been natural, it is not improbable," says he, "a cure would have been obtained." (See *Med. Chir. Trans.* vol. xvi. p. 14.)

On this subject I find the following observations made by my friend Mr. Crosse: — "I meet yearly with recorded instances of a portion of the aorta being entirely obliterated, and the accounts of such cases are often followed by a word of encouragement to repeat the application of a ligature to this vessel. Astley Cooper, James, and Murray, are the only names associated with this undertaking; and its intrepid originator allows me to say, that he would not repeat the operation, except under an improved and a more safe plan of conducting it; approaching to the sentiments of a recent writer, who sums up a full consideration of the subject by remarking that *the operation ought not to be again performed.*" (*Crosse*, in *Prov. Med. and Surg. Trans.* vol. v.) I am disposed to be of this opinion myself; and, at all events, believe with Mr. Guthrie, that the ligature of the aorta may be in almost every instance superseded by that of the common iliac artery. I think also with him, that if the operation ever succeed, it will be when the aorta is taken up by passing the finger under the peritoneum, along the common iliac artery, up to that vessel. (See *Guthrie*, op. cit. p. 372.)

[Since the above was written, two additional cases of ligature of the abdominal aorta have been published, making five altogether. The fourth case occurred in the practice of Dr. C. B. Monteiro, at Rio Janeiro. The case was one of false diffused aneurism of the femoral artery, forming a large swelling situated in the lower part of the abdominal cavity, on the right side. The operation was performed Aug. 5th, 1842. The ligature was applied behind the peritoneum, two lines above the bifurcation of the aorta. The patient died on the tenth day after the operation of secondary hæmorrhage, arising from a small opening in the aorta immediately above the ligature. (*South, Translation of Chelius*, p. 255.) The last and fifth case on record was under the care of Mr. South, in St. Thomas's Hospital. This was for an aneurism of the false and diffused kind, affecting the common iliac artery, in a robust young man, aged twenty-eight. The tumor was large, occupying the right side of the abdomen, extending from the iliac fossa to near the cartilages of the ribs. The operation was performed on the 21st of June, 1856. An incision was made on the left side from a little above the anterior superior spinous process of the ilium, to just below the cartilage of the tenth rib. The peritoneum was raised from the lateral and posterior wall of the abdomen, and a ligature was passed around the aorta from right to left, just above the bifurcation. The patient survived the operation forty-three hours. (*Lancet, for July 12th and Aug. 23rd*, 1856.)

The peritoneal cavity has been so frequently and extensively opened of late years, in the operation for the removal of ovarian cysts, that the opinions of surgeons with regard to abdominal surgery in general, and more especially in reference to the risks attending wounds of the peritoneum have been materially modified. It has been abundantly shown, that the danger of such wounds, when intentionally made by the surgeon with clean cutting instruments and without bruise or violence to the contained viscera, has been over estimated. With this knowledge before him the surgeon of the present day should, it appears to me, give the preference to Sir Astley Cooper's method of cutting directly through the peritoneum to expose the aorta, if called upon to apply a ligature to that vessel.

The danger attending this formidable operation, judging from the cases on record, does not appear to arise so much from the wound of the peritoneum as from the want of adequate circulation in the lower extremities, especially on the side of the aneurismal swelling. This latter cause of failure may fortunately, in future operations, to a great extent, be provided against, *by applying the ligature above instead of below the giving off of the inferior mesenteric artery:* by this proceeding a stream of blood corresponding to the size of the anastomosing branch of the middle and right colic arteries would be available for the supply of the lower limbs. The amount of blood entering the aorta by the inferior mesenteric artery through the channel above indicated, would appear to be a suitable quantity for the purpose of ensuring the required circulation, without distending the aneurismal sac so as to endanger its rupture.

From the above considerations, I am not altogether opposed to the performance of this operation where it offers the only chance of life, nor should I be greatly surprised to hear that a successful case of ligature of the aorta in the human subject had been added to the triumphs of operative surgery.]

Rupture of the Aorta within the Pericardium.

The surgical writings of Scarpa, in relation to the formation of aneurisms, have now gained extensive celebrity in the world. It is well known that this author maintains the doctrine, that, in all aneurisms, the internal and muscular coats of the artery are ruptured; and that the aneurismal sac is not formed of these tunics, but of the dilated cellular sheath which surrounds the vessel. When a large aneurism bursts, there is always a double rupture; one of the artery, another of the aneurismal sac. The last is that which is the immediate cause of the patient's destruction, by altering the *circumscribed* state of the aneurism into the *diffused.*

There are some exceptions, however to the foregoing statement; and Scarpa has not failed to point them out. When the internal and muscular coats of the aorta are ruptured in a situation where the outside of the vessel is only covered by a thin, tense, closely adherent membrane, such membrane may be ruptured at the same time with the proper coats of the artery, and sudden death be occasioned by the effusion of blood in the cavity of the thorax. These events are liable to happen whenever the proper coats of the aorta are ruptured within the pericardium, where the vessel is only covered by a thin layer reflected from this membranous bag. Walther has recorded one example of this kind, and Morgagni several others. A similar case is related by Scarpa. Several specimens are contained in the museums of the London Hospitals. (See *Haller*, *Disput. Chir.* tome v. ; *Acta Medic. Berlin*, vol. viii. p. 86; *Morgagni De Sed. et Causis Morb.* Epist. xxvi. art. 7, 17, 21; Epist. xxvii. art. 28; *Scarpa, On Aneurism, transl. by Wishart*, p. 81. Also *Hodgson, On the Diseases of Arteries and Veins.*)

Steatomatous Tumors of the Aorta.

Two steatomatous tumors were noticed by Stenzel in the body of a male subject. They were situated in the substance of the membranes of the aorta, immediately below its arch. Notwithstanding these swellings had rendered the vessel almost impervious, the man had the appearance of strength, and of having been well nourished. *Hæc corpora fere cor magnitudine aequabant ut omnem propemodum exeunti e sinistri cordis thalamo sanguini spatium præcluderent.* De Steatomatibus in principio arteriæ aortæ, &c. Wittemb. 1723. This is another striking fact, illustrating the great power of the inosculations to carry on the circulation.

Compression of the Aorta,

In order to restrain hæmorrhage from the inferior half of the body, more especially from the uterus, has been warmly advocated, and in thin persons seems calculated to be beneficial. (See *Crosse, Provincial Med. and Surgical Trans.* vol. v.) I have mentioned the adoption of this plan by Sir Astley Cooper, in the case where he opened the aneurismal sac, previously to putting a ligature on the aorta.

APHÆRESIS (from ἀφαιρέω, to remove). A term formerly used in the schools of surgery to signify that part of surgery which relates to the removal of any portion of the body.

APONEUROSIS. Matter often collects under aponeuroses, particularly under those which cover the muscles of the thigh, leg, and forearm. Abscesses are also sometimes met with under the temporal, the palmar, and the plantar fasciæ; in the tendinous thecæ, which include the flexor tendons of the fingers ; and, occasionally, also in the aponeurotic sheath, in which the rectus abdominis muscle is situated.

One particular effect of an aponeurosis, or fascia, lying between a collection of matter and the skin, is materially to retard the progress of the pus towards the surface of the body. Hence, if the case be allowed to take its own course, the quantity of matter increases; the pus spreads extensively under the aponeurosis in every possible direction ; separates the muscles from such fascia, and the muscles from each other ; and the abscess does not burst till a vast deal of mischief has been produced, together with more or less sloughing of the fascia, tendons, &c. These circumstances cannot happen without a considerable degree of constitutional disturbance, and a permanent loss of the use of certain muscles. Even when a spontaneous opening is formed, and some of the matter escapes, it is often only a very imperfect discharge ; for the aperture generally occurs, not in a depending situation, nor over the main collection of pus, but at a part where the aponeurosis is thinnest, and consequently where the matter has the least resistance to overcome in getting to the surface of the body.

In all such cases, the chief indication is to make an early and a depending opening with a lancet, so as to prevent the extension of the abscess, and to let the matter escape as fast as it is formed. If a spontaneous opening should have occurred in an unfavourable place, a new aperture must be made in a proper situation, or if the former should be sufficiently depending and near the principal accumulation of matter, but too small, it must be rendered larger with a curved bistoury and a director. Whenever any black dead pieces of fascia, or tendons, present themselves at the opening, they must be taken hold of with a pair of forceps, and extracted.

APPARATUS MINOR ; APPARATUS MAJOR; APPARATUS ALTUS. Three ways of cutting for the stone. (See Lithotomy.)

AQUA PICIS LIQUIDÆ. *Dubl.* Take of tar two pints ; water a gallon. Mix them with a wooden rod for a quarter of an hour, and after the tar has subsided, let the liquor be strained, and kept in well-corked bottles. This lotion is often used in porrigo, and ulcers surrounded with scorbutic redness.

ARCHOPTOSIS. See Rectum, Prolapsus of.

ARGENTI NITRAS. (*Nitrate of Silver, lunar caustic.*) See Silver, Nitrate of.

[ARNICA. The tincture of the flowers of this plant has been thought to be efficacious in promoting absorption in bruises, sprains, and extravasations of blood. A lotion composed of two ounces of tincture of arnica to eight ounces of water may be employed for this purpose. Mr. Erichsen "entertains no doubt of its efficacy." He states that he has employed it largely in extensive extravasations, and has rapidly promoted their absorption by its use. (See *Science and Art of Surg.* p. 83.)]

ARSENIC was the chief ingredient in a secret remedy, which long obtained celebrity in Ireland for the cure of cancer, and is now well known amongst surgeons by the name of Plunket's caustic. This application consists of the ranunculus acris, the greater crowfoot, the flammula vulgaris, and the lesser crowfoot, in the proportion of an ounce of each, bruised and mixed with a drachm of the white oxide of arsenic, and five scruples of sulphur. The whole is to be beaten into a paste, formed into balls, and dried in the sun. When required for use, these balls are beaten up with yolk of egg, and spread upon a piece of pig's bladder. The use of the ranunculus is to destroy the cuticle, upon which the arsenic would have no effect ; for it is to be observed that Plunket's caustic was employed for the dispersion of tumors as well as for the relief of ulcerated cancers. The application is to remain on the part twenty-four hours, at the end of which the slough is to be dressed with any simple unirritating ointment. When arsenic was first recommended as an application for cancer, it used generally to be blended with opium. When Plunket's caustic is employed, so as to form an eschar over a scirrhous tumor, I conjecture that if it ever do good, it is not by any specific effect of this arsenical application, but simply by its producing a slough. It is highly probable also that the swellings which have been thus dispersed, have never been complicated with the structure characteristic of true scirrhus. With respect to cancerous ulcers, Plunket's caustic sometimes produces a degree of amendment, which however, rarely lasts for any considerable time; but many inveterate ulcerations and anomalous sores derive permanent benefit from it, and are even completely cured by it. Some examples of lupus, ulcerations about the roots of the nails, and reputed carcinomatous sores of the lips, are of this description.

At Paris, an arsenical paste was formerly used by Dubois, and other surgeons of that capital, for cancerous sores of the penis, and other malignant ulcers. It was composed of seventy parts of cinnabar, twenty-two of sanguis draconis, and eight of the white oxide of arsenic (arsenious acid), formed into paste with saliva at the time when it is to be employed. "The pain and inflammation that succeed the use of it (says Mr. Crosse) cannot be equalled by the severest operations with the knife. (*Sketches of the Medical Schools of Paris*, p. 45, 8vo. 1815.) Even death may be occasioned by the absorption of the poison, as appears from the two annexed facts, the first of which is recorded by M. Roux, in his *Médecine Opératoire*. "The day after the paste was applied, the patient complained of colic and severe vomiting, and in two days perished in convulsions, *et les plus vives angoisses*. The internal coat of the stomach, and a great part of the intestinal canal were inflamed, and marked here and there with dark spots." Just before I visited Paris (adds Mr. Crosse), I dissected in London a woman who died under similar circumstances, and where the same morbid appearances were presented, &c. (Op. cit.)

Justamond's applications to cancer were generally combinations of arsenic and sulphur. One formula was an ounce of yellow arsenic, with half that quantity of armenian bole, and sometimes as much red precipitate. He also employed a sulphuret of arsenic, and a combination of this sulphuret with crude antimony. The arsenical preparation selected for use was scraped, and laid on the middle of the sore, the edges of which were moistened with a combination of the muriate of iron and muriate of ammonia. In some instances, it is alleged the effects of the treatment were the correction of the fetid smell, melioration of the appearance of the sore, and separation of the cancerous part.

In the Pharmacopœia Chirurgica, Justamond's arsenical caustic is directed to be made in the following manner:—℞. Antimonii pulverizati, ℥ j. Arsenici pulverizati, ʒij. These are to be melted together in a crucible. The application may be reduced to any degree of mildness by blending with this pulverised caustic a quantity of opium in the form of powder, which was also supposed to act specifically in diminishing pain.

The powder of white oxide of arsenic, unmixed with other substances, has sometimes been sprinkled upon cancerous and other inveterate ulcers; but the practice is now abandoned by every judicious surgeon, on account of the violent pain resulting from it, and the not unfrequently fatal consequences of its absorption. Could I suppose that a man so rash and ignorant as to revive this murderous practice yet existed in the profession, I should feel disposed to lengthen these remarks; but I am persuaded that, in this country at least, more judgment and knowledge everywhere prevail. The white oxide of arsenic, however, may be applied with more prudence in other forms; either in one of those already specified; or as a lotion, composed of eight grains of the oxide, and the same quantity of subcarbonate of potash, dissolved in four ounces of distilled water; or as an ointment, formed by rubbing together one drachm of the oxide, and twelve drachms of spermaceti ointment. (See *A. T. Thomson's Dispensatory*, p. 51.)

In the American edition of this Dictionary, Dr. Reese observes: "There can be little doubt that *arsenic* is the basis of the active ingredients of most of the popular nostrums of the day, which are set forth in our public papers as infallible remedies for the cure of cancerous affections, as they are termed; and hence the manifold evils which we often witness from such practice. So long ago as in 1786, Dr. Rush favoured the public with an exposition of the nature of the famous cancerous powder of Dr. Martin; its base was arsenic; though, like the specifics of our own time, it was alleged to be of a vegetable nature. The external application of arsenic ought to be had recourse to only after the severest scrutiny into the peculiar character of the case and constitution affected. Even in small quantities it has produced apoplexy, mental aberration, organic lesion of the stomach, paralysis, loss of motion, enlargement of the joints, fatal petechiæ, &c. Arsenic, in fact, may be enumerated among that class of poisons which induces nearly the same effects when externally applied as when taken inwardly. The experiments of Brodie, as well as those of other philosophers, demonstrate that its influence on the system is no less rapid and dangerous when had recourse to as an external application to denuded surfaces than when applied directly to the stomach. Another peculiarity of its action deserves also farther to be stated: according to Professor Francis (*Lectures on Forensic Medicine*), in *some cases*, even while favourable anticipations from the operation of this powerful agent locally applied are indulged, of a sudden the general health yields, and death *ensues rapidly and unexpectedly*; an occurrence of much consideration in the investigations of the juridical physician."

Febure's celebrated remedy consisted of ten grains of the white oxide of arsenic, dissolved in a pint of distilled water, to which were then added an ounce of the extractum conii, three ounces of the liquor plumbi subacetatis, and a drachm of laudanum. With this fluid the cancer was washed every morning. Febure likewise gave arsenic internally; and his prescription was two grains of the white oxide; a pint of distilled water; syrup of chicory, q. s.; and half an ounce of rhubarb. Of this mixture, a table spoonful was given every night and morning, with half a drachm of the syrup of poppies. Each dose contained about one-twelfth of a grain of arsenic; but, in proportion as the patient was able to bear an increased quantity, the dose was gradually augmented to six table spoonfuls of the solution.

Dupuytren was in the habit of employing certain preparations of arsenic, which cleaned the diseased surfaces without destroying them. One of his formulæ was a powder; the other a liquid. The arsenious acid constituted the basis of both. The calomel, joined with it, he conceived might have some effect; but the arsenic was the essential thing. The powder consisted of four parts of arsenious acid, or oxide of arsenic, and ninety-six of calomel. Sometimes the proportion of arsenic was increased to five or six parts in the hundred. The liquid preparation was principally the above powder mixed with gum arabic, and moistened with distilled water, so as to make a paste. In the latter formula, however, Dupuytren usually increased the proportion of arsenic, employing six, eight, ten, or twelve parts of arsenic, with so many parts of calomel as made, with the arsenic, one hundred. Dupuytren employed this application with considerable success for the cure of many phagedenic ulcerations of the lips, and other parts of the face, approaching almost to cancer in respect to obstinacy. (See *Clinique Chir.* t. iv. p. 471.) In University College Hospital, I employed Dupuytren's arsenical powder last year, in one or two instances of the same kind, with complete success. In lupus, or noli-me-tangere, it is a valuable application.

[In onychia maligna, Mr. Luke speaks highly of an ointment containing two grains of arsenious acid to an ounce of spermaceti ointment.]

The liquor potassæ arsenitis (Ph. Lond.), or Fowler's solution, is the formula commonly employed for the internal exhibition of this mineral. A fluid ounce of this solution contains four grains of arsenious acid. The dose, according to Dr. Fowler, is as follows :—From two years old to four, M. ij or iij to v ; from five to seven, M. v to vij ; from eight to twelve, M. vij to x ; from thirteen to eighteen, M. x to xii ; from eighteen upwards, M. xii. These doses may be repeated every eight or twelve hours, the medicine being diluted with thick gruel, or barley-water. [Dr. Pereira remarks, that the quantities here indicated are larger than it will be safe, in most cases, to commence with. Half an ounce, taken in the space of five days, is supposed to have caused death. (*Elem. of Mat. Med.* 3rd ed. vol. i. p. 669.) For an adult, about five minims is now the ordinary dose ; ten minims would be considered as an excessive quantity by most practitioners. As the preparation is decomposed by the infusion and decoction of cinchona, it should never be ordered with either of these medicines. It should be taken immediately after a meal, when the stomach is filled with food ; for when given on an empty stomach it is much more likely to occasion gastric disturbance.

The iodide of arsenic has been recommended by Dr. Walshe in the treatment of scirrhous tumors of the breast. It should be given in doses of a sixteenth to a twelfth of a grain twice daily, and may be continued without risk for several months. He thinks he has observed that under its use the pain decreases in violence, and that the active growth of the tumor may be diminished, and perhaps suspended. (See *Treatise on Cancer*, p. 202, Lond. 1846.)]

It will only be in my power to specify here a few of the numerous surgical cases in which the internal employment of arsenic has been proposed. The following are particularly worthy of attention : cancer ; lupus ; elephantiasis ; onychia ; various unnamed malignant ulcers ; various cutaneous affections, lepra, psoriasis, eczema, &c. A longer list of diseases, for which a trial of arsenic is suggested, may be seen in some papers published by Mr. Hill. (*Edin. Med. and Surg. Journ.* vols. v. vi.)

In cases of poison by arsenious acid, or arsenite of potash, practitioners universally agree respecting the first indication ; which is, to empty the stomach as quickly as possible, with the stomach pump or an emetic. In this country, if the pump be not at hand, the common practice is to exhibit an emetic of sulphate of zinc, or sulphate of copper, which (it is said) ought to be preferred ; first, because it does not require much dilution for its action — a circumstance of no small importance where poisons act by being absorbed ; and, secondly, because it is extremely expeditious, a dose of fifteen or twenty grains producing almost instantaneous vomiting, without exciting that previous stage of nausea, which so frequently characterises other emetics, and which produces a state of the vascular system highly favourable to the function of absorption. (See *Pharmacologia by Dr. Paris*, p. 232, vol. i. ed. 5.). If the pump be used, Dr. A. T. Thomson is of opinion that lime-water should be used to wash out the stomach. The union of lime and arsenious acid forms a nearly insoluble salt ; so that while we are freeing the stomach from its deleterious contents, we are also lessening the virulence of any part of it which may remain. If the above emetics be given, lime-water should be drunk immediately after the first act of vomiting. Oil, and also milk, may be given ; but no diluent fluid calculated to dilute and dissolve the arsenious acid. Alkaline solutions are objectionable, because the alkaline arsenites are very soluble, and as poisonous as arsenic itself. (See *Thomson's Elements of Therapeutics and Materia Med.* p. 518, ed. 2.)

It is remarked by Orfila, that lime-water offers no particular advantage in cases of poison with the solid arsenical acid ; but, where this acid is fluid, he admits the great utility of lime-water, as, in this circumstance, an insoluble arsenite of lime is formed, the action of which is very weak. This last observation is confirmed by experiments on dogs. (*Toxicologie Générale*, t. i. p. 233, ed. 2.)

When inflammation of the abdomen, and alarming nervous symptoms prevail, the means of relief are leeches, venesection, the warm bath, fomentations, emollient clysters, and antispasmodic narcotic medicines.

Success will depend, in a great measure, upon the regimen observed during the patient's convalescence : he should be chiefly nourished with milk-gruel, cream, rice, and beverages of a mucilaginous nature. (See *Orfila*, t. cit. p. 235.)

In 1831, the hydrated sesquioxide of iron was discovered, by Dr. Bunsen, to be a powerful antidote, if administered in time. (See *J. G. Crosse*, in *Prov. Med. Trans.* vol. v. p. 51 ; *J. Robson*, in *Lond. Med. Gaz. Nov.* 5. 1836.)

[If a sufficiently large quantity of the hydrated sesquioxide be added *to a solution* of arsenious acid, it combines with the acid, and forms an insoluble precipitate. Dr. Maclagan says that twelve, Devergie thirty-two, parts of the hydrated oxide are required for every part of arsenious acid swallowed. Dr. Beck recommends that it should be given in the quantity of a table spoonful every five or ten minutes, or as often as the patient can swallow it. But it appears from the experiments of Dr. A. Taylor, that when the hydrated sesquioxide is mixed with arsenious acid *in the form of powder*, that little or no chemical effect is produced. Now, as in most cases of arsenical poisoning, the arsenious acid is taken in the form of powder, it follows that in such the hydrated sesquioxide would not act as an antidote. Nevertheless, according to Dr. Beck, the results of its employment have been encouraging. In thirty-one cases in which it was given recovery took place in twenty-nine. In one of these, nearly two drachms of arsenic had been taken. In the two unsuccessful cases, the antidote could not be retained on the stomach. (See *Pereira, Elem. of Mat. Med.* 3rd ed. vol. i. p. 767.)]

ARTERIES. The process, by which a divided or punctured artery is healed, is particularly considered under the word HÆMORRHAGE; while the general principles, which ought to be observed in the application of the means for the stoppage of bleeding, may be collected partly from the remarks contained in that part of the work, and partly from what is stated in the articles AMPUTATION, ANEURISM, and LIGATURE.

As the condition of a bleeding patient admits of no delay, and the preservation of his life entirely depends upon proper measures being immediately taken, no man ought to be suffered to profess surgery who is not competent to the treatment of wounded arteries, whether injured by accident or in a surgical operation. Loss of limb, or life itself, is the too frequent consequence of such ignorance. Thus, Langenbeck recites the case of a turf-cutter, who let the instrument with which he worked fall against the lower part of his leg, whereby the posterior tibial artery was wounded. The blood gushed out profusely, and the surgeon who was sent for applied a tourniquet to the popliteal artery, and thus stopped the bleeding for a time; but, unfortunately, the tourniquet was kept so long on the limb, that the foot mortified, and sloughed away. (*Bibl. für die Chir.* b. i. p. 231, 232. Gott. 1806.) From the explanations, delivered in the article HÆMORRHAGE, it will be seen that, in all bleedings from considerable arteries, nothing is equal to the ligature, as a means of preventing the further loss of blood; and it may be laid down as a standing rule, that each extremity of the wounded vessel should be tied as near as possible to the wound in its coats. As Mr. Hodgson has remarked, "the necessity of tying both ends of a wounded artery is evident from the fact, that the anastomoses in all parts of the body are so extensive as to furnish a supply of blood, which may pass through the lower extremity of the wounded vessel in a sufficient stream to produce an alarming, and, in some instances, a fatal hæmorrhage." (*On Diseases of Arteries, &c.* p. 469.) This correct observation is followed by a case in which the bleeding from the lower end of a divided brachial artery caused the patient's death. Of course, the inference is that both extremities of the vessel ought to have been tied directly after the receipt of the wound. With regard to tying the trunk of an artery in a part of the limb where it can be exposed with facility, when it is difficult to secure its bleeding extremities, as Mr. Hodgson remarks, the practice "was falsely deduced from a knowledge of the fact that the ligature of an artery at a distance from the disease will effect the cure of an aneurism. But, a more intimate acquaintance with the condition of a limb after such an operation, and the processes by which the cure of an aneurism is effected after the modern operation, afford a complete illustration of the inefficacy and danger of this mode of treating a wounded artery; for it is now fully proved, that when an artery is tied a stream of blood continues to pass through it below the ligature." This well-informed surgeon is aware however, that instances do occur, in which only the upper end of a wounded artery is tied, and yet the patient recovers without hæmorrhage from the lower orifice, which is closed by the natural processes.

In the year 1814, in Holland, I took up the femoral artery, in the middle of the thigh, in a case where the popliteal artery had given way, ten days after the passage of a musket-ball through the ham. I employed only one smallish ligature, which was applied with the precaution of not detaching the artery from its natural connections. The hæmorrhage was effectually stopped, and the wound healed in the most favourable manner. Here, no doubt, the inflammation in the ham had obliterated the portion of the artery immediately below the point at which it had sloughed, or ulcerated; and there might even have been, from the same cause, some deposition of lymph within the upper portion of the popliteal artery, contributing to the success of the operation. But, no doubt, it was the diminution of the impulse of the circulation by the ligature of the femoral artery, which enabled nature to complete the obliteration of the wounded part of the vessel. In 1834, I cut down to and tied the popliteal artery in the University College Hospital, to stop hæmorrhage from the posterior tibial artery, which had been wounded in a boy who, in cleaning a window, slipped, and thrust his leg through a pane of glass. As, in consequence of the house-surgeon having made several ineffectual attempts to stop the bleeding by ligature of the posterior tibial, there was an extensive ill-conditioned wound, I judged it better to tie the popliteal artery than to increase the disturbed state of the parts lower down. The operation, which was attended with no difficulty, succeeded completely, as the ligature of the femoral artery has done in the hands of Dupuytren, Delpech, and others, for the stoppage of hæmorrhage from the tibial arteries in compound fractures of the leg. Sometimes, says Mr. Hodgson, when hæmorrhage takes place, a few days after the bleeding from a wounded artery has been stopped by compression, one extremity of the vessel will be pervious, whilst the other will have closed by the natural processes. Cases have even occurred, in which the upper end of the artery has been closed by the natural processes, whilst those processes failed in effecting the obliteration of the lower extremity of the vessel, from which a serious hæmorrhage took place. (*Hodgson*, op. cit. 475; and *Guthrie*, in *New Med. and Phys. Journ.* vol. iv. p. 177.) Indeed, in the example in which I took up the femoral artery myself, it was impossible to say positively, whether the blood came from the part of the popliteal artery above, or below the slough in it, as no incision was made into the ham.

It is observed by Mr. Guthrie, that the lower end of a divided artery is more prone to secondary hæmorrhage than the upper; and that when bleeding returns, after having been arrested for a period of four hours, it takes place, in all probability, from the lower end. "This (says he) may always be known by the darker colour of the blood, and by its flowing out in a continuous stream, in the same manner as water rises from a spring, and not with any arterial impulse." (See *Guthrie, On Dis. and Inj. of Arteries*, p. 248.) His observations lead him to conclude, that the retraction and contraction of the lower end of a divided artery, is neither so perfect nor so permanent, as at the upper end; and that the internal coagulum (see HÆMORRHAGE) is in many instances altogether wanting, or very defective in its formation (p. 251).

In this work Mr. Guthrie censures the common fear about cutting muscular fibres, in operations to secure wounded arties; and, in support of his own view, points out the inconveniences attending the plan of taking up the posterior tibial artery, as described by Mr. Harrison (see *Surgical Anat. of the Arteries,* p. 177, vol. ii. ed. 2). Instead of this, he is an advocate for dividing muscles entirely, or the fibres of a muscle, by an extensive transverse incision, if likely to facilitate the application of the ligature to a wounded artery (p. 261). This last maxim, however, is not entirely new, Desault having long ago recommended cutting the sartorius across to get at the femoral artery; Scarpa, the pectoralis major, to get at the wounded axillary artery; and Dupuytren, the anterior scalenus, to reach a particular point of the subclavian. Mr. Guthrie disapproves of the directions given in some of the latest works for the ligature of the wounded posterior tibial and axillary arteries, and makes some remarks on "the manner of securing the ulnar artery, when wounded a little below its origin, and whilst covered by the pronator teres, and the superficial flexors of the forearm; viz. the flexor carpi radialis, palmaris longus, and flexor digitorum sublimis. Here, instead of regarding the operation as impracticable on account of the intervention of these muscles, or tying the brachial artery, he is an advocate for making a clean incision down to the artery, through all the muscular fibres interposed between it and the surface, avoiding the median nerve, which runs between the two origins of the pronator teres, and placing a ligature above and below the wound in the artery" (p. 271). "It is necessary to be attentive to the course of the great vessels and nerves, but not to the safety of muscular fibres, the division of which leads to no permanent injury" (p. 319). Mr. Guthrie also strongly protests against Dupuytren's practice of tying an artery injured by gun-shot, or a fractured bone above the place of injury, instead of exposing the vessel at the wounded point, and applying a ligature above and below the opening in it; a subject which I shall notice in subsequent articles. (See FRACTURE and GUN-SHOT WOUNDS.)

The principle, respecting the application of a ligature to each end of every large divided artery, is to be extended also to punctured arteries, one ligature being placed above, and the other below the opening in the vessel.

When an artery is merely cut or torn, but not completely divided, it seems to Mr. Guthrie to be in the same state, with regard to hæmorrhage, as if it had given way by ulceration. It can neither retract nor contract; and unless pressure be accurately applied and maintained, will continue to bleed until the patient is destroyed. "The practice to be pursued (says he), is to divide the vessel, if it be a small one, such as the temporal artery, when it will be enabled to retract and contract, and the bleeding will soon cease. If an artery of larger dimensions be wounded, a ligature should be applied above and below the wound; and the vessel may, or may not, be divided between them, at the pleasure of the surgeon. (*On Dis. and Inj. of Arteries,* p. 253.)

From some observations in the article ANEURISM, it will be seen, that when the impulse of the circulation has been lessened by the ligature of the main trunk of an artery, some distance above the wound, the hæmorrhage from the more remote portion of the vessel may sometimes be effectually restrained by pressure, which, previously to the stoppage of one great current of blood to the part, had proved unavailing. This fact is worth remembering in cases in which the arteries of the hand or foot are wounded.

Mortification is observed to be more frequent after the ligature of an artery for a wound than for an aneurism. In wounds Mr. Hodgson, very correctly, I think, refers the difference to the frequent injury of the surrounding parts, and particularly of the veins and nerves, and to the loss of blood, and want of quietude, and proper care, after the accident. The principal anastomising vessels are also sometimes divided (p. 479).

In the article ANEURISM, I noticed the questions about the propriety and safety of tying both carotids, and whether this could be done without extraordinary risk, when no interval was left between the two operations. With respect to these points, I find that M. Manec is decidedly of opinion, that both the common carotid arteries may be tied at once in the same individual, without any marked or lasting derangement in the functions of different parts of the head. He believes that the numerous anastomoses which exist in the interior of the skull, between the terminating branches of the vertebral arteries and those of the internal carotid, are more than sufficient for the ready conveyance of blood from the former into the latter, and for the prevention of the brain from being sensibly affected by the obliteration of the two common carotids. Externally, the numerous communications between the branches of the external carotids, and those of the two subclavian arteries, more particularly the free anastomosis of the lower thyroid with the superior thyroid arteries, and those of the ascending cervical with the occipital arteries, leave no doubt in M. Manec's mind respecting the correctness of the opinion which he has advanced. He has frequently tied both the common carotids in animals, without the slightest impairment of their intelligence, or of their general health. At the period when he was recording his views of this subject, there was in the dissecting-room of the hospital a large strong healthy dog, on which he had performed this operation four years previously; and whose intelligence continued perfectly undiminished. So fully convinced is M. Manec of the safety with which it may also be practised on the human subject, that he wished to undertake it on a young man who had an extensive tumor of erectile tissue on the face, but who would not submit to the proposal. (See *Manec, Traité, &c. de la Lig. des Artères,* pl. iv.)

Having explained in the article ANEURISM the plans adopted by some of the most celebrated operators, in cutting down to and tying many of the principal arteries, I will now introduce some additional instruction on this very important subject.

Perhaps, in no operation of tying an artery, is the exclusion of the vein and nerves of so much consequence as it is in that of applying a *ligature to the common carotid artery.* As Dupuytren remarks, this fact depends upon the importance of the organs to which the adjacent nerves are distributed, viz. the heart, lungs, and stomach. (See *Leçons Orales, &c.* t. iv. p. 17.)

The right common carotid trunk is much shorter than the left; the former arising from the brachiocephalic trunk, the latter from the arch of the aorta. Both terminate opposite the space between the os-hyoides and upper edge of the thyroid cartilage; and behind each of them are the longus colli and rectus capitis anticus muscles, placed in front of the cervical vertebræ. In the lower part of the neck, the trachea is near their inner side; higher up, the thyroid gland; and still higher up, the larynx and pharynx. The external side of the common carotid is in contact with the internal jugular vein, which partly overlaps it; while, between the two vessels, but rather behind them, and enclosed in the same common sheath with them, the pneumogastric nerve descends. In the lower part of the neck, the carotid sheath has behind it the recurrent laryngeal nerve and the inferior thyroid artery. The descending branch of the ninth nerve commonly lies upon the fore part of the sheath, closely connected to it, and about the middle of the neck, forms a plexus, with some filaments from the second and third cervical nerves. At the upper part of the neck this nerve lies rather towards the outer side of the sheath; at the lower, on the inner side. Mr. Harrison has often found it within the sheath, behind the jugular vein. The sympathetic and cardiac nerves are situated between the sheath and the rectus anticus major muscle. The common carotid artery is covered below by the skin, platysma, and cervical fascia, and also by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles. Opposite the upper rings of the trachea, it is crossed by the omohyoideus. But, from this point to its bifurcation, the vessel is covered only by the skin, platysma, and fascia. The omohyoideus, as it proceeds from the shoulder behind the sterno-mastoid muscle, divides the artery into an upper and lower portion, and the side of the neck into two triangular spaces. In the lower triangle, bounded by the trachea, clavicle, and omohyoideus itself, the common carotid is concealed by the sternal origin of the mastoid muscle, and lies deeply under the sterno-hyoid and sterno-thyroid muscles. But, in the upper triangle, bounded externally by the margin of the sterno-mastoid muscle, above by a transverse line denoting the uppermost extent of this space below the os-hyoides, and on the inside by the omohyoideus, the vessel is much more superficial. Here, however, a plexus of veins often lies directly in front of the carotid sheath. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 234; *Quain's Anatomy*, ed. 2, p. 437; *Harrison's Anat. of Arteries*, vol. i. p. 19, ed. 2; *Manec, Traité de la Lig. des Artères*, No. i. pl. iv.) A chain of absorbent glands lies near the carotid sheath, principally on its external side, and is partly concealed by the sterno-mastoid muscle, and covered by the cervical fascia. In young subjects these glands are large and numerous; "they are frequently enlarged and indurated by chronic inflammation; the muscles and fascia press them closely to the vessels; they become fixed, and have a pulsation communicated to them, so as to resemble aneurism." (*Harrison*, op. et. vol. cit. p. 21.)

The operation of tying the common carotid is sometimes performed while the patient is in the sitting posture; but, on account of the chance of his becoming faint, I consider the recumbent position best, with the chest somewhat raised, the neck moderately extended, and the chin turned towards the opposite side. If the artery is to be tied below the omohyoideus, the front edge of the sterno-mastoid muscle is to be first felt for, and an incision, three inches long, made in the direction of it, commencing opposite the cricoid cartilage, and directed towards the sterno-clavicular articulation, a little above which it is to terminate. The second stroke of the knife divides the platysma myoides and cervical fascia, so as to bring into view the fibres of the sterno-mastoid muscle. Unless this last incision be made over the latter muscle, it is best to pinch up a portion of the cervical fascia with the forceps, and cut it across, so as to make a small opening in it for the introduction of a director, on which it is to be slit up. (See *Quain's Anatomy*, p. 450, ed. 2.) An assistant now draws the inner margin of the wound, and the sterno-thyroid and sterno-hyoid muscles, towards the median line, while the surgeon himself draws the external margin of the wound, and the sterno-mastoid muscle, outward. For this purpose, blunt hooks are sometimes preferred, as not concealing the parts so much as the fingers.

The *omohyoideus* is now seen running across the wound in the form of a red cord, and above and below it are the vein and artery, enclosed in their common sheath.

This sheath should be opened over the artery, and not over the vein, with the aid of a pair of forceps and a director. If the jugular vein swell up so much as to conceal the parts, pressure is to be made on it at the upper angle of the wound. (See *Velpeau, Nouv. Elém. &c.* t. i. p. 241.) Then an eye-probe, or aneurism-needle, is to be conveyed between the vein and artery, and directed inwards under the posterior surface of the latter, without meddling with the pneumogastric nerve, the great sympathetic, or any of their branches.

It seems to M. Velpeau, that if the surgeon were to cut at first to the inner side of the mastoid muscle, there would be some risk of mistaking the sterno-hyoideus for it, and getting wrong. He thinks it better, therefore, to cut down upon the surface of the sterno-mastoid muscle, a few lines from its anterior margin. As the coats of the vein are very thin and easily torn, the knife is never to be applied near it.

If the sheath were not duly opened, the pneumogastric nerve, situated within its posterior layers, between the carotid and jugular vein, might possibly be tied, and the cardiac nerves and descendens noni be in danger of suffering the same fate.

The ligature of the common cartoid above the omohyoideus is rendered easier by the more superficial situation of the vessel, which is merely covered by the skin, platysma, and the cervical fascia. The incision is to commence a little below the level of the angle of the jaw, and be continued down to the extent of about three inches in the interspace between the sterno-mastoid muscle and the larynx, in the upper triangle of the neck. The skin and platysma having been divided, the cervical fascia is to be pinched up with a pair of forceps, and an opening made in it. Then a director is to be introduced, and the operation finished according to the directions already given, as applicable to that below the omohyoideus.

In the operation of applying a *ligature to the* *subclavian artery, on the outside of the scalenus anticus*, the patient is to lie on his back, with his shoulders somewhat raised. The head and neck are to be turned towards the sound side, while an assistant depresses the shoulder, and raises the arm from the side. The first incision is to be made transversely, an inch above the clavicle, as Velpeau directs, or near, or even upon it, as many other surgeons prefer, from the outer edge of the sterno-mastoid muscle to the front edge of the trapezius. After the integuments have been cut, the platysma myoides is to be divided. The external jugular vein itself may generally be drawn aside with a blunt hook; but, if this cannot be readily done, a double ligature must be put under the vein and tied, after which it is to be cut through in the interspace. Then the cervical fascia is soon exposed, which is to be cautiously opened, by pinching a piece of it up with the forceps, and making a small opening, which is to be enlarged with the aid of a director. The edge of the scalenus anticus can then be immediately felt under and within the sterno-mastoid muscle. After having lacerated or separated the cellular tissue, absorbent glands, &c., in the bottom of the wound with a probe, or a director, the finger is conveyed towards the insertion of the scalenus anticus, where the tubercle of the first rib will be felt, a little behind and on the outside of which the artery is situated.

When once the artery is found, it is not necessary to bring it into view; for the nail being applied to its posterior and external side, serves as a guide for the bent eye-probe or aneurism-needle, the point of which is to be passed from before, backwards, and a little from without inwards, the surgeon keeping his finger over the artery, between it and the lowermost nerve of the brachial plexus, so as to steady the vessel. (See *Velpeau, Nouv. Elém. &c.* t. i. p. 229.)

With reference to the *ligature of the external iliac artery*, I have but little to add to the account given of this subject in the article Aneurism. From the sacro-iliac symphysis, where the common iliac artery bifurcates, down to the crural arch, the external iliac artery describes a gentle curve, which is more marked in the female than the male subject, and the convexity of which is turned outwards and backwards. The artery descends along the inner margin of the psoas muscle, to which it is connected by a thin membrane, derived from the iliac fascia, situated behind the artery. Although the production from the iliac fascia is so thin that the artery and vein can be seen through it, yet it is sufficiently strong to prevent them from being displaced or separated. (See *Harrison's Surgical Anat. of the Arteries*, vol. ii. p. 117.) The vein lies to the inner side of the artery, and at first rather behind it; but, near Poupart's ligament, it is on the same plane as the artery, resting upon the os pubis, and upon a few fibres of the psoas and pectineus muscles. The anterior crural nerve is on the iliac side of the artery, but on a plane posterior to it, and separated from it by the psoas between which and the iliacus internus the nerve covered by the iliac fascia is imbedded. "Two or three small branches from this nerve, and from the lumbar plexus, are connected to the artery, and descend along its external side. These branches are distributed to the spermatic cord and to the integuments of the groin. (See *Harrison*, op. cit.) The ureter, in its descent behind the peritoneum, crosses over the anterior surface of the external iliac artery at its commencement, and so does the vas deferens near its termination. As for the peritoneum, it is connected to the external iliac artery merely by loose cellular tissue, and below quits the vessel entirely to be reflected over the posterior surface of the parietes of the abdomen. The only branches of importance, which the external iliac artery gives off, are the circumflexa ilii and the epigastric, which usually arise opposite the ilio-pectineal line, though sometimes a quarter or half an inch above, or below this point. The absorbent glands, which lie in the course of the external iliac artery, being sometimes enlarged, excite a suspicion of diseases which do not exist. On the right side, the cœcum, and, on the left, the sigmoid flexure of the colon, are the only viscera, interposed between the external iliac artery and the parietes of the abdomen. As MM. Bogros and Velpeau have noticed, nothing is easier, in a thin person, whose abdominal muscles are relaxed, than to make effectual pressure on this artery. M. Velpeau had an opportunity of ascertaining the truth of this observation in a young man, who met with an accidental wound of the artery above the origin of the epigastric, requiring the injured vessel to be tied without delay. (See *Velpeau, Nouv. Elém de Méd. Opér.* t. i. p. 172.)

In Abernethy's method of tying the external iliac artery, an incision is made, about three inches and a half in length, in the direction of the artery, down to Poupart's ligament. The aponeurosis of the external oblique muscle being thus exposed, is to have an opening cautiously made in it; and a director being now introduced, the aperture is enlarged in the direction of, and to the same extent as, the wound in the integuments. "The internal oblique and transverse muscles, which are closely connected with each other, are to be carefully cut into at the lower part, so as to allow a director, or the point of a finger, to be introduced below them, when they also are to be divided, the finger separating them from the fascia transversalis and peritoneum. The fascia transversalis, running from Poupart's ligament to the peritoneum, is now to be torn through with the nail, immediately over the pulsating artery, and the peritoneum is to be separated by the finger, and pushed upwards until sufficient room is obtained; which, in this, as well as in all other operations on the iliac arteries, is sometimes difficult, on account of the protrusion of the intestines, covered by the peritoneum, when the patient is not sufficiently tranquil. The artery is yet at some depth, and covered by a dense cellular membrane, connecting it to the vein on its inside, and which must be torn through with the nail. The aneurism-needle should be passed between the vein and the artery, and the point made to appear on the outside of the artery." (See *Guthrie, On Dis. &c. of Arteries*, p. 373.) This description, with the observations in the article Aneurism, will suffice to render Abernethy's plan very intelligible.

To the account of Sir Astley Cooper's method of taking up the external iliac artery, given in that part of the Dictionary, I have nothing to add.

In the article Aneurism, a description is given of the operation of *tying the femoral artery* in the upper third of its course. If it were indispensable to apply a ligature to it in the *groin*, or *just below the crural arch*, the surgeon should remember, that here the situation of the artery corresponds to the mid point between the anterior superior spinous process of the ilium and the tuberosity of the os pubis; though, in women, in whom the pelvis is wider, the artery is rather nearer the pubes. The vessel may also be readily felt as it is passing over the os pubis, being only covered by the integuments, superficial fascia, some lymphatic glands, and the fascia lata. Immediately below Poupart's ligament, the femoral vein lies on the pubic side of the artery. The anterior crural nerve lies about half an inch away from the iliac side of the artery, imbedded between the iliac and psoas muscles. (See *Harrison's Surg. Anat. of Art.* vol. ii. p. 136.) In the operation, the limb should be extended and rotated outwards; an incision made, beginning about an inch above Poupart's ligament, and extended downwards in the direction of the artery, to the distance of two inches below this ligament. The layers of the superficial fascia are then to be divided to the same extent; and any lymphatic gland in the way pushed to one side, or, if enlarged and diseased, removed. The fascia lata is next to be divided, and the sheath of the femoral vessels pinched up with a pair of forceps, and cautiously opened. Lastly, the aneurism-needle, or eye-probe, used for the conveyance of the ligature under the artery, is to be introduced on the pubic side of this vessel, between it and the vein, so as to leave the latter completely safe. As in some individuals the origin of the profunda is unusually high up, and of nearly the same size as the femoral, one of them might be mistaken for the other. The profunda, however, is the more external of the two. The effect of pressure on each, in checking the hæmorrhage, or the pulsation of an aneurism, will also be a guide to the operator. (See *Harrison*, op. et. vol. cit. p. 160.) Sometimes a double femoral artery has been met with.

The direction, given by M. Malgaigne, to place the ligature as closely as possible above the origin of the profunda (*Man. de Méd. Opér.* p. 188), if adopted, would be very likely to be followed by secondary hæmorrhage, for reasons elsewhere explained. (See HÆMORRHAGE.)

The operation of *tying the femoral artery in the middle third of the thigh*, not having been fully described in the article ANEURISM, I annex the following particulars:—This artery, in its course from the crural arch to the lower third of the thigh, runs in the direction of a line, which, drawn from the centre of Poupart's ligament, descends obliquely inwards round the limb to the middle of the popliteal space. This description is nearly correct; but, as Dr. Quain observes, as this line runs along the inner surface of the thigh, its course is more oblique than that of the vessel, which is placed much nearer the shaft of the femur. (*Elem. of Anat.* p. 505, ed. 2.) In the middle third of the thigh, the femoral artery is more deeply placed than in the upper, because, in addition to the integuments, superficial fascia, and fascia lata, it has the sartorius lying upon it, beneath which there is also another fascia extended over it, from the adductor muscle to the vastus internus. This fascia, though thin above, becomes very dense where the artery approaches the opening in the adductor magnus. In the groin, the femoral vein lies close to the inner side of the artery, but, as it descends, it gets more under the latter vessel, and, in the popliteal space, it is situated quite to the outer side of it.

An incision, three inches in length, is to be made along the inner edge of the sartorius, which is the common rule, and perhaps better than Lisfranc's modification, which consists in making an incision of this length in the mid space between the gracilis and sartorius; for, by exposing the fibres of the latter muscle, their very course affords useful instruction to the surgeon; for he then knows immediately where he is, and what ought to be done. The integuments and superficial fascia having been divided, and the fascia lata to the same extent, the inner edge of the sartorius is exposed. This is to be gently raised, and drawn outwards. The fascia, extending from the vastus internus to the adductor, and covering the artery, is brought into view, and with the aid of a pair of forceps, and a director, it is to be cautiously opened, by which means the sheath of the femoral vessels will be exposed. Here the long saphenous nerve lies within the sheath, on the anterior and external side of the artery, and care should be taken not to include it in the ligature. Lastly, the aneurism-needle is to be conveyed under the artery, between it and the vein. In making the incision through the integuments, the great saphenous vein should be avoided, by not directing the knife too obliquely downwards and backwards.

In addition to what has been stated in the article ANEURISM, respecting the *ligature of the brachial artery*, I may observe, that the course of this vessel corresponds to an oblique line drawn from the armpit to the middle of the bend of the elbow. The median nerve, which above runs along its radial margin, soon gets in front of it, and, crossing it very obliquely, passes quite to its ulnar side below. Two satellite veins usually accompany the artery, and even sometimes cover it, and thus separate it from the median nerve. The ulnar and internal cutaneous nerves, which lie near it above, separate further and further from it as they descend, in order to reach the inner part of the fore-arm. The artery, lying at first near the humerus, between the coraco-brachialis and the tendon of the latissimus dorsi, afterwards passes over the insertion of the coraco-brachialis, and gets upon the brachialis anticus, a little behind the inner margin of the biceps, which last muscles it accompanies to its termination. In the supine state of the hand, the brachial artery is less covered by the biceps; and hence, in the operation of taking it up, this position is advantageous. (See *Manec, Man. de Méd. Opér.* p. 166.) In thin subjects, the fascia is almost contiguous to it, and sends off a duplicature to include the artery, its two accompanying veins, and the median nerve, all which form, as it were, one common fasciculus.

The whole is covered by the common integuments, and in the lower third of the arm, by the trunk of the basilic vein. The anomalies of the brachial artery are very frequent. Velpeau, and most other surgeons, have seen it divide near the axilla, and at nearly every other point between this and the elbow. In one subject, Velpeau found its bifurcation take place two inches above the trochlea of the humerus, to form the ulnar and posterior interosseous. In another, the latter was completely independent of both the ulnar and the radial. Sometimes the two trunks, produced by the bifurcation, pass down to the fore-arm parallel to one another; in other instances, they cross once, or several times; and it is not uncommon to find one piercing the fascia, so as to get immediately under the skin, while the other, which then gives off the radial and the interosseous, retains its ordinary relations. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 210.)

In the operation of *placing a ligature on the brachial artery at the bend of the elbow*, the surgeon should remember, that the course of the vessel here corresponds to a line drawn obliquely inwards and upwards, from the middle of the front of the elbow, to the inner border of the biceps. Its course is also denoted by the median basilic vein, which passes under the skin, almost in the same line as the artery. An incision, between two and three inches in length, is to be made through the skin, on the inner side of this vein, which is to be carefully drawn out of the way. Then, with the aid of a director, the fascia, and the fibrous production given off from the tendon of the biceps, are to be divided; which having been accomplished, the artery will present itself, bounded on the right and left by its two venæ comites, the median nerve lying three or four lines from its inner, and the tendon of the biceps the same distance from its outer, border. To facilitate the passage of the aneurism-needle or director under the artery, the elbow is to be a little bent, and the instrument passed from within outwards under the vessel. (See *Manec*, op. cit. p. 166.) If the operation were performed somewhat higher, the surgeon must remember, that two or three inches above the trochlea of the humerus, the median nerve would begin to be in front of the artery.

In the *upper part of the arm*, the brachial artery lies at the inner border of the coraco-brachialis, and has the median nerve at first external to it, and then in front of it. Below the insertion of the coraco-brachialis, it is situated at the inner edge of the biceps. Four circumstances are enumerated as guides for the external incision:—1. The inner edge of the coraco-brachialis above, and that of the biceps below. 2. A line drawn from the middle of the axilla to the middle of the bend of the elbow. 3. Placing the fingers on the median nerve, and cutting on its inner side. (*Lisfranc.*) 4. The pulsations of the artery.

The knife is carried in the direction of the artery from above downwards in the right arm, and from below upwards in the left, and an incision made in the integuments, about three inches long. With the forefinger, the surgeon next endeavours to feel the median nerve, which presents itself as a round very hard cord; and to distinguish the artery by its pulsations. He then divides, with the aid of a director, one after the other, the fascia, and the sheath given off by it to the median nerve; and breaking, with the end of a probe or director, the fibro cellular covering of the vessels, separates the artery from the veins, and puts a ligature under it. Except when anomalies occur, the operation is simple. M. Velpeau has only once seen the median nerve under the artery. In all ordinary cases, it is the first cord met with behind the inner margin of the biceps. (See *Velpeau, Nouv. Elém. &c.* t. i. p. 211.)

As some very celebrated surgeons have made the serious mistake of tying the median nerve for the brachial artery, I advise the practitioner never to tighten the ligature, until he has tried the effect of pressure on what he supposes to be the artery.

In order not to mistake the ulnar for the median nerve, and to be led to seek for the artery where it will not be found, it is an excellent rule to proceed in the operation from the anterior to the posterior part of the arm. (See *Manec, Man. de Méd. Opér.* p. 167.)

Ligature of the Radial Artery behind the Carpus.—If the thumb be forcibly extended, the tendons of its great abductor and long extensor will be made very prominent behind. In the depression between them, the pulsations of the radial artery can be felt. The thumb being drawn away from the forefinger, an incision, an inch and a half in length, is to be made in the direction of the foregoing tendons, first through the skin, and then through the fascia. The artery is then to be separated from some veins and nervous filaments, with a probe or director. (See *Manec*, op. cit. p. 163.)

Ligature of the Radial Artery in the Lower Third of the Fore-arm.—Here the artery can readily be felt, being only covered by the fascia and the skin. On each side of it is a vein; but the radial nerve is considerably to the outer side of it, having passed under the supinator radii longus, a little below the middle of the fore-arm. An incision, two inches and a half long, is to be made a little way from the radial margin of the flexor carpi radialis, between this and the supinator longus. The fascia is to be opened, and the ligature passed from within outwards, or from without inwards, as the surgeon may choose, as it is a matter of indifference, the nerve being out of danger.

Ligature of the Radial Artery in the Upper Third of the Fore-arm.—Here the artery runs in the space which separates the supinator radii longus from the pronator teres and palmaris longus, covered by the internal border of the first of these muscles, and of course by the fascia and the skin. It is always accompanied by two veins, and has the radial nerve at its outer side. Its course is accurately indicated by a line, drawn from the middle of the bend of the elbow to the mid point between the styloid process of the radius and the tendon of the palmaris longus.

In the direction of this line, M. Roux makes an incision, about two inches and a half in length, commencing a little below the elbow. If the median vein is met with, it is pushed aside. The fascia is then slit up with a director, and the border of the long supinator drawn outwards, without dividing it. The artery having been brought into view, the aneurism-needle, or eye-probe, is passed under it from without inwards, on account of the nerve. (See *Manec, Man. de Méd. Opér.* p. 164.)

Others adopt the following plan:—A finger is to be put on the insertion of the tendon of the biceps. A little below this insertion, an incision, about two inches and a half in length, is to be made in the integuments, in the oblique direction, denoted by the inner edge of the supinator radii longus. The subjacent fascia is then to be divided, and the inner edge of the supinator muscle drawn a little to the outer side of the arm: in the space between that muscle and the flexor carpi radialis, the radial artery immediately presents itself, passing over the tendon of the pronator radii teres. Below this it lies upon a few fibres of the flexor sublimis and the flexor longus pollicis. Afterwards it runs down between the latter-named tendon and the flexor carpi radialis. (See *Camper's Demons. Anat. Pathol.* lib. i. tab. 1, fig 2.)

Ligature of the Ulnar Artery at the Wrist.— Here the artery passes on the radial side of the pisiform bone, with the ulnar nerve on its inner or ulnar side, and a vein on each side of it. In this place an incision, two inches long, is to be made through the skin, cellular tissue, and palmar fascia, one after the other. The artery having been thus exposed, an eye-probe is to be passed under it from without inwards.

Below the middle of the fore-arm, the ulnar artery is superficial, and may easily be taken up by making an incision upon the radial side of the flexor carpi ulnaris, between the tendon of which muscle and that of the flexor sublimis digitorum, the vessel is situated. The artery, however, will not be reached until a thin aponeurosis under the fascia of the fore-arm has been divided. The nerve is rather more under the tendon of the flexor carpi ulnaris than the artery. When the ulnar artery arises from the brachial above the elbow, it sometimes pierces and runs above the fascia, and is easily taken up in any part of its course.

For bringing into view *the ulnar artery at the upper third of the fore-arm*, the situation and breadth of the flexor carpi ulnaris muscle must first be ascertained. An incision is then to be made from above downwards, beginning two inches below the inner condyle of the humerus, and following the course of the inner margin of the above muscle to the extent of two inches and a half. The fascia is then to be divided ; and the flexor carpi ulnaris drawn a little away from the flexor sublimis. In this opening, rather under the margin of the latter muscle, the ulnar artery will be felt with the finger, continuing its course over the flexor profundus. The ulnar nerve is situated on the ulnar side of the artery. Mr. Guthrie's opinions, respecting the propriety of dividing the muscles which conceal the upper third of the ulnar artery, have been noticed in the beginning of the present article.

Ligature of the Anterior Tibial Artery on the Foot. — The anterior tibial artery becomes superficial about six inches above the ankle, from which point it descends between the tendon of the tibialis anticus and that of the extensor of the toes. It passes with these tendons under the annular ligament, and rather nearer to the internal malleolus than the external; thence inclining inwards, it penetrates between the first and second metatarsal bones to the sole of the foot, where it inosculates with the external plantar artery. The dorsal nerve of the foot is at its inner side; its corresponding veins lie on either side. It is covered— 1st, By a thin fibro-cellular expansion, separating it from the adjoining tendons. 2ndly, By adipose cellular tissue. 3rdly, By the fascia of the instep. 4thly, By the common integuments. On the instep, the first tendon of the extensor communis digitorum pedis, lies upon the outer side of the artery ; that of the extensor of the great toe upon its inner side.

An incision, two inches and a half long, is made in the skin, in the direction of an oblique line from the middle of the instep to the first interosseous space. The skin, adipose substance, and fascia, are to be divided ; the fibro-cellular aponeurosis, between the tendons of the first two toes, opened ; and the artery tied, after being separated, by means of a director, from the accompanying nerve and veins. (*Velpeau.*)

Ligature of the Anterior Tibial Artery in the Leg. — The two upper thirds of this artery lie close to the interosseous ligament; but lower down the artery advances towards the outer side of the spine of the tibia; consequently, the higher it is, the more deeply it is situated. The two veins accompanying it inosculate across it by several small branches. The anterior tibial nerve crosses over it obliquely inwards and downwards, though sometimes it continues on its outer side down to the instep. The artery, veins, and nerve, are included in cellular tissue, which does not, however, form a true sheath for them. Above, the artery lies between the tibialis anticus and the extensor communis ; in the middle of the leg, between the tibialis anticus and the extensor of the great toe; and still lower down, between the extensor of the great toe and the extensor communis.

Ligature of the Anterior Tibial Artery in its Lower Third. — The skin, the subcutaneous fat, the cellular tissue, and the fascia, are to be divided in succession, to the extent of about three inches, and in the direction of a line drawn from the mid point between the head of the fibula and spine of the tibia to the instep. Then, with a director or the fore-finger, the tendon of the extensor muscle of the great toe is to be separated from that of the tibialis anticus, pushing it outwards towards the extensor communis, if the operation be at the upper part of the lower third of the leg ; but inwards, if the operation be done quite at the inferior extremity of the leg. Nothing, then, remains to be done, but to separate the artery from its accompanying veins, and from the anterior tibial nerve, which in this part of the limb is at its inner side, having crossed it from the outer in its descent. (See *Manec*, pl. xii. fig. 1 ; *Velpeau, Nouv. Elém. &c.* t. i.)

Ligature of the Anterior Tibial Artery in its Middle or Two Upper Thirds.—Lisfranc makes an incision extending obliquely from below upwards, from the spine of the tibia towards the fibula. Having cut transversely through the fascia, the interspace between the tibialis anticus and the extensors is sought for.

In the ordinary method an incision is made in the track of the artery, as determined by the line above specified, about an inch on the outside of the spine of the tibia. The skin and fascia are divided to the extent of three inches. The muscular interspace, at the bottom of which the artery will be found close to the interosseous ligament, is denoted by a yellowish line, and is more distinct at the lower part of the wound. In order to convey the ligature round the artery, Velpeau passes a director under it very obliquely, from below upwards, and from the fibula towards the tibia.

Ligature of the Posterior Tibial Artery.—From its origin, a little below the poplitæus muscle, to its division into the external and internal plantar arteries, the posterior tibial artery follows very precisely the direction of a line, with a slight convexity inwards, from the middle of the upper part of the calf to a point half an inch behind the internal malleolus. Two veins usually accompany it, sometimes forming by their anastomoses a complete network round it. In the upper part of the leg, for the first two inches, the posterior tibial nerve lies to the inner or tibial side of the artery, and then passes over it to the outer or fibular side. In the two upper thirds of the leg, the posterior tibial artery is deep seated, lying in the upper third upon the tibialis posticus, in the middle third upon the flexor digitorum communis; while lower down it is separated from the tibia only by fat and cellular tissue. From the gastrocnemius and soleus, which muscles lie over its two upper thirds, it is separated by the deep crural fascia. In the lower third, no muscles cover it.

In the arch of the os calcis, the posterior tibial artery is in contact with the fibrous sheath of the flexor communis digitorum, about half an inch from the posterior border of the inner malleolus. Here the nerve is behind it, the veins on either side. The artery is enveloped in cellular and adipose tissue. The internal ligament of the tarsus, a fibrous layer continuous with the fascia of the leg, after covering the artery, becomes blended with the dense cellular tissue interposed between the vessel and the skin. (*Velpeau.*) Between the internal malleolus and the lower part of the calf, the posterior tibial artery is somewhat further from the internal edge of the tibia, and the nerve is rather on its outer side than behind it. The deep-seated fascia, which is here very thin, keeps the artery bound down upon the flexor longus communis digitorum. Superficial to this fascia is the tissue that fills the sheath of the tendon of Achilles, and then the common fascia of the leg directly under the skin.

Opposite the calf, the posterior tibial artery is very deeply seated, almost on the same plane as the posterior surface of the tibia, and much nearer to its external or fibular edge than its internal. It is covered by a strong fascia, that lies over the flexor muscles; and then by the tibial portion of the soleus; the internal head of the gastrocnemius; the fascia of the leg; the subcutaneous cellular tissue, in which are found the great saphenous vein and the long saphenous nerve; and lastly the skin. (See *Velpeau.*)

In this operation the leg is to be bent and laid upon its outside.

Behind the malleolus internus. — An incision, slightly curved, with its concavity forwards, is to commence an inch above, and to terminate an inch below the posterior edge of the malleolus internus, and to be at least three lines behind it. It will, therefore, be between the malleolus internus and the tendo Achillis. If the operation is to be performed in the hollow of the os calcis, it is necessary, as M. Velpeau directs, to divide the tissues cautiously, layer by layer, and to introduce a director under the fascia, previously to its division, lest the artery, which is sometimes very superficial, be wounded. If the incision were made too near the malleolus, the fibro-synovial sheath of the groove, which that process contributes to form, would be opened: if too far backward, the artery would be more difficult to find. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i.) In fact, behind the lower end of the tibia, the tendons of the tibialis posticus and of the flexor communis digitorum pass in a kind of furrow. Along with these two tendons, but somewhat nearer to the os calcis, the posterior tibial artery descends to the sole of the foot.

The depth of the posterior tibial artery in the two upper thirds of the leg, makes it difficult to take it up in these situations. When necessary, however, it may be exposed, and tied above and below the wound in it, by proceeding as follows:— An incision, four inches in length, is made along the inner side of the tibia; the soleus muscle detached from the bone to the same extent, and reflected. The internal saphenous vein is to be avoided. Under the soleus muscle is found the fascia, which separates the muscles of the calf into superficial and deep-seated. When this fascia has been divided, the posterior tibial artery may be seen, or felt, deeply situated, running on the tibialis posticus and flexor muscle of the toes. (See *Haller, Icon. Anat.* fasc. v. tab. 5; *Manec, De la Lig. des Artères*, fol. Paris, 1822, pl. 13.)

The method of trying to take up the posterior tibial artery, by making the incision at the inner and posterior edge of the tibia, is disapproved of by Mr. Guthrie on account of its difficulties. "The operator (says he) has cut his four inches, has turned up the edge of the gastrocnemius, and has insinuated his director under the head of the soleus, which he has also sliced away from the bone. The artery is still an inch outwards bound down by a strong fascia," which "must be cut immediately over, or by the side of the artery: it will not do to separate it from the bone, and then to push it outwards or towards the fibula; it cannot be done." Then supposing the fascia to be divided in the best way, Mr. Guthrie deems the separation of the two veins from the artery, and the passage of the aneurism-needle under the artery from without inwards, so as to avoid the nerve, almost impracticable. "If a bystander should inquire why this most painful, difficult, bloody, tedious, and dangerous operation is done, the answer would be, solely because it was not usual to make a longitudinal incision in the muscles of the calf of the leg, — an incision, which, if made by accident, would be pronounced to be one attended with little danger, and not likely to lead to any subsequent detriment." (See *Guthrie, On Inj. and Dis. of Art.* p. 259.)

Instead of this method, Mr. Guthrie advocates the following:—An incision is to be made, six or seven inches in length, through the integuments and muscles of the calf down to the fascia. If the case is a gun-shot wound, the centre of the incision is to be on a line with the shot-holes; or if they are diagonal to each other, between them. The smoothness of the fascia points it out; and the loose cellular membrane, connecting the divided muscles to it, allows the edges of this long incision to be easily separated and the fascia cut, so as to expose the nerve, artery, and veins. The tourniquet is now to be unscrewed, and the bleeding denotes where the artery is injured. The knife may be applied perpendicularly to the fascia, and the artery laid bare for three or four inches in extent (p. 261). Perhaps the length of the incision, as here described, is rather greater than actually necessary. Five inches will afford a great deal of room; but, where the muscles of the calf are very bulky, it will be requisite to make the wound long.

Ligature of the Peroneal Artery. — Here, in following Mr. Guthrie's directions, the incision should also be made through the muscles of the calf, towards the fibular side of the leg; and after the deep fascia under them has been divided, the artery will be found covered by the fleshy fibres of the flexor longus pollicis, at any point below three inches and a half from the head of the fibula. These fibres having been divided, the artery will be found close to the inside of the bone. Above the point specified, the artery lies upon the tibialis posticus, under the deep fascia interposed between it and the muscles of the calf. No large nerve accompanies it.

Ligature of the Axillary Artery.—In proportion as this vessel approaches the hollow of the axilla, it gets nearer to the vein, and becomes surrounded by those nervous fasciculi, by means of which, one portion of the brachial plexus communicates with another. Hence, to cut down to the artery in this place in the living body, and to tie it separately, is acknowledged to be an arduous task. The difficulty is further increased by the distance of the vessel from the surface. Hence, M. Manec objects to any attempt being ever made to apply a ligature to the artery between the pectoralis minor and the lower border of the subscapularis. Independently, says he, of the difficulties of the operation, this part of the axillary artery would be unfavourable to its success, on account of the several branches which are given off from it, near one of which the ligature must be placed.

Directly the axillary artery has arrived opposite the lower border of the great pectoral muscle, the difficulty ceases. Here the brachial plexus no longer exists; each of the different nerves arising from it has taken the course to its particular destination, and the artery is only covered by the integuments and fascia. Behind, it rests upon the tendons of the teres major and latissimus dorsi; in front, it corresponds to the coraco-brachialis, from which it is separated by the median nerve. At its inner side are the internal cutaneous nerve, and the axillary vein, which sometimes consists of two or three branches, and renders the dissection of the artery more tedious. Farther backward than the axillary vein are the ulnar and musculo-spiral nerves. The relation of these last nerves to the artery it is of great importance to recollect, in order that neither of them may be mistaken for the median nerve.

In the operation of taking up the extremity of the axillary artery, the patient should be placed upon his back, and the arm raised from the side. An incision, two inches and a half in length, is to be made six or eight lines behind the anterior margin of the axilla, through the skin and subcutaneous cellular tissue. A piece of the fascia is then to be lifted up with the forceps, and an opening made in it, by cutting transversely, close to the end of the forceps; then a director is to be passed into the opening, and the fascia slit up to the extent of the external wound. If the fascia be tough and dense, so as not to afford convenient room, Manec recommends the incision in it to be converted into a crucial one. These things having been accomplished, the further use of the knife is not necessary. The anterior edge of the wound being now lifted up, the coracho-brachialis will be seen, and the median nerve at its inner side. This nerve being detected, the artery will be found behind it.

M. Manec offers valuable cautions with reference to the manner of avoiding the serious mistake of supposing the ulnar or musculo-spiral nerve to be the median. To escape this blunder, he very properly insists upon the prudence of proceeding backwards from the coraco-brachialis, for in doing so the first nerve arrived at is the median. (See *Manec, Traité de la Lig. des Artères*, fol. Paris, 1832, Expl. of pl. 6.) In the case of a wound, however, the surgeon has not exactly the choice of the place for the application of the ligature to the axillary artery. Here he must obey the rule of applying it to the wounded part of the artery, and putting one ligature above and another below the bleeding orifice; or if the artery be completely severed, both its extremities will require to be tied.

In taking up the axillary artery, when it is wounded, Scarpa believes that nothing tends more to embarrass the surgeon, than an injudicious smallness of the first incision through the skin and such other parts as conceal the wound in the artery. An assistant must compress the vessel, from above the clavicle, as it passes over the first rib. When the weapon has penetrated from below upward, directly into the axilla, the surgeon is to make a free dilatation of the wound upon a director, or his finger. This must be done to a sufficient height to expose a considerable portion of the artery, and the precise situation of the wound in it.

When the weapon has pierced obliquely, or from above downwards, through a portion of the great pectoral muscle, into the axilla, Scarpa advises the surgeon to cut through the lower edge of this muscle, and enlarge the wound, on a director, or his finger, so as to bring fairly into view the injured part of the artery. The thoracic arteries, divided in this operation, must be immediately tied. The clots of blood are then to be removed, and the bottom of the wound cleaned with a sponge, by which means the opening in the axillary artery will be more clearly seen. As this vessel lies imbedded in the brachial plexus of nerves, the surgeon must take care to raise it from these latter parts with a pair of forceps, before he ties it. Two ligatures will be required; one above, the other below, the wound in the artery.

ARTERIOTOMY (from ἀρτηρία, an artery, and τέμνω, to cut). The operation of opening an artery, and taking blood away from the system in this manner, for the purpose of preventing, alleviating, or curing disease. The only arteries of any size from which blood is ever taken in practice are the trunk and branches of the temporal artery, which lie in such a situation that after the due quantity of blood has been taken away the bleeding can be readily stopped by compressing the wounded part of the vessel against the neighbouring portion of the cranium. A narrow sharp-pointed bistoury, or a lancet, a basin for the reception of the blood, a compress, and a roller, are the only things required. In general, it is best to open the trunk of the temporal artery; but sometimes its frontal or occipital branch will yield blood enough. When the part of the artery which the surgeon chooses to open lies near the surface and its pulsation is very distinct, and even visible, it may be opened at once with a lancet. But, in many instances, it is better first to make a cut in the skin, and then puncture the vessel. In all cases, the surgeon should recollect, — 1st, That the temporal artery and its branches are covered by the skin, adipose cellular tissue, a thin aponeurosis, and the slender and pale fibres of the anterior auris muscle. 2ndly, That the trunk of the artery divides in the temple, about fifteen lines above the zygoma, and is situated about four lines in front of the meatus auditorius. 3rdly, That its frontal branch runs forward from its origin, and its occipital branch in the opposite direction. A good place for the puncture is about four lines above the zygoma. In many instances, the requisite quantity of blood cannot be drawn by this operation, as every surgeon of experience must have observed. In order to prevent the blood from trickling down over the bedding or clothes, when it does not issue in a jet, the French make a little gutter with a piece of card for conveying it into the basin. After the proper quantity of blood has been taken away, a graduated compress and a few turns of a roller round the forehead, temple, and occiput, are to be applied. In a few cases, notwithstanding pressure, the blood bursts forth from time to time ; and when this happens, it is best to cut the vessel completely across, which will enable its ends to retract and contract, and thus promote the process of nature in closing them. In three or four days the wound is generally healed, but occasionally an aneurism follows ; an interesting memoir on which subject has been published by M. Desruelles. (See *Mém. de la Soc. Méd. d'Emulation,* t. ix. p. 277.) In one instance, Cavallini effected a cure by dividing the vessel and compression. (*Collez di Casi Chir.* t. ii. Firenze, 1762.) Sir Benjamin Brodie informed me of a case which he treated successfully in a similar manner. In the course of the present year, 1836, a woman was under my care in University College Hospital for a temporal aneurism, which followed cupping on the temple. As the blood found its way freely into the tumor, after one branch had been tied, I divided another, and applied a compress ; the plan was then effectual. Sir Astley Cooper informed me of a temporal aneurism which was produced by a person falling with his temple against the corner of a table.

M. Blandin had a patient, who, in consequence of arteriotomy, suffered acute pains, which extended to the top of the head, in the track of the superficial temporal nerve ; this consequence, which is uncommon, may be relieved by lengthening the puncture, or incision, at each of its angles, or even cutting out a portion of the nerve. (See *Dict. de Méd. et de Chir. Pratiques,* t. xiv. p. 422.)

ARTERITIS. *Inflammation of an Artery.* As the coats of arteries possess vessels and nerves of their own, and have an organisation more or less similar to that of all the living textures of the body, they must be liable to inflammation, suppuration, ulceration and gangrene, as well as other morbid changes, especially a deposit of calcareous or atheromatous matter, between the inner and middle coats. Arteritis, as contrasted with phlebitis, or inflammation of veins, is much less perfectly understood, so far as the symptoms and diagnosis are concerned. It is very certain, however, that the arteries are not so irritable as the veins, and, consequently, that arteritis is less frequent than phlebitis. Pathologists divide it into *acute* and *chronic.* The anatomical characters of the acute are, redness of the internal membrane of the artery affected, an effusion of plastic fibrine on its inner surface, thickening of its substance, and sometimes ulceration. When inflammation runs from a wound, or some other point of irritation, along the internal coat of an artery far towards the heart, it is like phlebitis ; a formidable disease, rapidly producing great irritative fever, an extremely quick pulse, complete collapse, low delirium, and generally death. Arteritis, by completely obstructing a main artery and its principal branches, is sometimes a cause of mortification. The treatment of acute arteritis consists in bleeding, purgatives, diaphoretics, low diet, cooling diluent drinks, and perfect tranquillity. Digitalis, tartrate of antimony, and super acetate of lead, are also prescribed on the principle of calming the circulation ; but, as Dr. Hope observes, they must be used with discretion. (See *Cyclop. of Pract. Med.* part. ii. p. 149.) After the first violence of the inflammation has been checked, mercury is sometimes given, so as to excite gentle but quick salivation.

Chronic arteritis is more common than acute. The internal membrane becomes thickened, softened, and of a deep, dirty red colour. "These appearances," says Dr. Hope, " are not uniformly diffused, but more marked in the vicinity of calcareous and other degenerations. Hence, some have supposed that these degenerations were the cause of the inflammation. There can be little doubt that they tend, in many instances, to keep it up ; but, it is highly probable that the degenerations themselves were originally caused by increased vascular actions of a chronic nature." (See *Cyclop. of Pract. Med.* part ii. p. 145.)—The formation of spontaneous aneurisms is now commonly believed to have its origin in chronic arteritis.

[As our opinions change with regard to the vascular supply to, and mode of nutrition of, any tissue, so must our views, with respect to the morbid changes to which such tissue is liable, and their mode of production, undergo modification. Many histologists now consider that the internal and middle fibrous coats of arteries belong to the so-called non vascular tissues, and that they are dependent for their nutrition not upon the blood carried to them by the vasa vasorum, but that they obtain it by imbibition from the blood current they contain, and with which they are in contact. Pathologists who hold these anatomical views, must explain the well-known morbid conditions of the inner and middle coats of arteries very differently from their predecessors. Accordingly, we find Rokitansky and others ascribing to arteritis only those changes which are observed as the result of inflammation carried on in the outer coat of an artery by the vasa vasorum, to which coat alone they admit these vessels to belong. These morbid changes consist of the ordinary results of inflammatory action, and are attended by the usual symptoms associated with this process, such as increased vascularity, pain, and tumefaction. and are of course accompanied by the ordinary infiltration of serum, lymph, or pus; these infiltrations, it is admitted, may permeate, and more or less disintegrate the middle fibrous coat, and thus secondarily interfere with its nutrition, and even with that of the internal coat. The principal changes produced by inflammation of an artery carried on by the vasa vasorum of the outer coat, Rokitansky thus describes : — 1. "*Injection, redness of the cellular sheath of the vessel.*—This is commonly no longer distinctly apparent after the establishment of those products which we are about to name.—2. *Infiltration of the cellular sheath,* with a serous, serofibrinous, partially solidifying moisture, causing puffiness ; in some few cases the tissue exhibits purulent exudations, which are either diffused, or limited to individual points, or grouped into circumscribed foci.—3. *Extreme lacerability — the facility with which the cellular sheath may be removed* from the circular fibrous coat. — 4. *The circular fibrous coat* appears loosened and succulent ; admits readily of being drawn into fibres, and separated from the elastic coat; is commonly blanched, and sometimes coloured in different shades of red from the inner surface of the vessel through imbibition, although without any apparent injection. *The lining membrane* of the vessel is loosened, and may be easily detached or torn ; its free surface is dull, and occasionally exhibits a felt-like or wrinkled appearance ; it is either pale or reddened by imbibition. — 5. The vessel is frequently, although not always perceptibly, *dilated;* which is owing to the paralysis of the elastic layer of the cellular sheath and the circular fibrous coat. A coagulum of blood, acting as a plug, is lodged in the canal of the vessel, whose bore is thus more or less completely filled and obstructed. — 6. *The presence of a free product* (*exudation*) *covering the inner surface of the vessel in the form of a pseudo membrane* is, in most cases, problematical.—7. In rare cases arteritis gives rise to a partially or wholly *purulent exudation.*" (*Rokitansky's Manual of Pathological Anatomy,* translated by Dr. Day for the Sydenham Society, vol. iv. p. 254.)—It is to the above affections of the arteries that the antiphlogistic treatment is alone applicable.

The remaining, and most frequently observed morbid changes, such as atheromatous, steatomatous, osseous, cretaceous, and fibrinous depositions, Rokitansky attributes to defects and alterations in the mode of nutrition of the internal and middle coats as obtained from the blood itself. Speaking of the atheromatous and osseous deposits so commonly found in the arteries of old persons, he concludes — 1. " *The deposit cannot be regarded as the product* (*exudation*) *of an inflammation of the arteries.* The chronic inflammation of the cellular sheath of the diseased vessel is almost always a secondary consecutive appearance, which associates itself with the already established deposit.—2. *The deposit is an endogenous product derived from the blood, and for the most part from the fibrine of the arterial blood.* — 3. *Its formation demonstrates the pre-existence of a peculiar crasis of the blood,* which is intrinsically *arterial,* although at the present time we are wholly ignorant of the character of the peculiarity on which this depends. We must regard the old dogmatic view which sought the cause of the affection in arthritis, as an opinion deficient in proof. — 4. *In proportion to the extent of the disease of the arteries, so much less likely is it to be combined with tuberculosis ;* and this disease undoubtedly is in part the cause of that immunity against tuberculosis which we constantly notice in large aneurisms of the trunk of the aorta. — 5. *The deposit and its metamorphoses present numerous highly important analogies, that have hitherto been wholly neglected.* For the sake of brevity, we will here notice only the most important, viz. the deposit also occurring under certain conditions in the veins, the phlebolites, &c." (Op. cit. p. 272.)

These latter morbid changes, incident for the most part to that advanced period of life in which the nutrition of the body becomes impaired, manifest no recognisable symptoms until the arterial tubes are damaged to an extent to interfere with their mechanical and vital functions of containing and conveying the arterial blood, and when it is probably too late to effect much beneficial change either in the crasis of the blood itself, or in the altered nutrition of the inner and middle coats of the arteries as derived from the blood.

Little more can be done in the treatment of these altered states of nutrition, either in a curative or preventive point of view, beyond regulating and attending to the quantity and quality of the blood circulating in the vessels. It appears probable that a mild, unstimulating diet, so regulated as to obviate habitual repletion during adult life, might retard, if it could not entirely prevent the occurrence of these inevitable changes of structure, which sooner or later invade and deteriorate the tissues of our vital organs.]

ASCITES (ἄσκιτης from ἀσκὸς, a bottle). *Abdominal Dropsy,* especially that which consists of an effusion of serous fluid in the cavity of the peritoneum. (See PARACENTESIS ABDOMINIS.)

ASPHYXIA (from α privative of, and σφύξη, the pulse). Cessation of the action of the heart from the interruption of respiration, or rather of the effect produced by that function on the blood.

Asphyxia may also be defined to be a suspension of the phenomena of respiration, occurring primarily, and followed by that of all the other functions, and frequently by death.

[The term asphyxia, which signifies literally want of pulse, is objectionable, and likely to lead to erroneous views of the nature of the condition which it is employed to denote. That condition, from whatever cause it may arise, results from the non-arterialisation of venous blood, and the cessation of the pulse only takes place as a consequence of the interruption of the function of respiration. The action of the heart, instead of being primarily affected, is in reality the last of the vital functions which gives way. The incorrectness of this designation has been strongly insisted upon by Dr. Watson, who adopts the term *apnœa,* or privation of breath, as more justly expressive of the condition to which the term asphyxia is commonly given by authors. (See *Lectures on Practice of Physic,* vol. i. p. 61.) The word asphyxia, however, has been so generally in use, that it appears necessary still to retain it ; but it should be understood that it is used in an arbitrary sense, and without reference to its etymological signification.]

The general causes of asphyxia may be arranged under three principal heads. 1. Asphyxia from deficiency of air. 2. From the air being unfit for respiration, yet not producing any deleterious effect on the economy. 3. From the inspiration of some gas which is deleterious. As M. Duvergie rightly observes, however, the suspension of functions, or the mode of death in the last case, is very different from what is exemplified in the two first ; because it is, in fact, a kind of poisoning, brought about by the action of a deleterious principle, either on the nervous system, or the blood, and the individual may perish, though he is actually respiring air. (*Duvergie,* in *Dict. de Méd. et de Chir. Prat.* art. Asphyxie.)

Cases of Asphyxia admit of a classification, *first,* into those in which there is primarily a stoppage of the *mechanical* phenomena of respiration ; and, *secondly,* into others in which the *chemical* phenomena are primarily interrupted.

As examples of the first mode of asphyxia may be mentioned those cases in which the muscles of inspiration cannot act. 1. This happens where a heavy mass of earth or other materials, suddenly falls upon a man, and makes great pressure on the chest or abdomen. 2. Where the nervous influence does not extend to these muscles, as where the phrenic nerves have been paralysed by the effect of lightning, or the medulla spinalis is injured high up. Thus an injury of the medulla as high up as the third cervical vertebra, by destroying the influence of the phrenic nerves will paralyse the diaphragm. It will, at the same time, paralyse the other principal muscles concerned in producing the requisite changes in the dimensions of the chest; and, consequently, a fatal asphyxia must take place. This was well illustrated in a case brought into University College Hospital. The ends of the neck-handkerchief of a youth, aged fifteen, were caught by the wheel of some machinery, which drew his neck with great force against the works, and at the same time caused violent strangulation. In about one minute the handkerchief was cut through, and the constriction removed: he was brought to the hospital with his respiration stopped, and in a state of asphyxia from this cause. Attempts were made to restore respiration, and the action of the heart, first, by blowing air into the lungs, through the nostrils. Whenever this was done, the action of the heart returned, the pulse rose, and the lividity of the lips and countenance disappeared; but as soon as the inflation of the lungs was discontinued, the pulse sank so as to become undistinguishable, and the skin assumed the purple colour again. Finding that this happened repeatedly, a suspicion was entertained that the cervical vertebræ had sustained injury; but, in order that the inflation of the lungs might have every chance of doing good, in the event of other injury not existing, I performed tracheotomy, and air was introduced into the lungs with a pair of bellows and a tube. All this, however, was in vain; and galvanism was equally unsuccessful. The boy was kept in a state exhibiting signs of life for about six hours from the period of the accident; but his temperature continuing to get lower and lower he at length sank. In the *post mortem* examination, a fracture of the arch of the third cervical vertebra, a laceration of the anterior ligament of the spine, an effusion of blood on the medulla, and also another effusion behind the pharynx, were detected. 3. Where the respiratory muscles are in a state of inaction from the influence of intense cold. Asphyxia, from the passive expansion of the lungs not taking place, may be exemplified in cases where the abdominal viscera are forced through an accidental or natural opening of the diaphragm into the chest, or when the lungs are compressed by fluid in the cavity of the pleura, and various other causes.

The second mode of asphyxia mentioned above, which depends upon the primary cessation of the *chemical* phenomena of respiration, may be of two kinds. 1. It may arise from some impediment to the entrance of air into the lungs; as the lodgment of a foreign body in the larynx, trachea, or œsophagus; a swelling of the membrane of the larynx from inflammatory effusion, or from œdema; obstruction of the larynx and trachea with fibrine, as in croup; tumors formed near, or pressing upon, some part of the respiratory tube; and pressure upon the same organ from any other cause, as is exemplified in strangulation. One manner in which asphyxia is very frequently occasioned is by submersion, the lungs of warm-blooded animals not having an organisation qualifying them to derive from the oxygen contained in water the salutary influence on the blood, which they collect from the respiration of atmospheric air. 2. It may depend upon a deficiency (in quantity or in quality) of air fit for the purposes of respiration. As the salutary effect of respiration depends upon the respired air containing a due proportion of free oxygen, the deficiency or absence of this element must necessarily produce asphyxia. On this principle, nitrogen, hydrogen, carbonic acid gas, and air too highly rarefied, will cause asphyxia. Carbonic acid and some other gases act fatally also, on the principle of being positively deleterious to life when introduced into the air-cells.

Asphyxia may be the original affection, or it may be only the termination of another disorder. Thus, a person is attacked by pneumonia, and dies of asphyxia, caused by hepatisation of the lungs; or, he is seized with pleurisy, and is ultimately destroyed by an effusion of serous fluid in the chest. (See *M. Duvergie*, in *Dict. de Méd. et de Chir. Prat.* art. Asphyxie.)

Formerly, the cessation of the action of the heart in hanging or drowning was referred to a mechanical impediment to the transmission of blood through the lungs to the left cavities of the heart. But the experiments of Goodwyn and others prove that no such mechanical obstruction exists; and that, even after the fullest expiration, the air remaining in the air-vesicles of the lungs distends them sufficiently to permit the blood to circulate freely through them. The real obstacle arises out of the interruption of those chemical changes which atmospheric air produces on the blood while circulating in the pulmonary vessels, and which convert it from venous to arterial blood. In fact, the blood, which in asphyxia thus retains its venous character, does, for a time, pass through the pulmonary circulation, and is conveyed into the left ventricle, which propels it into the aortic system of arteries.

The notion of a mechanical impediment having been disproved, the idea next advanced was, that the blood, which is thus substituted for arterial, has deleterious properties, and deprives the organs to which it is sent of the power of performing their respective functions. Sensibility, irritability, together with all the physical and vital actions depending upon them are suspended. (See *Roget, in Cyclop. of Pract. Med.* art. Asphyxia.) The investigations of Bichat, led him to believe that the primary effect of the circulation of venous, or what he called black blood, is on the brain, and that this effect extends, through the intervention of the brain, to the whole nervous system. Loss of sensibility, therefore, precedes the suspension of the action of the heart, and takes place as soon as the venous blood, sent into the arteries, reaches the brain. According to Bichat, the action of the heart soon afterwards ceases, from the injurious effect of the venous blood which is circulated through the coronary arteries upon its muscular structure. (See *Bichat, Recherches sur la Vie et la Mort.*)

[It is to Dr. Kay (now Sir J. Kay Shuttleworth) that we are indebted for a more correct explanation of the phenomena of asphyxia. Dr. Kay truly observes, that were Bichat's theory correct, we might vainly have expected any auspicious result from attempting resuscitation; for no means short of removing from the minute vessels of the body that fluid, the qualities of which were thus considered incompatible with life, could have been sufficient to accomplish resuscitation, which would therefore have been impossible.

It was discovered by Edwards that reptiles, in which the circulation of venous blood is permitted to proceed when they are deprived of air, live much longer than others in which the supply of blood is, under similar circumstances, prevented altogether; and, according to Dr. Kay, "the heart, so far from being rendered less irritable by the presence of venous blood in its structure, retains its irritability longer when the fluid fills its cavities, and when a certain congestion of its fibres is produced by retarding the exit of the venous blood from the small veins of its tissue. If the irritability of the heart could not survive the circulation of this blood through its fibres, the circulation ought to be arrested in the left auricle and ventricle; and their cavities and the pulmonary veins should be found congested with this fluid. On the contrary, the left ventricle is invariably found contracted, and containing no more blood than that which moistens its parietes. In the left auricle accumulates the last drainings from the pulmonary veins; but this supply is so inconsiderable, as to be unworthy of notice, and the pulmonary veins themselves are always empty. The obstacle to the circulation does not, therefore, exist in the heart, but in the lungs."

Dr. Kay's investigations and experiments led him to the conclusion, "that death occurs in asphyxia, because the air not being admitted into the lungs, the changes which are necessary to the transmission of blood through their structure no longer ensue, and the circulation gradually becomes feebler, and is at length arrested in *the capillaries of the pulmonary tissue.* Before this result takes place, the blood by degrees assumes more and more of the venous character, until its qualities become incompatible with *the activity of the minute vessels of the lungs.* A certain quantity of dark blood, not so changed as to be inconsistent with vital action, is transmitted by the heart and arteries to all the organs of the body, and circulated through the nervous system and muscles; but it is found that this fluid, far from destroying the vitality of these parts, maintains the life of the muscles for a certain time, though in a comparatively feebler manner; and it is also discovered, that though it is deficient in stimulus to the nervous system, and is not capable of supporting the greatest activity of the nervous power, it has no *positively noxious influence on it.* The cause of death in asphyxia is the arrest of the circulation, but during the supply of the darker blood to the organs (as it is deficient in stimulating and nutritious qualities), and the rapid diminution of the supply of even this fluid, the functions of every part are enfeebled, and sense and voluntary motion extinguished, before the circulation has actually ceased."— *On the Physiol. Pathol. and Treatment of Asphyxia, by J. Phillips Kay*, p. 25. Lond. 1834.)

Mr. Erichsen offers a somewhat different explanation of the mode in which the circulation through the lungs is interrupted in asphyxia; he thinks that the carbonic acid which is retained in the blood acts as a stimulus to the coats of the smaller pulmonary vessels and excites their contraction, and that it is in this way that the blood is interrupted in its course and ultimately stagnates. He believes also, "that a diminution in the force and frequency of the contractions of the heart consequent upon the altered quality and lessened quantity of the blood circulating through its muscular substance, is one of the principal causes of the cessation of the circulation in asphyxia; as is evident from the fact, that when the force of the heart's contractions is maintained by a supply of arterial blood to its muscular substance, it is enabled to propel black blood through a collapsed lung."

The cause of the stoppage of the circulation, according to Mr. Erichsen, is *threefold;* "depending, 1. Upon the arrest of the respiratory movements; 2. Upon the weakening of the heart's action; and 3. Upon the obstruction offered to the blood (propelled with diminished force) by the refusal of the pulmonary veins and minute arteries to receive venous blood." For further information on this subject, and for an account of the experiments performed, the reader is referred to *Erichsen's Experimental Inquiry into the Pathology and Treatment of Asphyxia.* Lond. 1847; and to the excellent work by Dr. Kay, already quoted.]

The face of a person who has been drowned is, in general, pale, though slightly livid. A frothy liquid and some water are found in the trachea, bronchi, and air-cells of the lungs: the latter organs are of a violet colour, but contain less blood than where asphyxia has been occasioned by carbonic acid gas; the right auricle and ventricle are filled with black blood; in the stomach there is generally more or less water, which has been swallowed; the surface of the brain is of a darker appearance than usual, but its vessels not particularly turgid; and the air remaining in the lungs contains little oxygen. (*J. F. Berger, Essai sur la Cause de l'Asphyxie par Submersion.* Genève, 1805; *Goodwyn, On Connection of Life with Respiration*, p. 19.)

When the person, at the time of falling into the water was intoxicated, stunned by a blow on the head, or in a state of syncope, there can have been no struggle. Under such circumstances, the trachea will contain a little water, but no froth; the lungs will be of their natural colour, and not much expanded; no water will be found in the stomach; and the blood in the venous system will not be so disproportionate to that contained in the arterial. As Dr. Roget justly observes, the great diversity in these and other circumstances "will enable us, perhaps, to explain the differences that are met with in the time, during which the body may remain under water, compatibly with the possibility of restoring life. If the submersion have not exceeded five minutes, and no blow against a stone or other violence has occurred to complicate the effects, our efforts at resuscitation, if properly conducted, will generally be successful. After a quarter of an hour, recovery is not very common; after twenty minutes, or half an hour, it may be considered as nearly hopeless. The longest period recorded in the Reports of the Humane Society is three quarters of an hour. On the other hand, some who have only been a few minutes under water, cannot be restored to life, even by the prompt application of proper means." (*Dr. Roget*, in *Cyclop. of Pract. Med.* art. Asphyxia.)

In the endeavour to resuscitate a person whose animation has been suspended by immersion, the wet clothes should be promptly removed, and the body covered with blankets and placed on a table, with the head and chest raised; the nostrils and mouth are to be freed from froth, and kept perfectly unobstructed. The lungs are then to be inflated with the kind of bellows employed by the Humane Society, and provided with a short flexible tube, one end of which is adapted to the nozzle of the bellows, and the other to a silver tube, designed for introduction into the nostril. As the glottis is open, air, conveyed into one of the nostrils, while the other and the mouth are closed, and the larynx is pressed toward the vertebræ, so as to close the œsophagus, must necessarily pass into the lungs. The lungs being thus filled, are next to be emptied, by an assistant compressing the chest, and expelling the air. The same operations are to be repeated until natural respiration begins, or until this and other approved measures have been tried at least six hours. (*Dr. Curry, Obs. on Apparent Death, &c.*) When this method fails to fill the lungs with air, tracheotomy may be performed, but, in the opposite case, it is not necessary. As the body is insensible, there is, indeed, commonly, little or no difficulty in passing any bent tube of moderate diameter and proper length into the glottis, when the tongue is drawn forwards, and tracheotomy, under these circumstance, cannot be needed. Thus, with an ordinary silver catheter, air may be blown into the lungs. Together with inflation of the lungs, gentle friction of the body with warm flannels or the hand, stimulating the nostrils with hartshorn, and injecting warm stimulating fluids into the stomach with a syringe and tube passed down the œsophagus, are plans generally recommended. Slight shocks of electricity, or galvanism, through the heart and diaphragm, may also be tried, if the apparatus be ready at hand.

After the breathing has been restored, the patient is to be watched, lest he yet fall a sudden victim to a returning accumulation of black blood in the brain, or to the violent effects of reaction in the system.

[The method of carrying on artificial respiration in asphyxia, recommended by Dr. Marshall Hall, has lately excited considerable attention. His instructions are as follows:—

"*The patient is to be laid prone on his face.* In this position the tongue falls forwards, drawing with it the epiglottis, and leaves the glottis open, while all fluids will flow from the fauces and mouth. In order that the face may not come in contact with the ground, the patient's wrist is to be carried upwards and placed under the forehead.

"It will be perceived that the thorax and abdomen will now be pressed by a force equal to the weight of the trunk. This pressure will induce expiration; and, additional pressure being now made on the posterior part of the thorax and abdomen, the expiration will be more complete.

"This latter pressure is to be then removed. Its removal will be followed by slight inspiration. The weight of the body is then to be removed from the thorax and abdomen, by gently turning it *on the side and a little beyond*, placing one hand under the shoulder, and the other under the hip of the side moved. In this manner a fair degree of inspiration is induced. And thus without instruments of any kind, and with the hands alone, if not too late, we accomplish that respiration which is the sole, but sure effective means of the elimination of the blood poison."

These movements should be performed at the rate of about sixteen times in a minute, *and not more*, and gently and equably. The patient should be treated on the spot without the loss of a moment of time, in the open air, exposing the face and chest freely to the breeze, except in too cold weather. If there are sufficient assistants present, some of them may be directed to seize the limbs with their hands, and rub them with firm pressure upwards, but all other modes of procedure must be held as perfectly subsidiary to the one only remedy, *prone and postural respiration.*

Dr. Marshall Hall deprecates the application of heat to the surface, and especially the warm bath, which is recommended in the instructions of the Royal Humane Society. The more rapidly the changes take place in the tissues of the body, the more carbonic acid will be generated in the blood; therefore any attempt to restore the circulation by the application of heat, *before* respiration is established, will only augment the mischief. (See *Dr. M. Hall, On Prone and Postural Respiration in Drowning and other forms of Apnœa or Suspended Respiration.* London, 1857.)]

The treatment of persons whose animation is suspended by *strangulation* should be conducted on the same principles as that of persons in a similar condition from submersion. Here, however, the fulness of the sinuses of the brain may render bleeding indispensable.

In cases of asphyxia depending upon obstruction of the glottis, larynx, or trachea, by disease, foreign bodies, or tumors, tracheotomy or laryngotomy, according to circumstances, is frequently the only means by which life can possibly be saved. (See LARYNGOTOMY and TRACHEOTOMY.)

The treatment of asphyxia from carbonic acid gas, consists in removing the body immediately into the fresh pure air, sprinkling it with cold water, if its temperature be high, galvanising it, and endeavouring to restore the breathing, by blowing air down the glottis: oxygen gas, if at hand. Differences of opinion are entertained about the utility of bleeding. (See *Goodwyn's Connection of Life with Respiration*, Lond. 1788. *A. Portal, Obs. sur les Vapeurs Méphitiques sur les Noyés, &c.* 8vo. Paris, 1787. Also, *Instructions sur le Traitement des Noyés*, Paris, 1811. *W. F. Edwards, De l'Influence des Agens Physiques sur la Vie.* 8vo. 1824. *Bichat, Recherches sur la Vie et la Mort.* 8vo. Paris. *Babington*, in *Med. Chir. Trans.* vol. i. *Coleman, On Natural and Suspended Respiration*, ed. 2, 1802. *James Curry, M.D., Obs. on Apparent Death from Drowning, &c.* ed. 2. 8vo. 1815. *P. M. Roget, M.D.* in *Cyclop. of Pract. Medicine*, art. Asphyxia. *Reports of the Royal Humane Society. Marc, De Moyens de Constater la Mort par Submersion.* Paris, 1808. *Orfila, Secours à donner aux Personnes Empoisonnées ou Asphyxiées*, ed. 3. Paris, 1825. *J. Leroy, Recherches Expér. sur l'Asphyxie.* 8vo. Paris, 1829. *P. A. Piorry. Nouv. Expér. sur les Effets de l'Insufflation de l'Air dans les Poumons, &c. Journ. Hebdom. de Méd.* t. iii. 1829. *J. Phillips Kay On the Physiology, Pathology, and Treatment of Asphyxia.* London, 1834. *J. E. Erichsen, Experimental Inquiry into the Pathology and Treatment of Asphyxia.* Lond. 1847. *Mar-*

shall Hall, M.D. On Prone and Postural Respiration in Drowning and other forms of Apnœa or Suspended Respiration. Lond. 1857.)

ATHEROMA (from *ἀθήρα*, pap). An encysted tumor, so named from its contents being of the consistence of pap. (See Tumors, Encysted.)

For the so-called atheromatous deposits in the coats of arteries, see Arteritis and Aneurism.

ATROPHY (from *α* privative, and *τροφὴ*, nutrition). A deficiency in the nutritive powers of a part, in consequence of which its natural dimensions are reduced, and the number of its constituent molecules diminished. (*Townsend*, in *Cyclop. of Prac. Med.* art. Atrophy.) According to another pathologist, atrophy is degeneration of growth, deficiency in the size and weight of a part, and commonly of one or more of its usual constituents in particular. (*Mayo, Outlines of Human Pathology,* p. 16.) When the functions of organs cease, or are long suspended, an atrophy of them usually follows. Thus in a limb, kept for a long while unexercised in consequence of disease, the bones suffer atrophy, as well as the soft parts. But certain states of disease and injury, frequently lead to atrophy of various organs and textures. This fact is often exemplified in the testicle. Wounds of the occiput and back of the neck were remarked by Larrey, in Egypt, to be often followed by atrophy of this organ. The want of a free supply of blood and nervous energy, leads necessarily to weakness and atrophy of parts. In old age, various parts undergo what is termed *senile atrophy.* Thus, in advanced life, the ovaries and mammary glands are reduced to mere rudiments.

According to Dr. Carswell, atrophy "is the modification of bulk, which takes place in consequence of a diminution in the quantity of the solid materials which enter into the healthy composition of organs and tissues." This diminution of bulk, which constitutes the essential physical character of atrophy, is described by him as depending upon diminished exercise of the nutritive functions. (See *Carswell's Illustrations of the Elementary Forms of Disease,* p. 10.) In this valuable work, one of the most correct ever published on this interesting branch of pathology, notice is taken of certain forms of *congenital atrophy,* as exemplified in *monstrosities,* and occurring as the consequences of the formative process having been arrested at certain periods of the evolution of particular organs. Dr. Carswell next adverts to the atrophy, or even total disappearance of organs, soon after birth, which performed functions essential to the existence of the fœtus, but which are now no longer necessary to the maintenance of life; as the ductus arteriosus, umbilical arteries, the thymus gland, supra-renal capsules, &c. Different from these two forms of atrophy is that which, as Dr. Carswell observes, takes place in advanced life, "as the fulfilment of a general law of nature, so conspicuously manifested in the limited duration of all organised beings, which, having attained the maximum of their development, decline, after a variable period of time, and tend gradually towards decay." *Senile atrophy,* as Dr. Carswell terms it, is carried to a great extent in the vasicular structure of the lungs, the spongy structure of the penis, the testes, the lymphatic and mammary glands, the uterus, and ovaries. The bones in general lose much of their weight; and, as every surgeon of experience knows, fracture of the neck of the thighbone is rendered common in old persons, in consequence of the effects of senile atrophy. After seventy, the brain is diminished from $\frac{1}{15}$ to $\frac{1}{20}$ of its average weight, and becomes specifically lighter, and the trunks and branches of the nerves are reduced in size. The muscles, especially those of voluntary motion, participate likewise in the general decay: and so do the blood-vessels, which always bear a relation to the increased or reduced size of the organs to which they are distributed.

This fact is exemplified in the size of the large, or the number of small arteries being lessened. The general interstitial absorption of John Hunter, the atrophy of the whole body, or the marasmus and emaciation from disease deranging the important functions of digestion, respiration, and the qualities of the blood, from fevers, profuse suppuration, and various severe and organic diseases, I need not consider in this place. But, besides these forms of atrophy affecting the whole body, there are others which are local, and divided by Professor Carswell into three classes. 1. Atrophy from a diminished supply of blood. 2. From diminished exercise of the function of innervation. 3. From diminished exercise of the functions of the organ. For numerous original, philosophical, and practical remarks on these heads, I refer to *Carswell's Illustrations of the Elementary Forms of Disease,* fasc. 10.

[Mr. Paget ranges atrophy under two heads, one in which a part simply wastes, or is reduced in size, with little or no change of texture; the other in which it gradually and regularly degenerates. He says:—"There are two modes of atrophy, the one with simple decrease, the other with degeneration of tissue. In both, there is a loss of functional power in the part; but in one this loss is due to deficient quantity, in the other to the deteriorated quality of the tissue." Farther on he remarks, in reference to senile atrophy:—"All the expressions usually employed about these changes imply that they are not regarded as the results of disease: nor should they be; they are, or may be, completely normal; and were it not that the forces which are efficient in degeneration are, probably, very different from those which actuated the formative processes, we might justly call the degeneration of advanced age another normal method of nutrition. For to degenerate and die, is as normal as to be developed and live; the expansion of growth, and the full strength of manhood, are not more natural than the decay and feebleness of old age; not more natural, because not more in accordance with constant laws, as observed in ordinary conditions. As the development of the whole being, and of every element of its tissues, is according to certain laws, so is the whole process regulated by which all that has life will, as of its own workings cease to live." In addition to the mere wasting or emaciation of tissues, under the head of degenerations, he mentions the fatty, the earthy, the pigmental, and the thickening of primary membrane. (*Paget's Lectures on Surgical Pathology.*)

Wedl observes, "There are two principal causes by which atrophy is induced, first, an atrophic condition of the blood as a nutritive fluid; secondly, defective circulation of the blood (imperfect locomotion of the nutritive fluid.)"—(*Rudiments of Pathological Anatomy,* translated by Busk, p. 126.)

The important and active part taken by cells in the processes of growth and nutrition, renders it necessary to consider their influence in any impairment or modification of these processes, such as are implied in atrophy of the tissues. On this part of our subject, hitherto but little attended to by pathologists, Wedl remarks (p. 57, op. cit.) — "Now, if the absorption of the fluid nutritive material, and the giving off of the non-assimilable parts, do not proceed according to the determinate mode appropriate to the cell, unorganisable elements will be left, and undergo the same metamorphosis which we have enumerated as forms of involution of the separate parts of the cells. The defective assimilation of the cells removes them, as it were, from the domain of vitality, and they remain like dead particles, incapable of again entering upon their proper formative processes, enclosed within the sphere of the living organism." For an account of the atrophies and degenerations of the blood, and of the several tissues of the body, I cannot do better than refer the reader to *Wedl's Rudiments of Pathological Anatomy*.]

[ATROPIA; ATROPIÆ SULPHAS. Ph. Lond. The alkaloid atropia, or atropine, is the active principle of the atropa belladonna, or deadly nightshade. It is now frequently employed instead of the extract of belladonna, for producing dilatation of the pupil. It is more powerful, more certain in its action, and it has the advantage of being a cleaner application. A drop of a solution of sulphate of atropine placed in the eye will produce the required effect. The sulphate being freely soluble in water, is preferable to the alkaloid itself, which requires the assistance of alcohol for its solution. It should be used in the proportion of three grains to an ounce of distilled water. It is almost needless to state that both atropine and its sulphate are substances of an intensely poisonous character. (See BELLADONNA.)]

AUSCULTATION (from *auses* or *aures*, and *colo*). The method of judging of the nature and conditions of various diseases by the particular sound which they communicate either to the unassisted ear, or to that organ, through the medium of the *stethoscope*. Thus, in diseases of the lungs and pleura, the practitioner may derive important information respecting the condition of those organs, by attending minutely to the changes in the sounds of the heart or of respiration, to the sound of the voice and coughing within the chest, and other sounds occasionally heard in the same situation. [Another mode of employing auscultation is called *percussion*. The part of the body to be examined is struck with the finger, and information is gained by listening to the resulting sound. For example, in this way we may distinguish whether distension of the abdomen depends upon the presence of fluid in the peritoneal cavity, or gas in the intestines.] The stethoscope, in many ambiguous cases, must be deemed an instrument of great importance in practice. For a particular description of it, however, I refer to Laennec's invaluable work on diseases of the chest, in the translation and improvement of which, by numerous instructive notes, Dr. John Forbes has rendered himself a benefactor to medical science. In surgery, the stethoscope is usefully employed in detecting the real nature of various doubtful swellings, particularly those of an aneurismal character. By M. Lisfranc it has been found of considerable service, in enabling him to judge with more accuracy of the collision of the sound against calculi, or other substances in the bladder, in the operation of sounding. M. de Kergaradac has used the stethoscope with much success for ascertaining pregnancy, where the history was obscure. It has also been found of great utility in determining the existence and state of various collections of fluids, and particularly of pus; and it has enabled practitioners to ascertain, with certainty, the communications occasionally existing between abscesses of the liver and the interior of the lungs, as well as the occasional communication of pulmonary abscesses with the abdominal cavity. In cases of fracture, where the crepitus is obscure, the stethoscope removes all ambiguity. In all diseases about the heart, and large blood-vessels near this organ, much useful information may be derived from it; but, the method of using it, and the circumstances by which it affords instruction, must be gathered from a careful perusal of Laennec's and other works.

De l'Auscultation Médiate, vol. ii. 8vo. Paris, 1826, ed. 2. *Lejumeau de Kergaradac*, Mem. sur l'Auscultation. 8vo. Paris, 1822. *J. Lisfranc*, Mém. sur des Nouvelles Applications du Stethoscope. 8vo. Paris, 1823. *J. Forbes*, M.D. Original Dissections, &c. illustrating the Use of the Stethoscope. 8vo. Lond. 1824. Also, the Notes in his Transl. of Laennec, On Dis. of the Chest. *W. Stokes*, Introduction to the Use of the Stethoscope. 8vo. Edinb. 1825; also, *P. A. Piorry*, De la Percussion Médiate, &c. 8vo. Paris, 1828. *P. M. Latham*, M.D. Lectures on Subjects connected with Clinical Medicine, vol. i. 8vo. 1836. *James Hope*, M.D. Treatise on the Diseases of the Heart and great vessels. 8vo. 3rd ed. 1839. *C. J. B. Williams*, M.D. Pathology and Diagnosis of Diseases of the Chest. &c. 8vo. 4th ed. 1840. *Jos. Skoda*, Treatise on Auscultation and Percussion, translated by *W. O. Markham*, M.D. 8vo. Lond. 1853.

B

BANDAGE. The use of bandages is to keep dressings, compresses, remedies, &c. in their proper situation; to compress blood-vessels, so as to retain hæmorrhage; to rectify certain deformities by holding the deranged parts in a natural position; to unite parts in which there is a solution of continuity; and, in particular, to prevent such parts from moving, or quitting their desired position. As the application of bandages is an important branch of surgery, authors have not neglected it. Much has been written on the subject, and almost every writer has devised new bandages, perhaps, without real benefit to the art. Unfortunately, it is next to impossible to give clear ideas of the numerous sorts of bandages by a printed description of them, especially when it is not accompanied by diagrams or engravings. The surgeon can only acquire all the necessary instruction from experience and practice. Hence, I shall confine myself to a general account of the subject.

Bandages should be made of materials possessing sufficient strength to fulfil the end proposed in applying them, and at the same time they should be supple enough to accommodate themselves to the parts. They are made of linen, cotton, or flannel. If possible, they should be without a seam, or selvage, which is likely to cause unequal and painful pressure.

[When elasticity rather than firm support is required, rollers made of cotton web may be employed. India rubber bandages may also be procured of every degree of strength and firmness. But the necessity for bandages is now in many cases done away with by the manufacture of elastic supports, made to fit accurately the part affected, as in the elastic stockings for varicose veins, elastic abdominal supports, &c. The spiral elastic manufacture of M. Bourjeaurd deserves especial mention and commendation.]

In particular cases, a bandage should have a degree of firmness that does not belong to the materials usually employed. This circumstance is exemplified in hernia, and in all examples in which there is occasion for inelastic bandages. As already observed, linen, flannel, and cotton (calico), are the common materials. The first employment of flannel bandages is imputed to the Scotch surgeons, who preferred them to linen ones, in consequence of their being better calculated for absorbing moisture, while, being more elastic, they yield in a greater degree in cases requiring this property; as in the swelling subsequent to dislocations, fractures, &c. It has been asserted, that linen is better than flannel, because more cleanly; but neither one nor the other will continue clean, unless care be taken to change it often enough. Where the indication is to keep the parts warm, flannel is of course preferable both to linen and calico.

In applying a bandage, care must be taken that it be put on tight enough to fulfil the object in view, without running any risk of stopping the circulation, or doing harm in any other way. If it be not sufficiently tight to support the parts in a proper manner, it is useless; if it be too tense, it will produce swelling, inflammation, and even mortification.

In order to apply a roller skilfully, the part which is to be covered must be put in its proper situation and position, while the head of the roller is held in the surgeon's hand, and only so much unrolled as is necessary for the commencement of the application.

In general, the bandage should be applied in such a manner as will admit of its being most conveniently removed, and allow the state of the subjacent parts to be examined, as often as occasion may require, with the least possible disturbance of them. Thus, when a broken leg is placed on M'Intyre's apparatus, three rollers may be employed. One is applied to keep the knee steady; another to maintain the foot and lower part of the limb motionless; while the central one covers the fracture, and can be taken off, so as to let the fracture be examined, or a wound dressed, without any occasion to meddle with the other pieces of bandage, or disturb the fracture in the slightest degree.

For the same reason, in fractures of the leg and thigh, the eighteen-tailed bandage is often preferred to a simple roller. The former may be loosened and tightened at pleasure, without occasioning the smallest disturbance of the affected limb; a thing which could not be done were a common roller to be employed in the ordinary way, with ordinary splints.

As soon as the bandage has fulfilled the object for which it is applied, and it has become useless, its employment should be discontinued; for, by remaining too long on parts, it may obstruct the circulation, diminish the tone of the compressed fibres and vessels, and thus do serious harm.

Bandages are either *simple* or *compound*. They are also sometimes divided into *general* and *particular*. The latter often derive their names from the parts to which they are usually applied.

A simple bandage is a long piece of linen or cotton, of an indefinite length, and from one to six inches in breadth. When about to be applied, it is commonly rolled up, and the rolled part is termed its *head*. When rolled up from each end, it is called a *double-headed roller* or *bandage*.

The chief of the simple bandages are the *circular*, the *spiral*, the *retaining*, and the *expellent*.

The *circular* bandage is the simplest; consisting merely of a few circles of a roller covering or overlapping each other.

The *spiral* bandage is the most frequently used of all; for it is this which is seen in such common employment on the limbs, in cases of ulcers, varices, fractures, &c. In applying a common roller to the whole of a limb, the bandage must be carried round the part spirally; for otherwise the whole member cannot be covered. When the leg is the part, the surgeon is to begin by surrounding the foot with a few turns. Then carrying the head of the bandage over the instep, he is to convey it backward, so as to make the bandage unroll, and apply itself just above the heel. The roller may next be brought over the inner ankle; thence again over the instep, and under the sole; and the surgeon then brings the bandage spirally upward once more to the outer part of the leg. After this, every circle of the roller is to be applied so as to ascend up the limb in a gradual, spiral form, and cover about one-third of the turn of the roller immediately below it. The unequal diameter of the limb is one great cause, which brings into view the unskilfulness of a surgeon in this operation; for it prevents the roller from lying smoothly, although spirally applied, unless a particular artifice be dexterously adopted. The plan alluded to is, to double back the part of the roller that would not be even, were the application to be continued in the common spiral way without this manœuvre. When the bulk of the limb increases very suddenly it is sometimes necessary to fold, or, as it is termed, *reverse* every circle of the bandage in the above manner, in order to make it lie evenly on the limb. It is manifest that the pressure of the roller will be greatest where the duplicatures are situated; and hence, when it is an object to compress any particular part, the surgeon should contrive to reverse the turns of the bandage just over the situation where most pressure is desirable.

When a roller is to be applied to the fore-arm, it is often best to put a few of the first turns of it round the hand.

Particular care must be taken not to make the bandage very tight, if it be intended to wet it afterwards with any lotion; for moisture always renders it still more tense.

Mr. John Bell describes the principal purposes for which a roller has been employed, as follows: "Although, in recent wounds, it is with plasters and sutures that we unite the parts point to point, yet it is with the bandage that we support the limb, preserve the parts in continual and perfect contact with each other, and prevent any strain upon the sutures with which the parts are immediately joined; and we often unite parts by the bandage alone. But, it is particularly to be observed, that, in gun-shot wounds, and other bruised wounds, though it would be imprudent to sew the parts, since it is impossible that they should altogether unite, yet the gentle and general support which we give by a compress and bandage, prevents them from separating far from each other, unites the deep parts early, and lessens the extent of that surface which must naturally fall into suppuration."

"In the hæmorrhagy of wounds, we cannot always find the artery; we dare not always cut parts for fear of greater dangers; we are often alarmed with bleedings from uncertain vessels, or from veins as well as arteries: these hæmorrhages are to be suppressed by the compress; which compress, or even the sponge itself, is but an instrument of compression, serving to give the bandage its perfect effect. Frequently, in bleedings near the groin, or the armpit, or the angle of the jaw, —wherever the bleeding is rapid, the vessels uncertain, the cavity deep, and the blood not to be commanded by a tourniquet, and where the circumstances forbid a deliberate and sure operation, we trust to compress and bandage alone."

"Bandage is very powerful in suppressing bleeding. At one period of surgery, it took place of every other method, &c. If a compress be neatly put upon the bleeding arteries, if there be a bone to resist the compress, or even if the soft parts be firm below, and the bandage be well rolled, the patient is almost secure. But such a roller must be applied smoothly from the very extremity of the fingers or toes; the members must be thoroughly supported in all its lower parts, that it may bear the pressure above. It is partial stricture alone that does harm, creates intolerable pain and anxiety, or brings on gangrene. Hæmorrhagy requires a very powerful compression, which must therefore be very general, &c. It must not be made only over the bleeding arteries, which is all that the surgeon thinks of in general, &c."

"In abscesses, where matter is working downwards along the limb, seeking out, as it were, the weak parts, undermining the skin, and wasting it, insulating and surrounding the muscles, and penetrating to the bones, the bandage does every thing. The expelling bandage, the propelling bandage, the defensive bandage, were among the names which the older surgeons gave to the roller, when it was applied for these particular purposes; and these are properties of the roller which should not be forgotten." (See *Principles of Surgery*, vol. i.)

Soon after this description, in which the advantages of the roller in gun-shot wounds and hæmorrhage are rather exaggerated, Mr. John Bell proceeds to explain in what manner this most simple of all bandages may be put on a limb.

"Practice will convince you, that the firmness and neatness of a bandage depend altogether upon these two points; First, upon the turns succeeding each other in a regular proportion; and, Secondly, upon making reverses, wherever you find any slackness likely to arise from the varying form of the limb. Thus, in rolling from the foot to the ankle, leg, and knee, you must take care, first, that the turns, or, as the French call them, *doloires*, of the roller lie over one another by just one third of the breadth of the bandage; and, secondly, that, at every difficult part, as over a joint, you turn the roller upon the limb, with the opposite flat side towards it: you must turn the bandage so as to reverse it, making what the French call a *renversée* of the roller at the ankle, at the calf of the leg, and at the knee. You must be careful to roll your bandage from below upwards, and support the whole limb by a general pressure. That you may be able to support the diseased part with a particular pressure, you must lay compresses upon the hollows and upon the bed of each particular abscess, and change the place of these compresses from time to time, so as now to prevent matter sinking into a particular hollow, now to press it out from a place where it is already lodged, and again to reunite the surface of an abscess already completely formed, from which the matter has been discharged." (*Principles of Surgery*, vol. i.)

In applying a roller to the leg, as Dr. Cutler observes, the turns cannot be laid down flatly, as the upper border will compress the salient part of the limb, while the lower one hangs loose. This inconvenience is obviated by reversing it at every turn, so that the inferior becomes the superior, and the external face the internal. The band should press lightly over each reverse, so as to flatten it. Two things are to be observed in applying this reversed bandage; one is not to unroll, in making the angle, more of the band than is absolutely necessary; the other, to carry the angles upwards, in a perpendicular line, and always far from the part affected. (See *Cutler's Surgeon's Pract. Guide in Dressing*, &c. p. 18.)

When we make use of a single-headed roller, merely as a *retentive bandage*, we should remember always to begin the application of it on the side opposite the wound. The obvious reason for so doing is to prevent a further separation of the lips of the wound, as the contrary manner of applying the roller would tend directly to divide them. (*Gooch*, vol. i. p. 143.)

The intention of the *expellent bandage* is to keep the discharge sufficiently near the orifice of the wound to prevent the formation of sinuses. In general a compress of unequal thickness is necessary; the thinner part of the compress being placed next, and immediately contiguous to, the orifice of the wound; the thicker part over the hollow in which the matter would become collected. Before the bandage is applied, the pus must be completely pressed out, and the rolling begin with two or three circular turns on the lower part of the compress. The bandage must then be carried spirally upwards, but not quite so tightly as below. It is afterwards to be rolled downward to the place where it began.

A bandage is termed *compound*, when several pieces of linen, cotton, or flannel, are sewed together in different directions, or when the bandage is torn or cut, so as to have several tails. Such are the T bandage, the suspensory bandage, the capistrum, &c.

The *eighteen-tailed bandage* is one of the most compound. This is in common use for fractures of the leg and thigh; sometimes, but not often, for those of the fore-arm, and frequently for particular wounds. Its great recommendation is the facility with which it can be undone, so as to allow the parts to be examined, and its not creating, on such an occasion, the smallest disturbance of the disease, or accident. This renders it especially applicable to cases of compound fracture.

The eighteen-tailed bandage consists of a longitudinal portion of a common roller, and a sufficient number of transverse pieces, or tails, to cover as much of the part as is requisite. Each of the cross pieces is to be proportioned in length to the circumference of the part of the limb to which it is to be applied; so that, in making this sort of bandage for the leg, or thigh, the upper tails will be twice as long as the lower ones. After laying the long part of the bandage on a table, fix the upper end of it in some way or another. Then arrange the tails across it, in sufficient number to cover such part of the limb as requires the bandage. Each tail must be long enough to extend about two inches beyond the opposite one, when they are both applied. The tails being all arranged across the longitudinal band, they are to be stitched in this position with a needle and thread. When the bandage is intended for the leg, a piece of the longitudinal part of the roller below is to extend beyond the tails. This is usually brought under the sole of the foot, and then applied over the inner ankle, directly after the bandage has been put under the limb. Then the surgeon lays down the first of the lower tails, and covers it with the next. In this way, he proceeds upward, till all the cross pieces are applied, the uppermost one of which he fastens with a pin. This bandage has a very neat appearance. The tails are said to lie better, when placed across the longitudinal piece a little obliquely.

The T *bandage* is, for the most part, used for covering parts of the abdomen and back, and, especially, the scrotum, perineum, and parts about the anus. Its name is derived from its resemblance to the letter T, and it is, as Mr. John Bell remarks, the peculiar bandage of the body. If the breast, or belly, be wounded, we make the transverse piece, which encircles the body, very broad; and having split the tail-part into two portions, one of these is to be conveyed over each side of the neck, and pinned to the opposite part of the circular bandage, so as to form a suspensory for the latter, and prevent its slipping down. But, says Mr. John Bell, if we have a wound, or disease, or operation, near the groin, or private parts, the tail-part becomes the most important part of the bandage; then the transverse piece, which is to encircle the pelvis, is smaller, while the tail-part is made very broad. When the disease is in the private parts, perineum, or anus, we often split the tail according to circumstances; but when the disease is in one groin we generally leave the tail-part of the bandage entire and broad.

The *scissum linteum*, or *split-cloth*, is a bandage applied occasionally to the head, and consists of a central part, and six or eight tails, or heads, which are applied as follows: —

When the cloth has six heads, the middle, or unsplit part of the cloth is applied to the top of the head. The two front tails go round the temples, and are pinned at the occiput; the two back tails go also round the temples, and are pinned over the forehead; the two middle tails are usually directed to be tied under the chin; but as Mr. John Bell observes, this suffocates and heats the patient, and it is better to tie them over the top of the head, or obliquely, so as to make pressure upon any particular point. (*Principles of Surgery*, vol. i. p. 131.) The old surgeons usually split this middle tail into two parts, a broad and narrow one. In the broad one, they made a hole to let the ear pass through. This broad portion was tied under the chin, while the narrow ends were tied obliquely over the head.

The *nodose bandage*, called also *scapha*, is a double-headed roller, made of a fillet four yards long, and about an inch and a half broad. It must be reversed two or three times, so as to form a knot upon the part which is to be compressed. It is employed for the stoppage of hæmorrhage, or for securing the compress after the performance of arteriotomy in the temples.

The most convenient bandage for the forehead, face, and jaws, is the *four-tailed one* or *single split-cloth.*

It is composed of a strip of cloth, about four inches wide, which is to be torn at each end, so as to leave only a convenient portion of the middle part entire. This unsplit middle portion is to be applied to the forehead, if the wound be there, and the two upper tails are carried backward, and tied over the back part of the head, while the two lower ones are to be tied either over the top of the head, or under the chin, as may seem most convenient.

When the wound is on the top of the head, the middle of the undivided part is to be applied to the dressings. The two posterior tails are to be tied forward, and the two anterior ones are to be carried backward, so as to be tied behind the head. This is sometimes called *Galen's bandage.* It is curious that writers on bandages should use the terms *head* and *tail* synonymously; and hence this *four-tailed bandage* is often called the *sling with four heads.* Such confusion of language is highly reprehensible, as it obstructs the comprehension of any, the most simple, subject.

If the upper lip be cut, and a bandage needed, which is seldom the case, it is almost superfluous to say that this bandage will serve the purpose. It serves also in cuts of the lower lip, though in them also we trust rather to the twisted suture than a bandage.

The single split-cloth is particularly useful for supporting a fractured lower jaw; and in such cases is the only one employed in modern surgery. This bandage, when used for this particular purpose, namely, supporting the lower jaw, is named *capistrum*, or *bridle*, because it goes round the part somewhat like a bridle.

The *triangular bandage* is generally a handkerchief doubled in that form. It is commonly used on the head, and, now and then, as a support to the testicles, when swelled. The French term it *couvre-chef en triangle.*

Another manner of applying the handkerchief, called the *grand couvre-chef*, is as follows:—You take a large handkerchief, and fold it, not in a triangular, but a square form. You let one edge project about three finger-breadths beyond the other, in order to form a general border for the bandage. You lay the handkerchief upon the head, so as to make the lower fold, to which the projecting border belongs, lie next the head; while the projecting border itself is left hanging over the eyes till the bandage is adjusted. The two corners of the outermost fold are first to be tied under the chin; the projecting border is then to be turned back, and pinned in a circular form round the face, while the corners of the fold next the head are to be carried backward and tied.

After the outer corners of this bandage have been tied under the chin; after the inner corners have been drawn out and carried round the occiput; and after the border has been turned back and pinned; the doubling of the handkerchief over each side of the neck hangs in a loose, awkward manner. It remains, therefore, to pin this part of the handkerchief up above the ear, as neatly as can be contrived. (See *J. Bell's Principles.*)

The grand couvre-chef has certainly nothing to recommend it, either in point of utility or elegance. A common nightcap must always be infinitely preferable to it. In the event, however, of a cap not being at hand, it is proper that the surgeon should know what contrivances may be substituted to fulfil the objects in view.

Having, in numerous articles of this Dictionary, noticed the mode of applying bandages in particular cases, and allotted a few separate descriptions for such bandages as are not here mentioned, but which are often spoken of in books, we shall conclude for the present with referring the reader for further information to *Rees's Cyclopædia; John Bell's Principles of Surgery*, vol. i.; *Dict. des Sciences Méd.* art. Bandage. Galen and Vidus Vidius are reckoned the best of the old writers on the subject; M. Sue, Thillaye, Heister, Juville, Lombard, Bernstein, J. Bell, and Cutler, of the modern ones. The Treatise of the latter is entitled *The Surgeon's Practical Guide in Dressing and in the Methodic Application of Bandages*, 12mo. Lond. 1834. Illustrated by numerous engravings. The mode of applying the *starched bandage* will be considered in the article FRACTURE.

BARK, PERUVIAN. (See CINCHONA.)

BELLADONNA. (*Atropa Belladonna, Deadly Nightshade.*) A powerful sedative and narcotic. The leaves were first used externally for discussing scirrhous swellings, and they have been subsequently given internally, in scirrhous and cancerous diseases, amaurosis, &c. Five grains of them dried are reckoned a powerful dose; one is enough to begin with. At present, the extract, in doses of half a grain, gradually increased to three, is more commonly prescribed.

[No reliance is now placed in this drug for the dispersion of scirrhous tumors. If employed at all, it is solely for the purpose of relieving pain by its sedative influence.]

It is said that the recent leaves powdered, and made into an ointment with an equal weight of lard, more effectually prevent priapism, and relieve chordee, when rubbed on the penis, than any other application. (*Paris's Pharmacologia*, vol. ii. p. 110, ed. 5.)

In neuralgia of the testicle, breast, and other parts, the use of the extract of belladonna, in the form of a plaister is well known.

From the power which belladonna is known to possess, of lowering the action of the whole arterial system, it seems to be a fit medicine in many surgical cases, where that object is desirable, particularly in examples of aneurism.

An ointment, composed of one drachm of the extract, and seven drachms of lard, and rubbed on the perineum, affords great relief in hæmorrhoids, and chordee. (See *A. T. Thomson's Mat. Med. &c.* p. 433, ed. 2.) It may also be applied directly on the tumors, or the induration itself.

Belladonna has the power of producing a dilatation of the pupil, when applied to the eyebrow and eyelids. The late Mr. Saunders, a little while before undertaking the operation for congenital cataract, was accustomed to introduce some dissolved extract of belladonna between the eyelids, or rub the eyebrow and skin about the eye freely with the same application. The consequence was, that, if there were no adhesions of the iris to other parts, a full dilatation of the pupil was produced in less than an hour, and the whole of the cataract was distinctly brought into view. This was unquestionably a considerable improvement in practice, as the iris was kept out of danger, and the operation materially facilitated. I allude here more particularly to Mr. Saunders's own method, in which he introduced the needle through the cornea, in front of the iris, and then conveyed it to the cataract through the enlarged pupil. Belladonna was also externally applied by Mr. Saunders, after the operation, with the view of preventing the edge of the iris from becoming adherent to the edges of the torn capsule. The influence of belladonna on the iris led also Professor Reimarus to propose its use for facilitating the extraction of the cataract. In iritis, the same plan is an important part of the treatment. It must, however, be admitted, that the iris, when much altered by inflammation, is not affected by belladonna; but, even under such circumstances, its use is not attended with any disadvantage. But it is not from its effects on the pupil alone, that the extract of belladonna should be applied. Very decided relief is obtained from its application in cases where there is a deep-seated pain, extending from the eyeball to the temple, and especially in rheumatic inflammation. It may be used as recommended by Beer, in the form of ointment, rubbed in upon the temple (half a drachm of the extract, with an equal quantity of mercurial ointment every night), or the extract alone, softened with water and daubed over the lids and brow, and kept moist for one or two hours, with a light fold of old linen, wetted every ten minutes, may be preferred. (See *Jacob* in *Trans. of Assoc. of Physicians of Coll. Ireland*, vol. v. p. 476.) Whenever the state of the eye, behind the pupil, requires to be minutely examined, the plan of dilating this aperture by means of belladonna, very materially facilitates the examination. Stramonium is found to have the same effect upon the iris as belladonna. Some experiments, in which this fact is clearly proved, were detailed many years ago, by a namesake of my own in the United States. (See *A Diss. on the Properties and Effects of the Datura Stramonium, &c. by Samuel Cooper*, Philadelphia, 1797. *C. Himly, De la Paralysie de l'Iris par une application locale de Jusquiame, &c.* 2nd ed. 12mo. Altona, 1805. *J. Bailey, Obs. relative to the use of Belladonna in painful disorders of the Head and Face*, 8vo. Lond. 1818.)

[Belladonna causes dilatation of the pupil by paralysing the ciliary nerves, which supply the muscular fibres of the iris. This effect is produced both when it is taken internally and when it is used as a local application. In the former case, the poison is absorbed into the blood, and reaches the ciliary nerves through the central organ of the nervous system, both eyes being influenced alike: in the latter case, it acts upon these nerves by direct imbibition, the paralysing influence is entirely a local one, and the pupil of the other eye is unaffected. (See *Muller's Physiology*, translated by *Baly*, vol. i. p. 630.)

According to Mr. Bowman, the ciliary muscle is also paralysed, and the adjusting power of the eye to vision at different distances is impaired.

A solution of atropine, the essential principle of belladonna, is now often employed in preference to the extract. (See ATROPIA.)]

BISTOURY. (*Bistoire*, French.) Any small knife for surgical purposes. [English surgeons usually give the name of *scalpel* to the ordinary knife used in operations, and distinguish by the term *bistoury* a long narrow bladed knife, which is made either straight or curved, sharp or probe pointed.]

BLADDER, INFLAMMATION OF. CYSTITIS. [Inflammation of the bladder is rarely an idiopathic affection. It is met with occasionally in cases of gonorrhœa, but more frequently it is the result of the irritation produced by other diseases, as stone, stricture, enlarged prostate, &c. Inflammation of the bladder almost invariably originates in the mucous membrane, but it may extend from this to the muscular and peritoneal coverings, and may lead to suppuration, circumscribed or diffused. in the walls of the bladder. In the great majority of cases, however, it is as an inflammation of the mucous lining that the surgeon has to deal with it, its leading characteristic being an excessive mucous or muco-purulent secretion; although in severe and protracted cases, it may terminate in ulceration, or even gangrene.

Inflammation of the bladder is usually described as being acute or chronic, but it may exist in every intermediate degree; while the acute may subside into the chronic, or the chronic become aggravated into the acute. Inflammation of the bladder, occurring *primarily as an acute affection*, is of rare occurrence. It is most frequently met with in cases of gonorrhœa, in which complaint the inflammation sometimes extends backwards along the urethra till it reaches the bladder. Under these circumstances, when the bladder becomes inflamed, the urethral discharge is usually remarkably diminished, or suppressed altogether; and hence the case has been regarded rather as a transference or metastasis of the inflammation from the urethra to the bladder, than as an extension by continuity of surface. This appears to be the opinion of Sir B. Brodie, who says: "Where there is a sudden suppression of the discharge from the urethra, the metastasis takes place, sometimes to the testicle, sometimes to the prostate gland; at other times, but less frequently, to the mucous membrane of the bladder." (*On Dis. of the Urinary Organs*, ed. 4, p. 104.)] However this may be, when the bladder becomes inflamed, "The patient has a frequent desire to void his urine, *with a sensation as if there were urine in the bladder, when there is really no urine in it; and he* strains to make water *when the bladder is empty*." (*Sir B. Brodie*, op. cit. p. 82.) Desault's account of the symptoms is accurate. He says:—"This form of the complaint makes its attack suddenly, and may be known by the frequent desire to make water; the acute pain in the region of the bladder; pain, which is increased by the efforts to make water, and which shoots up to the loins and along the urethra to the end of the glans; by the frequency and hardness of the pulse, and other symptoms of fever; by the aggravation of the pain, when the hypogastric region is pressed; by the easy passage of a catheter into the bladder; by the acute pain which is excited by the instrument touching the inside of this organ; and by the red inflammatory colour of the urine."

This is not properly, as Desault regarded it, a case of retention of urine, but rather of painful and frequent micturition, resulting from inflammation; the bladder being so irritable as to be incapable of bearing even the smallest quantity of urine within it. Hence Desault's theory, which led him to enjoin the use of the catheter, was practically wrong and hurtful, as the bladder is always emptying itself, and the instrument would only increase the inflammation.

[The urine is mostly acid and high coloured; blood in small quantities is frequently mixed with it. The secretion of mucus is considerably augmented, it forms a semi-transparent cloud at the bottom of the vessel, when the urine has been allowed to stand. The mucous deposit possesses more or less viscidity, but it is not characterised by that remarkable adhesiveness and tenacity which will be presently described as met with in chronic inflammation. At a later stage, the secretion becomes more purulent; as this takes place, the viscidity diminishes, and the semi-transparent appearance becomes altered to an opaque whitish yellow colour.

Acute inflammation of the bladder is sometimes caused by cantharides, not only when administered internally, but also when applied to the skin to produce vesication. A remarkable peculiarity which has been met with in inflammation of the bladder from this cause, is an albuminous exudation from the mucous membrane, resembling the false membranes in croup. In a fatal case, examined by M. Vidal de Cassis, the surface of the bladder was found lined with portions of membrane of this kind, and of considerable thickness. The membrane beneath presented signs of intense inflammation. The false membrane, says M. Nélaton, is passed with the urine, sometimes in fragments so small as to escape notice, sometimes in portions sufficiently large to distend the urethra, and even to become impacted in the canal. (*Nélaton, El. de Pathol. Chir.* t. v. p. 266, 1858.) Inflammation from this cause is usually rapid in its progress, and the symptoms are severe.]

Acute inflammation of the bladder is to be counteracted by powerful antiphlogistic remedies; cupping on the loins; the application of leeches to the perineum and hypogastric regions; venesection, if necessary; the warm bath; occasional doses of castor oil; opiate clysters; fomentations on the abdomen; and cold mucilaginous beverages. Saline medicines, with full doses of alkalies, as the liquor potassæ, or the carbonates of soda or potash, should be given three or four times daily, to diminish, as much as possible, the irritating qualities of the urine.

"Sometimes," Sir B. Brodie remarks, "the urine retains its acid quality, turning the blue litmus paper red; and the sediment which it deposits is of a yellowish colour, having no adhesive quality, and bearing some degree of resemblance to pus; and in these cases, if I am not much mistaken, the patient will derive benefit from the use of mercury, two grains of calomel, and half a grain of opium, being administered twice or three times a day. In other cases the urine is alkaline, turning the reddened litmus paper blue, and depositing a small quantity of tenacious adhesive mucus of a brown colour; and, under these circumstances, I have known much good to arise from the use of the vinum colchici, thirty drops being given three times daily for three or four successive days." (*Sir B. Brodie*, op. cit. p. 83.)

[*Chronic inflammation of the bladder* is most commonly a secondary disease, occasioned by the presence of a calculus, or by the incomplete evacuation of the urine, in cases of stricture or prostatic enlargement. In all these diseases, the inflammation of the bladder is often one of the most urgent and distressing complications. In paralysis of the bladder, also, the inability of this organ to expel its contents, combined perhaps with the diminished vitality consequent upon the loss of nervous influence, is soon followed by inflammatory action. Occasionally, however, the inflammation may be *primary;* Sir B. Brodie speaks of having seen a few patients in whom it had existed for a considerable length of time, and could not be traced to any other disease. Some of these cases may perhaps be the result of exposure to cold, which is so common a cause of inflammation of the respiratory and alimentary mucous surfaces, that we may reasonably expect the urinary apparatus will not always be exempted from its influence. The term *vesical catarrh* is often applied to this disease, the increased secretion of mucus forming its most constant and leading characteristic.

The following succinct and accurate account of the symptoms, from the earliest to the most advanced stages, is given by Sir B. Brodie. "The patient has frequent desire to void his urine, and the urine deposits, as it cools, a thick adhesive mucus, which clings to the bottom of the vessel. This mucus is of a greyish colour, often exhibiting white streaks, arising from a deposition in it of phosphate of lime, and sometimes tinged with blood. There is pain previously to making water, and also while the urine flows. These symptoms may continue for a great length of time without becoming urgent. However, they gradually increase, until the irritation of the bladder becomes excessive, the quantity of mucus deposited being so great, as in some cases to be nearly equal to that of the urine itself. In this last respect, however, there is a great difference in different cases. The urine ultimately assumes a brownish hue, and is of a most offensive ammoniacal odour. The extension of the inflammation to the glandular structure of the kidneys is indicated by the access of a still more formidable train of symptoms. The patient has shiverings; is troubled with sickness and vomiting, with cold extremities and great prostration of strength; his pulse becomes irregular and intermittent, his tongue brown; he sinks and dies." (*On Dis. of the Urinary Organs*, ed. 4, p. 108.)

Condition of the Urine.—The leading peculiarity of this secretion in chronic inflammation of the bladder, is the presence in it of mucus in increased quantity, and of a viscid adhesive quality. The mucus falls to the bottom as the urine cools, and after it has been deposited, it does not readily mix again with the urine when agitated, but adheres to the bottom of the vessel, and when an attempt is made to pour it away, it is drawn out in long ropes, and hence the term "*ropy mucus*" is commonly used in describing it. The mucus is always alkaline; its tendency, therefore, will be to impart an alkaline quality to the urine; but when only present in small quantity, it may not be sufficient to neutralise the normal acid of the urine, and that fluid will still exhibit an acid reaction. Sometimes litmus paper, reddened by the urine, will again become blue as it sinks to the bottom of the vessel, and comes in contact with the alkaline mucus. A white amorphous sediment of phosphate of lime is often mixed with the mucous deposit. Phosphate of lime is present in small quantities in the normal secretions of all mucous membranes, and is produced in excess when these membranes are irritated and inflamed. In addition to the phosphate of lime, the urine, as it becomes alkaline, will deposit crystals of the triple phosphate of ammonia and magnesia. As the alkalescence increases, phosphate of lime *from the urine* will be also thrown down; but by far the larger quantity of this latter substance is formed, as already stated, by the mucous membrane. It is a mixture of these phosphates which constitutes the concretion known as the *fusible calculus.* As the disease progresses, pus is mixed with the mucus, or the mucus may be replaced almost entirely by pus. The pus globules fall to the bottom of the urine, and form a sediment, but instead of being semi-transparent and viscid, like mucus, it is of an opaque whitish yellow colour; when both are present, they may be found to have subsided in layers, the pus resting upon the mucus. Pus globules readily diffuse themselves in the urine when agitated, and render it cloudy; mucus, as already stated, does not mix, but remains at the bottom. Pus, however, by the action of alkalies, is converted into a semi-transparent gelatinous substance; hence in very alkaline urine this distinction will not always hold good. The clear urine, from which pus globules have been deposited, contains the albumen of the liquor puris in solution; and this may be made evident by the addition of nitric acid and the application of heat; the liquor muci in true mucus contains no albumen. The presence of albumen might perhaps give rise to a suspicion of diseased kidneys; but the two cases may usually be distinguished by the circumstance that the quantity of albumen present in purulent urine is proportionate to the amount of pus globules deposited, and that it never approaches in amount to the albumen of diseased kidneys. In purulent urine also the specific gravity is unaltered, or, if anything, is increased; whereas in true albuminuria it is remarkably diminished. The deposit of phosphates often much resembles that of pus globules; the phosphates, however, may be known by their solubility in acids, which have no influence on the pus globules. The microscope will at once display the difference between pus globules and phosphatic deposits, for the appearances of which latter the reader is referred to the article URINARY DEPOSITS; but it is not *always* easy to distinguish with certainty between pus globules and certain nucleated particles met with in mucus, and usually spoken of as mucus corpuscles. The pus globules are rather larger than blood globules, their diameter being about $\frac{1}{2800}$ of an inch. They are spherical in form; and they are white, opaque, and granular on their surface. The addition of acetic acid renders evident, in their interior, the presence of three or four transparent nuclei. But the mucus corpuscle is also a granular round nucleated particle, and it is often nearly, if not quite, impossible to distinguish between them. Dr. Golding Bird observes, indeed, that it may be questioned whether they are not identical. Where mucus and pus essentially differ is not in the nature of the particles, but in the fluid secreted with them, and in which they float; the liquor puris being albuminous and coagulable by heat, the liquor muci not being affected by it. Treated with acetic acid, the mucus particle exhibits internal nuclei similar to those seen in pus. (*On Urinary Deposits*, p. 337.) The particles in mucus perhaps are not so uniform in size, or so granular on the surface, and the nucleus may be more distinctly seen without the use of reagents. Mr. Coulson has drawn the following distinction:—"The characteristic nucleus of the pus globule is ordinarily tripartite, sometimes quadripartite, more rarely only bipartite; each division of the nucleus is biconcave, and measures about $\frac{1}{8000}$ of an inch in diameter. The only bodies with which the pus corpuscles are likely to be confounded are young epithelial scales. These, however, are readily distinguished by their *solitary nucleus.* As to the mucus corpuscle, *its existence is totally unproved:* under that name have been confounded pus corpuscles seen without the use of reagents; the pyroid corpuscles of Lebert, really a variety of compound granular corpuscles; young epithelial scales, and the nuclei of epithelial scales." (*On Diseases of the Bladder*, p. 145.) Fortunately, the diagnosis between the pus and mucus particle, about which so much has been written, though interesting pathologically, is not of any great practical importance.

The following account of the appearances which the diseased parts exhibit on dissection is given by Sir B. Brodie. "The mucous membrane is of a dark red colour, in consequence of its numerous vessels ramifying on its surface injected with their own blood. As the disease proceeds, the discoloration becomes greater, until at last the mucous membrane appears almost black from the turgid state of the vessels, at the same time that it is somewhat thickened and pulpy to the touch. The inflammation extends up the membrane of the ureters; which in their turn assume much the same appearance with the bladder itself. The pelvis of each kidney, and the processes of the pelvis or infundibula become inflamed also; and these, as well as the ureters, are generally dilated, so as to be more capacious than natural. This dilatation is greatest where there has been a long continued difficulty in expelling the urine from the bladder; but it exists in other cases also, though in a less degree. In the advanced stage of the disease, the inflammation is found to have extended to the glandular structure of the kidneys; and these organs become not only more vascular than natural, but enlarged in size, and of a soft consistence, even approaching in appearance to that of a medullary tumor. Collections of muco-purulent fluid, tinged brown with grumous blood, and offensive to the smell, are sometimes found in the dilated infundibula; at other times there are distinct abscesses in the glandular structure. In cases where the disease is still further advanced before the patient dies, we find that the inflammation has extended to the muscular tunic of the bladder, and to the loose cellular membrane by which the bladder is surrounded. Then, coagulated albumen is deposited in the cellular texture; not unfrequently small putrid abscesses are formed in it; and sometimes after death it is found in a state of slough, or approaching to it. Occasionally, but rarely, ulceration takes place in the inner surface of the bladder, and sometimes to a very great extent." (*On Diseases of the Urinary Organs*, ed. 4, p. 106.) In one case, which is an exemplification of what is not unfrequently met with, "the mucous membrane was found destroyed everywhere, except a very small portion near the neck of the bladder. The muscular fibres were as distinctly exposed as they could have been by the most careful dissection." It would be erroneous, however, to infer, from the above description, that inflammation of the bladder is often *per se* a fatal disorder. On the contrary, when the cause which has produced it has been removed, it is ordinarily very amenable to treatment. Patients may die from inflammation of the bladder, and its extension to the kidneys, after lithothrity, in prostatic disease, or in severe cases of stricture; but it is to the maintenance and aggravation of the inflammation, through the persistence of its exciting cause, that we are indebted for so lamentable a result.

Inflammation of the muscular coat of the bladder has been described by authors; but it is very doubtful whether such an affection, occurring primarily, has an independent existence. The only exception, perhaps, is one alluded to by Dr. Prout, of certain gouty and rheumatic inflammations of the bladder, in which he thinks it probable that the muscular and nervous structures and their appendages may be the chief seat of the affection. The late author of this Dictionary says, "as to the effects of an inflammation of the detrusor urinæ, I know nothing of them from experience." Mr. Coulson's opinion is, that the muscular coat is seldom, perhaps never, exclusively the seat of inflammation, if we except those cases in which abscesses form between the serous and muscular coverings; and then, perhaps, it would be more correct to regard the areolar tissue, and not the muscular fibres, as the seat of inflammation; in short, to class the affection as we should class an abscess occurring in any other situation. (*On Dis. of the Bladder*, p. 180.) Even the occurrence of an abscess, however, seems improbable, excepting as the result of some irritation communicated from either the mucous or peritoneal surfaces.

The irritation of the bladder and the constant straining to pass water in urinary disease of long standing, often lead to a *chronic inflammation*, or *hypertrophy*, of the muscular coat, which may be found after death to be half an inch, or even an inch, in thickness. Such a bladder is quite incapable of a proper amount of distension, and hence, as soon as a small quantity of urine has collected, violent efforts are excited for its expulsion.

The efforts to evacuate the urine may occasion a protrusion of the mucous coat through the interstices of the muscular fibres, and a *sacculated bladder* is the result. The existence of these sacculi will aggravate the mischief, for, as they are uncovered by muscular fibres, they are not emptied by the usual efforts of the patient, and the urine accumulates in them and undergoes decomposition. This stagnation is favourable to the formation of urinary concretions, and calculi are not unfrequently found encysted in these cavities. (See LITHOTOMY.)

Treatment.—The first indication in the treatment of inflamed bladder is obviously the removal of its exciting cause. This having been done, the principal difficulty will have disappeared, and the patient will, in most cases, with appropriate management, soon be restored to health and comfort. But even when the exciting cause does not admit of removal, much may be done to palliate his sufferings.

Active antiphlogistic treatment, such as the abstraction of blood, or the administration of calomel or antimony, is seldom required; for although the local irritation is considerable, the general state of the system is mostly characterised by debility and depression. The bowels should be kept open by mild unirritating purgatives. The irritability of the bladder and the frequent desire to micturate should be relieved by the administration of opium, either by the mouth, or by the rectum in the form of an enema or suppository. Alkalies will, in most cases, be beneficial, although, in consequence of the alkaline state of the urine, acid remedies, and especially the mineral acids, are often administered. This practice, however, is based on erroneous principles, for the urine is often acid when first formed, but is rendered alkaline subsequently by the alkaline mucus of the bladder. Its *acidity*, in fact (as Dr. G. O. Rees has explained), may often be a source of irritation, and therefore if we lessen the acidity as it is secreted on to the mucous surface, and thereby render it less irritating, that surface may in time recover itself, and no longer pour out that fluid which is the result of inflammation. The urine will after a time pass over it without producing irritation, and the result will be that *acid* urine is voided, its natural acidity being only partially neutralised by the dose of alkali which has been administered. This is the only satisfactory explanation of the fact, so anomalous at first view, that *alkaline* urine may be rendered *acid* by the administration of an alkaline remedy (see *Lond. Med. Gaz.* vol. i. 1851, p. 36.). With this object in view, the liquor potassæ may be prescribed; or the sesquicarbonate of soda ; or the bicarbonate of potash ; or the common effervescing saline draught, consisting of the tartrate or citrate of soda or potash. It is important to be aware, with respect to these latter, that the vegetable acids which enter into their composition become converted into carbonic acid in passing through the system, and they therefore reach the urine in the form of carbonates, and not in their original state as citrates or tartrates. Hence they will have the same effect upon the urine as if an equal quantity of the alkaline carbonates had been given, while they are more pleasant to the taste, and will often agree better with an irritable stomach.

On the same principle, Dr. Rees remarks, that acid wines, especially champagne, taken in quantity, are capable of producing alkaline urine. The alkalinity might be looked upon as a sign of rapid decay of vital power, whereas it may be owing merely to the support we are affording the patient in the form of champagne (loc. cit. p. 36). In all cases, however, where there is reason to believe that the urine *is alkaline when secreted by the kidneys*, as in cases of extreme depression, or when there is a large quantity of crystalline phosphatic deposit in the urine, all remedies likely to increase the alkalescence should be carefully withheld.

But there are, besides, certain remedies which are regarded as having a specific action on the vesical mucous membrane. The chief of these are, the leaves of uva ursi, of diosma crenata or Buchu, and of chimaphila umbellata, and the root of pareira brava. These drugs may often be employed with advantage, especially in those cases where the catarrh is excessive, and the inflammatory symptoms are not prominent. They are all astringent in their action, and are frequently prescribed indiscriminately; but, according to Dr. Golding Bird, "each fulfils a second indication which should never be lost sight of. Thus we find in the uva ursi a simple astringent, but slightly diuretic ; chimaphila, a less active astringent, but freely stimulating the kidneys; burosma (diosma, Buchu), a stimulating tonic, diuretic and diaphoretic, whose active principle (volatile oil) is excreted by the kidneys; pareira, a narcotic (?) tonic diuretic." The latter is especially recommended by Sir B. Brodie, in the form of a decoction, prepared from half an ounce of the root to three pints of water, simmered gently near the fire, till reduced to one pint. The patient to drink from eight to twelves ounces daily. When the catarrh is excessive, and the inflammatory symptoms are slight, copaiba, cubebs, or Chios turpentine, may sometimes be given with advantage.

But in addition to the general treatment, it is possible to reach the diseased mucous surface with local applications. Sedative, or astringent solutions, may be injected into the bladder through an elastic gum catheter. On this subject, Sir B. Brodie remarks, that in aggravated cases of disease the mildest injections, even those of tepid water, will do harm rather than good. When, however, the symptoms have in some degree abated, he thinks the injection of tepid water, or decoction of poppies, is, in many instances, productive of excellent effects. The liquid should be allowed to remain in the bladder thirty or forty seconds, and not more than an ounce and a half or two ounces should be injected at a time. Any distension of the bladder will be injurious instead of beneficial. The injection may be repeated once or twice in the twenty-four hours. When the symptoms have still further abated, a small quantity of nitric acid may be added to the injection, from five to ten minims of the dilute acid to an ounce of distilled water. (See *Brodie*, op. cit. p. 114.) Weak solutions of nitrate of silver have also been recommended. Some French surgeons have used injections of balsam of copaiba, of turpentine, and other similar substances. (See *Nélaton, El. de Path. Chir.* t. v. p. 277.) M. Lallemand has even practised cauterisation of the mucous membrane of the bladder with *solid* nitrate of silver. (See *Coulson, On Dis. of the Bladder*, p. 170.) The double current catheter may conveniently be used for injecting the bladder; by this instrument, a continuous stream of fluid may be passed through the organ, and its cavity may be more effectually washed out, while over-distension is at the same time avoided.

Rugous bladder, a thickened and contracted condition of bladder, with hard, prominent rugosities on its inner surface, is not unfrequently met with in children, and sometimes, though more rarely, in adults. This condition is accompanied by great irritability of the bladder, and frequent desire to pass water. There is acute pain in passing it, and it is often mixed with blood. The symptoms simulate very closely those of stone in the bladder, and it may be necessary to sound the patient to clear up the doubt. Even when the sound is introduced, a surgeon unaware of this condition of bladder, or whose hand is inexperienced, might mistake the sensation conveyed by the hard and roughened walls of the bladder for that produced by a calculus (see LITHOTOMY). This state of bladder, however, is rarely coexistent with stone. The *treatment* should be mainly directed to soothe the irritability of the bladder. Alkalies and sedatives, together with gentle purgatives, will usually be of great service. Further indications must be sought for in an examination of the urine, and a careful inquiry into the general state of health of the patient.]

[Paralysis of the Bladder.]

[Paralysis of the bladder may form part of a *general* paralysis, and is thus a common result of injuries or diseases of the brain and spinal cord, and especially of the latter; or it may be *locàl*, and affect the bladder only. The latter kind of paralysis is often consequent upon retention of urine, and is the result of the over-distension which the bladder has undergone. Paralysis of the bladder may occasionally be seen in cases of typhus fever, and there is a species of paralysis belonging to hysteria which is sometimes brought under the notice of the surgeon; and a partial paralysis, apparently independent of other disease, is not uncommon in old age.

Some writers describe paralysis of the bladder as of two kinds; one affecting the body, and the other the neck, of the organ; the former being attended with retention, and the other with incontinence, of urine. It is the former condition, however, which is usually understood when paralysis of the bladder is mentioned, and which will be alone referred to here. For information on the other variety, or the so-called paralysis of the neck of the bladder, the reader is referred to the article, Urine, Incontinence of.

Paralysis of the bladder may be complete or partial, it may be sudden or gradual in its appearance. Perhaps the best example of sudden and complete paralysis of the bladder is that met with in fractures or dislocations of the verterbræ, with injury of the spinal cord; but here, of course, it only forms part of a general paralysis, affecting all the structures below the seat of the injury. In these cases, there is not only a loss of the muscular power to expel the urine, but there is also a complete absence of sensibility, and the patient is altogether unaware of the presence of the accumulated urine in his bladder. Under these circumstances, the bladder becomes distended, and when the distension is excessive, the sphincter action of the neck of the bladder is overcome, and the urine dribbles away by slow degrees, in sufficient quantity to prevent *further* distension, but without relieving that which already exists. A practitioner unaware of this might mistake the case for one of incontinence of urine, in which there is inability to *retain*, instead of inability to *expel*, the urine.

In paralysis, a fluctuating swelling caused by the distended bladder may usually be felt by the hand applied to the hypogastric region, where it forms a tumor, which in some cases may reach as high as, or even higher than, the umbilicus. Percussion of this swelling will elicit a dull sound, which will serve to distinguish it from distension of the bowels with flatus. In cases where the surgeon is in any doubt, however, the introduction of the catheter will at once clear up the difficulty. In injuries of the spine, this paralytic retention must always be expected, and its consequences provided against by the continued use of the catheter. In these cases, chronic inflammation of the bladder rapidly supervenes, there is increased secretion of viscid mucus, the urine is alkaline, ammoniacal, and putrescent, and contains an abundant deposit of phosphates: ulceration, gangrene, complete separation of the mucous from the muscular coats, are not unlikely ultimately to occur. The increased secretion of mucus may perhaps be, in the first instance, an effort of nature to shield the mucous membrane from irritation by the urine retained in the bladder; but the rapid progress of a low inflammatory action, and the tendency to ulceration or gangrene, are probably owing to that diminution of the power to resist degenerative processes which always accompanies the deprivation of nervous influence. The only treatment applicable to the paralysis of the bladder accompanying spinal injury, beyond the appropriate management of the injury itself, is the use of the catheter twice or thrice daily, and the occasional washing out of the bladder with tepid water, or water weakly acidulated with nitric acid. (See Fractures of Vertebræ.)

In *diseases* of the brain or spinal cord, the paralysis may be incomplete, and may make its appearance slowly. In examples of this kind, the patient may pass a normal quantity of urine in the twenty-four hours, but the bladder be nevertheless always distended. When a certain degree of accumulation has taken place, the contractility of the bladder is excited, and it *partially* empties itself, but never *completely*. A certain amount of urine, therefore, is always retained in the bladder, becomes decomposed, and excites inflammation of the mucous membrane. The patient may be unaware that he does not empty his bladder completely, and will be greatly astonished to find, when his surgeon introduces a catheter, that one or two pints of fluid escape. In these cases also, the surgical treatment will be confined to the introduction of the catheter, to prevent the urine accumulating and decomposing in the bladder; the ultimate recovery from the paralysis of the bladder will depend upon the curability, or otherwise, of the disease of which it forms a part, and to which any further treatment should be directed.

The cases in which the paralysis of the bladder is *purely local* are most frequently the result of over-distension; the stretching which the muscular, and it may be, also, the nervous, fibres have undergone, seems to deprive the bladder, although, perhaps, only for a time, of its contractile power. Thus, in cases of retention of urine, after relief has been obtained by the introduction of a catheter, the bladder may not recover its power to empty itself for some days, unless artificial assistance is afforded; a second retention, therefore, takes place, this time not from any impediment to the expulsion, but from the want of power to expel. Perhaps, after a certain amount of redistension has taken place, a partial evacuation may be obtained, not from the contraction of the bladder itself, but on account of the compressing influence of the abdominal muscles being brought into play.

Paralysis from over-distension is very common in old persons, in whom the enlargement of the prostate gland forms a mechanical obstruction to the evacuation of the urine. These persons frequently have their bladders unduly distended, and suffer from attacks of retention more or less severe; the consequence is, that in the course of time, the contractility of the muscular fibres is impaired, and paralysis, more or less complete in different cases, is induced.

In treating the paralysis of the bladder caused by over-distension, the indication is to maintain the muscular fibres in a state of rest a sufficient length of time for them to recover from the injury they have suffered. Accumulation of urine, therefore, in any quantity must be carefully prevented. The catheter should be introduced at regular intervals, or be retained altogether in the bladder. The latter plan is perhaps the more effectual, as it enables the patient himself to regulate the escape of urine as soon as it begins to accumulate; but it is attended with the risk, that the point of the instrument may irritate, or even cause ulceration of, the interior of the bladder. In many cases, the patient can be easily taught to introduce the instrument himself as often as he requires it. The contractile power may be completely regained in a few days, or it may only be recovered by very slow degrees, that is to say, it may take weeks or even months. If the affection has been caused by a sudden attack of retention, recovery may generally be expected; but in old persons with prostatic enlargement the prognosis is less favourable, partly because the mechanical obstacle which has been the cause of the complaint will continue in operation, but partly also on account of the advanced period of life and feeble powers of the patient.

A tonic plan of treatment will often prove very beneficial. Quinine; steel, and especially the tincture of the sesquichloride of iron; small doses of the tincture of cantharides, and, in some cases, strychnine, may be employed with advantage. In addition to this, some assistance may be obtained from counter-irritation, by means of a blister over the sacrum.

Paralysis of the bladder in old persons, independent of any other disease, was formerly considered a very common affection. Desault and Boyer, and the late author of this Dictionary, thus regarded it. M. Mercier, on the other hand, has denied the correctness of this opinion, and attributes the symptoms to some obstruction existing in the prostate at the neck of the bladder. These contradictory views are partly reconciled, if we remember that obstructions at the neck of the bladder may, as already explained, be the cause of paralysis, by producing over-distension; but the reader will find the subject further alluded to in the article URINE, RETENTION OF. In the same place will also be found additional information on the subject of retention from paralysis, and on the retention caused by the simulated paralysis of hysteria.]

BLADDER, PUNCTURE OF.

The making of an artificial outlet for the urine is an operation to which we are sometimes obliged to have recourse, after having in vain employed all the other means indicated for the prevention of the bad, and even fatal, consequences of a stoppage of the evacuation of this fluid, and distension of the bladder. Various accidents and diseases, both acute and chronic, may occasion this dangerous state, as will be more particularly noticed in the article URINE, RETENTION OF. At the present day, however, the artificial outlet is not so frequently made by puncturing the bladder, as by opening the distended part of the membranous portion of the urethra, behind the stricture.

The bladder, which can conveniently hold about a pint and a half of urine, is no sooner dilated, so as to contain two pints, than uneasy sensations are experienced. The desire of discharging the water now becomes urgent, and if the inclination be not gratified, and the bladder be suffered to be dilated beyond its natural state, for a certain time, it loses all power of contraction, and becomes paralytic. The desire, indeed, continues, and the efforts are renewed in painful paroxysms; but, the power is lost, and the bladder becomes more and more distended. When this viscus is dilated to the utmost degree, and neither its own structure, nor the space in the abdomen, can allow a further distension, either the bladder must be lacerated, which it rarely is, so equally is it supported by the pressure of the surrounding parts, or its orifice must expand and the urine begin to flow. After the third day of retention, the urine often really begins to flow, and whatever descends from the kidneys is evacuated in small quantities from time to time, and at this period, the bladder is distended in as great a degree as it ever can be, however long the patient may survive. This dribbling of the urine, which begins when the bladder is dilated to the utmost, and continues till the eighth or tenth day, or till the bladder sloughs, has long been understood, and is named by the French, "*Retention par régorgement.*" To practitioners who do not understand it the occurrence is most deceitful. The friends felicitate themselves, that the urine begins to flow; the surgeon believes it; basins and cloths wet with urine are easily produced; but the patient lies unrelieved. The continued distension of the bladder is followed by inflammation of it and the peritoneum. The insensibility, and low delirium of incipient gangrene, are mistaken for that relief which was expected from the flow of urine, till either hiccough comes on, and the patient dies of fever and inflammation, or the urine gets into the abdomen through an aperture formed by mortification. Let no surgeon, therefore, trust to the reports of nurses and friends, but lay his hand upon the hypogastric region, and tap with his finger, in order that he may distinguish the distended bladder and the fluctuation of urine. As the bladder suffers no further distension after the third day, why should it burst? Not from laceration, for it is supported by the uniform pressure of the surrounding viscera; not by yielding suddenly, for it is distended to its utmost on the third day of the retention, and yet seldom gives way before the tenth; not by attenuation, for it becomes thickened. The term *laceration* was never more wrongly applied than in this instance; for when there is a breach in the bladder, it is found, on dissection, to be a small round hole, such as might be covered with the point of the finger. The rest of the viscus, and the adjacent bowels, are red and inflamed, while this single point is black and mortified. Delay is more dangerous than even the worst modes of making an opening into the bladder; and, while life exists the patient should have his chance. (See *John Bell's Principles of Surgery*, vol. ii. part 1, p. 262, &c.) That many patients die after paracentesis of the bladder is an undoubted truth, and this circumstance has rather intimidated practitioners against the operation. It appears to me, however, that in general death may be more fairly ascribed to the effects of the disease than to the puncture of the bladder, and that, if the making of an outlet for the urine, in some way or another, were not deferred so long as it often is, the recoveries would be more numerous. Hence, when relief cannot be obtained by the treatment described in the article URINE, RETENTION OF; when no urine at all has come away for three days, and no catheter can be introduced, the making of an outlet for the urine should not be delayed. Indeed, in urgent cases, one should rather operate earlier. As Sir Benjamin Brodie has observed, it is impossible to lay down any general rule concerning the period beyond which the operation ought not to be deferred. "Sometimes there will be no reason for resorting to it, until after the lapse of three or four days, and, at other times, it ought to be performed within thirty-six hours, or even sooner. After all, however necessary it may be to the safety of the patient in some instances, it is an operation that is very rarely required; surgeons, who see a great number of cases of retention of urine, may be called upon to perform it in a *few* instances. Those who perform it frequently, must often perform it unnecessarily." (See *Brodie, On Dis. of the Urinary Organs*, ed. 2, p. 41.) These remarks, I infer, apply more particularly to puncturing the bladder, and not to the less serious operation of opening the membranous part of the urethra behind the stricture; one of the modern improvements in surgery, for which we are indebted to Sir Astley Cooper, and which, in cases of insuperable retention from stricture, renders a puncture of the bladder itself but rarely advisable. Puncture of the bladder "in the male," says Sir Astley, "is not the operation which I perform, nor do I recommend it as a general practice." (*Lectures, &c.* vol. ii. p. 307.) In another place, he pronounces the puncture of the bladder in the male to be scarcely ever necessary (p. 315). Being called many years ago to a case of retention of urine from a stricture situated in the urethra behind the scrotum, he tried to pass different instruments, without success. "Reflecting upon the case," says he, "it appeared to me to be exposing the patient to unnecessary pain and danger, if I punctured his distended bladder; as, when I directed him to make attempts to discharge his urine, the urethra swelled excessively behind the stricture, from the urine passing as far as its seat. I therefore determined to make an incision into the urethra only" (p. 316). This was opened behind the scrotum, and the urine readily discharged. The patient rapidly recovered. Sir Astley Cooper gives other instances of the success of this practice, which has also an advocate in Sir Charles Bell (see *Surg. Reports*, part v.); and, I believe, in all the best surgeons of this country. Sir Astley introduces a female catheter through the wound to prevent extravasation; but he deems this not absolutely necessary. If any difficulty were experienced in opening the urethra behind the stricture, he recommends a catheter or staff to be passed to the stricture; and, under the guidance of its beak, an incision to be made, and extended an inch backward, in a line with the beak. "The state of the urethra in stricture," he adds, "is very different from that which exists with fistula in perinæo: in the former case, it is large behind the obstruction; in the latter, it is contracted, and very difficult to find." (*Lectures, &c.* vol. ii. p. 318.)

No doubt, a man who is exceedingly skilful in the use of the catheter, and knows how to practise, with science and judgment, all the other means for relieving the retention of urine, will not frequently find it necessary to have recourse to any operation. This is said to have been so much the case with the eminent Desault, that, in the course of ten years, he had occasion only once to puncture the bladder in the Hôtel Dieu, where diseases of the urethra are always numerous. (See *Œuvres Chir. de Desault, par Bichat*, t. ii. p. 316.) M. Roux is stated never to have met with a single instance in which there was a necessity for puncturing the bladder. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 960.) When, however, this superior manual dexterity with the catheter is not the acquirement of the practitioner, the timely performance of paracentesis of the bladder, or at all events, the making of an outlet for the urine in some way or another, should not be neglected. It is gratifying to know, however, that, at the present day, the absolute necessity for puncturing the bladder is rendered less frequent, not only by the treatment of diseases of the urethra being better understood than formerly, but also by the very great perfection to which the construction of elastic gum catheters is brought, instruments from which the most essential assistance may frequently be derived. Strictures in the urethra, and enlargement of the prostate gland, are the two cases most frequently producing a retention of urine; and in both of them, Sir Astley Cooper considers the operation of puncturing the bladder (with very few exceptions) entirely unnecessary; an opinion with which my own observations lead me fully to concur. In cases of enlarged prostate gland, a skilful surgeon will almost always succeed in introducing a catheter of proper shape and length; and in examples of retention from stricture, when relief cannot be afforded by ordinary means, the best plan, generally, is not to puncture the bladder, but to make a small opening in the part of the urethra between the stricture and the prostate gland; a part which is most commonly much dilated.

1. Puncture through the Perineum.

This operation was first performed by M. Tolet, the author of a treatise entitled *Traité de Lithotomie, ou de l'Extraction de la Pierre hors de la Vessie, troisième édition*, Paris, 1681. Dionis first suggested the method of opening the bladder on one side of the perineum, at the part where Frère Jacques used to perform lithotomy, and he conceived that this mode had advantages, because neither the urethra nor the neck of the bladder was injured. A narrow scalpel was first introduced, so as to make a passage for the probe, and along this a canula was guided into the bladder, where it was allowed to remain as long as necessary, care being taken to fix it by means of tapes put through the rings at the broad part of the instrument. The opening was then closed with a linen tent. The idea of substituting for these unsuitable instruments a trocar originated in 1721, with Juncker (see *Conspectus Chirurgiæ*, tab. 97, p. 674), unless the following passage be correct: "In the year 1717, or 1718, M. Peyronie showed in the King's garden a long trocar, which he had successfully employed in a similar puncture." (*Desault's Parisian Chir. Journ.* vol. ii. p. 267.)

The patient having been placed in the same position as for lithotomy, an assistant is to press with his left hand on the region of the bladder above the pubes, in order to propel that viscus as far downward into the pelvis as possible, while with his right hand he supports the scrotum. The surgeon is then to introduce the trocar at the middle of a line drawn from the tuberosity of the ischium to the raphe of the perineum, two lines more forward than the verge of the anus. The instrument is first to be pushed in a direction parallel to the axis of the body, and its point is afterwards to be turned a little inwards. Here, according to Bichat, there is no occasion to convey the canula so far into the bladder as is done when the operation is performed above the pubes. The portion of this viscus which is to be pierced being incapable of changing its position, with regard to other parts in the perineum, if the canula only project a few lines into its cavity, it will not be liable to slip out. It would be wrong, indeed, to carry it in further; for the pressure of its end against the posterior parietes of the bladder would do harm. Lastly, the canula is to be fixed in its place by means of the T bandage. (See *Œuvres Chir. de Desault,* t. iii. p. 320.)

As a silver canula, when kept introduced too long, becomes covered with a thick incrustation, rendering its extraction difficult and painful, care should be taken to withdraw it after five or six days, and to replace it as soon as it has been cleaned, or else to substitute another for it, according as the circumstances of the case require. When Dr. Ehrlich visited London, Mr. Chandler tapped the bladder through the perineum, and introduced a canula, which, after remaining in the puncture three weeks was so thickly covered with an incrustation, that its extraction produced considerable laceration of the parts, and a great deal of inflammation followed by an urinary fistula was the result. (See *Dict. des Sciences Méd.* t. ii. p. 205.)

The parts divided in the puncture are the skin, perineal fascia, a good deal of adipose and cellular substance, the levator ani muscle, and that portion of the lower part of the bladder which is situated on one side of its neck.

The puncture of the bladder from the perineum is now universally abandoned by British surgeons. "We may esteem it fortunate," says Desault, "if the trocar penetrates directly into the bladder, after piercing the fat and the muscles, situated between the tuberosity of the ischium and the anus; and as this viscus is subject to much variation in its form, the surgeon will often be defeated, unless he be perfectly clear in his ideas respecting its situation and figure. This disappointment is not without example, and there is sufficient cause to deter a practitioner from performing this operation, independently of the danger of wounding with the trocar the vasa deferentia, vesiculæ seminales, ureter, &c." (*Parisian Chir. Journ.* vol. ii. p. 267.) Sabatier conceives that the operation would be more safe if the surgeon were to begin with making a deep incision in the perineum, as is practised in the lateral way of cutting for the stone, and if he were to desist from plunging the trocar into the bladder until he had assured himself of the situation of this viscus, and felt the fluctuation of the urine. (*Médecine Opératoire,* t. ii. p. 127.) Sir Astley Cooper also directs an incision to be made in the perineum, as in lithotomy; the bulb of the penis to be pushed towards the patient's right side; the knife then carried within the ramus of the ischium till it reaches the prostate gland, which is likewise to be pushed toward the patient's right side; and lastly, the instrument to be passed obliquely upwards into the bladder, the operator's finger resting on the prostate gland. (*Lectures, &c.* vol. ii. p. 314.)

2. Puncture above the Pubes.

The method of tapping the bladder above the pubes was suggested by the possibility of extracting calculi from that viscus, by what is usually denominated the high operation. The first performers of the puncture above the pubes are said to have employed a straight trocar. The consequence was that when such a trocar was too long, its canula remaining in the bladder injured its opposite parietes, so as to occasion inflammation and a slough, on the separation of which the urine was liable to insinuate itself either into the abdomen, or rectum, as happened in a case mentioned by Mr. Sharp, where no more urine was discharged through the canula, and the patient died of a sort of diarrhœa. When the trocar is short, the bladder, on subsiding and contracting itself, gradually quits the canula, which becomes useless, and a necessity for making another puncture may be produced. Whatever pains may be taken to direct the trocar obliquely downwards and backwards, so that the canula may be, in some degree, parallel to the axis of the bladder, one or the other of these accidents cannot always be prevented.

Their prevention, however, may be effected by merely employing, instead of a straight trocar, a curved one, which will naturally take a suitable direction. This improvement was soon embraced by Frème Côme.

To this way of operating Mr. Sharp was partial, and Mr. Abernethy has recommended it under certain circumstances. It is an operation generally of no difficulty to the surgeon, and of little pain to the patient, the violence done to the bladder being at a distance from the parts affected. It is equally applicable whether the disorder be in the urethra or prostate gland; and when there are strictures, the use of bougies may be continued, while the canula remains in the bladder. (*Critical Inquiry,* p. 125, ed. 4.)

Some surgeons recommend making an incision, about two inches long, through the linea alba, a little way above the pubes, and then introducing a trocar into the bladder. Others deem this preliminary incision quite useless, asserting that the operation may be performed with equal safety, and less pain to the patient, by puncturing at once the skin, the linea alba, and the bladder. If the person were very corpulent, an incision might be proper; but, in ordinary cases, it is not necessary. When the trocar has been introduced, the stilette must be withdrawn, and the canula kept in its position by a riband, passed through two little rings, with which it should be constructed, and fastened round the body. The orifice of the canula should be stopped up with a little plug, which will keep the urine from dribbling away involuntarily, and may be taken out as often as necessary. (*Encyclopédie Méthodique; Part. Chirurg. art. Paracentese de la Vessie.*)

The trocar should be introduced in a direction obliquely downward and backward; for, as this corresponds with the axis of the bladder, the instrument will be less likely to injure the opposite side of that organ.

Many writers advise the puncture to be made an inch, or an inch and a half, above the pubes. The reasons for so doing are the following:— "If the puncture be made close to the os pubis, the bladder in that part, often rising with an almost perpendicular slope, leaves a chasm between it and the abdominal muscles, or, to speak more strictly, a certain depth of membrana cellularis only, so that, if the trocar penetrate but a little way, it possibly may not enter into the bladder. If it penetrates considerably, it may pass through the bladder into the rectum, or if not in the operation itself, some days afterwards, when by the course of the illness and confinement the patient is more wasted; for the abdominal muscles shrinking and falling in occasion the extremity of the canula to press against the lower part of the bladder, and in a short time to make a passage into the rectum." (*Sharp*, in *Critical Inquiry*, p. 127.) Though the reasons here adduced seem formidable, does not the danger of injuring the peritoneum form an objection to plunging in a trocar at the above distance from the pubes? Certain it is, peritonitis would be more apt to be induced by such practice than by introducing the instrument nearer to the pubes. Richerand decidedly condemns the plan, principally because the higher the puncture is made, the more apt the bladder will be to quit the canula, on the urine being discharged. (See *Nosogr. Chir.* t. iii. p. 472, ed. 2.) In Desault's works, by Bichat, the puncture is advised to be made immediately above the pubes (t. iii. p. 318). Some of Sharp's objections are removed, by taking care to pass the trocar into the bladder in the axis of this viscus, and employing one which is somewhat curved, as Hunter, Frère Côme, Sabatier, &c. have advised. Sharp confirms the danger of using too long a canula, by mentioning an accident which occurred in his own practice. Though he introduced the instrument more than an inch and a half above the os pubis, yet, having pushed it full two inches and a half below the surface of the skin, its extremity in six or seven days insinuated itself into the rectum. (*Critical Inquiry*, p. 127.) The instrument should be more or less long, according as the patient is fat, or otherwise; but, the ordinary length should be about four inches and a half. The curvature should be uniform, and form the segment of a circle, about eight inches in diameter. (*Œuvres Chir. de Desault, par Bichat*, t. iii. p. 317.)

A catheter left in the bladder longer than ten days, may gather such an incrustation from the urine, as to render the extraction of it difficult. Surgeons, therefore, should never leave the canula in the bladder quite a fortnight; or, if it must be kept introduced so long, Sharp advises a second one to be introduced, made with an end like that of a catheter. (*Critical Inquiry*, p. 129.)

Mursinna, however, has reported one example, in which a canula was kept in for a long time without inconvenience. (*Hecker, Annales der Ges. Medicin.* 1810, Jul. p. 39.) I have seen one such case myself; and another example of the same kind is mentioned by Sir Astley Cooper. (*Lectures*, vol. ii. p. 310.)

Mr. Abernethy recommended making an incision between the pyramidales muscles, passing the finger along the upper part of the symphysis pubis, so as to touch the distended bladder, and introducing a common trocar, of the middle size, in a direction obliquely downwards. On withdrawing the stilette, he directs a middle-sized elastic catheter to be passed through the canula into the bladder. The canula is withdrawn, and the catheter left in till the urine passes through the urethra. After a week, the instrument is taken out, and a new one introduced. (*Surgical Obs.* 1804.) It might be objected to this plan of employing a gum catheter, that, as it is smaller than the wound, the urine is not kept from passing between the instrument and the parts into which it is introduced, as well as through the tube itself. This happened in Mr. Abernethy's case; and though no urine in this instance got into the cellular membrane, it might sometimes do so, because it is not till after inflammation has taken place that the cavities of the cellular tissue are closed with coagulating lymph. In one instance where I performed this operation, and substituted an elastic catheter for the silver canula, on the second day it was suspected that some small quantity of urine had got between the catheter and side of the wound; for, in the *post-mortem* examination, pus was found in the course of the puncture, and inflammation of the neighbouring parts. After two days, however, the canula of the trocar may be safely withdrawn, and the elastic gum catheter employed.

The following is one of Sir E. Home's conclusions:—"When the puncture is made above the pubes, the canula which encloses the trocar is not to be removed, till the surrounding parts have been consolidated by inflammation, so as to prevent the urine, in its passage out, from insinuating itself into the neighbouring parts; for wherever the urine lodges, mortification takes place. Any advantage, therefore, which may arise from a more flexible instrument remaining in the bladder, is more than counterbalanced by its not filling completely the aperture through the coats of the bladder, and allowing the urine to escape into the cellular membrane." (*Trans. of a Soc. for Med. and Chir. Knowledge*, vol. ii.)

In six or eight days, when the track of the canula is surrounded by the adhesive inflammation, some surgeons withdraw the tube entirely, believing that, after this space of time, there is no risk of effusion of urine. (See *Manec, Man. de Méd. Opér.* p. 684.) Whether this should be done, or not, seems to me to depend materially upon the circumstance whether the urine has resumed its natural course or not. In the latter case, I would not discontinue the employment of the tube.

Some surgeons prefer this method to tapping the bladder from the rectum. It is easy. The little thickness of the parts which are wounded renders it quick, and triflingly painful. With moderate care, it is almost impossible to miss the bladder, except it be exceedingly contracted, which, I believe, was the case in an instance where I saw the late Mr. Abernethy fail to make the trocar reach that organ. If the trocar be directed too much downwards, it may also not enter the bladder, but pass between it and the pubes. It should, therefore, be pushed in a line towards the upper part of the hollow of the sacrum, and not in one leading to the point of the coccyx. There is no risk of piercing the peritoneal cavity. Anatomy proves that here the bladder is in immediate contact with the recti muscles, or rather the fascia transversalis, and that when it is distended with urine, it pushes the peritoneum upwards and backwards, under which it enlarges, and thus makes the point of the trocar become more and more distant from the peritoneum. No nerves nor vessels of importance are exposed to injury. No difficulty is experienced in fixing the canula, the presence of which does not hinder the patient from sitting, standing up, or even walking about in his chamber. (See *Œuvres Chir. de Desault*, t. iii. p. 219—324.)

This operation (according to Sir Astley Cooper) is easily performed, and not liable to the objections formerly made to it. To prevent the urine from passing through the canula incessantly, a stopper is employed, and withdrawn as often as necessary. In the female, it is the only proper one in cases of retention of urine from retroversio uteri, and from an obliteration of the meatus urinarius by cancerous disease; for (says he) opening the bladder through the vagina "would probably cause a fistulous orifice, by which the urine would constantly irritate the vagina." He adds that, in the female, the operation above the pubes appears on every account preferable to all other methods. (See *Lectures*, vol. ii. p. 319.)

The following passage in a modern publication is decidedly a mistake:—"Whenever the bladder rises fairly an inch and a half above the pubes, it is in contact with the peritoneum, lining the wall of the abdomen, in addition to its own peritoneal covering. In other words, the shining surface of the peritoneal covering of the bladder is in contact with the same surface of the peritoneum lining the muscles of the abdomen; so that an instrument, to penetrate this part of the organ, must traverse the peritoneum twice." (*T. King*, *Lithotrity and Lithotomy compared*, *&c.* p. 31, 8vo. Lond. 1832.) I was once called upon to tap the bladder above the pubes, in University College Hospital, in a case of enlarged prostate gland, where the spiral course of the urethra through that body, and the existence of a perforation in it, frustrated the attempts to make the catheter pass by the natural route into the bladder. The patient died on the third or fourth day after the operation. The parts, which are preserved in the museum of University College, exhibit the track of the trocar, completely below the peritoneum, which has not been penetrated at all. After the puncture above the pubes, the patient may easily lie on his side, so as to discharge all the urine contained in the bladder.

[Strange to say, the error here pointed out has been repeated in a recent work on Operative Surgery. Mr. Skey says, "In puncturing the bladder above the os pubis, the trocar passes through two layers of peritoneum, viz., the layer which lines the abdominal muscles, and that which forms the external coat of the bladder. I am aware that this opinion is not a general one, for it is more consonant with common belief that the peritoneum is detached from the os pubis, and from the bladder, in cases of great distension of this organ. But in favour of my own opinion, I would point to the wonderful extensibility of the serous membrane in hernia, and ask the physiologist whether it is possible that because the bladder is unnaturally, or rather unusually distended, nature would deprive it of the most extensible of its coats." (*Skey*, *Op. Surg.* p. 516.) The physiologist would probably reply, that the peritoneum is a membrane possessing extensibility and elasticity only in a very limited degree, remarkable, in fact, rather for the absence of these qualities; and that the gradual formation of a hernial sac, is altogether a different thing from the rapid dilatation which would be necessary to enable the peritoneum to surround a distended bladder in a case of retention of urine. And the anatomist might add, that the remains of the urachus and umbilical arteries passing upwards from the summit of the bladder to the umbilicus, must necessarily prevent the peritoneum forming a fold between the bladder and abdominal parietes in the manner suggested.]

3. Puncture from the Rectum.

This method is not, like the puncture in the perineum, liable to the objection, that the wound is made in diseased or inflamed parts, which afterwards become gangrenous. Nor is it, like the puncture above the pubes, attended with a chance of the urine diffusing itself in the cellular tissue. It has also the advantage of emptying the bladder completely. It is attended with little pain, since there is no skin nor muscles to be wounded, but merely the coats of the bladder and rectum, at a point where these viscera lie in contact with each other.

We read in the *Phil. Trans.* for 1776, of a case of total retention of urine, from stricture, where the bladder was successfully punctured from the rectum. The plan was suggested to Mr. Hamilton, who did the operation, by his feeling the bladder exceedingly prominent in the rectum, when his finger was within the bowel. The patient was placed in the same position as that for lithotomy; a trocar was passed along the finger into the anus, and pushed into the lowest, and most projecting part of the swelling in the direction of the axis of the bladder. A straight catheter was immediately introduced through the canula, lest the bladder, by contracting, should quit the tube, which was taken away, and as soon as the water was discharged, the catheter was also removed. Notwithstanding the puncture, the bladder retained the urine as usual until a desire to make water occurred. Then the opening made by the instrument seemed to expand, and the water flowed in a full stream from the anus. The urine came away in this manner for two days, after which it passed the natural way, with the aid of a bougie, which had been passed through the urethra into the bladder, and which was used till all the disease in this canal was cured.

The method was originally proposed in 1750, by M. Fleurant, surgeon to *La Charité*, at Lyons; and Pouteau, in 1760, published an account of it, together with three cases in which Fleurant had operated. It was also the feel of the bladder, on the introduction of a finger *intra anum*, which led the latter surgeon to make the puncture in this situation. The urine was immediately discharged, and the canula supported in its place with a T bandage, until the natural passage had been rendered pervious again. But as the canula was left in the rectum, it annoyed the patient when he went to stool, and the inconvenience was vastly increased by the continual dribbling of the urine from the mouth of the instrument. Hamilton avoided both these inconveniences, by withdrawing the canula at first. In another instance, however, Fleurant left the canula in the anus and bladder, thirty-nine days, without the least inconvenience.

In order to lessen the tenesmus, and other inconveniences attending the presence of the canula, Fleurant suggested, that it would be better to employ a flexible tube, and some of the moderns approve the plan of passing a flexible catheter through the silver one into the bladder, and withdrawing the latter instrument.

In the first volume of the *Mem. of the Medical*

Society of London, two cases are related, in which, after the bladder had been punctured from the rectum, the canula was immediately withdrawn, without any bad effect; and a similar fact is recorded in the *Medical Communications*, vol. i.

A curved trocar, five inches in length, is the best for performing the operation, and was recommended by Pouteau. It should be introduced into the prominence made by the distended bladder a little beyond the prostate gland, exactly in the centre of the front of the rectum; but not imprudently far up the intestine, lest the cul de sac of the peritoneum be injured. For some useful cautions on this head, the profession are indebted to Mr. Carpue, who has adverted to the very low point, to which the portion of peritoneum reflected over the rectum descends. (*Hist. of the High Operation, &c.* p. 178, 8vo. Lond. 1819.)

The trocar should be introduced in the direction of the axis of the bladder, or nearly in an imaginary line drawn from the spot to be punctured to the middle point between the umbilicus and the symphysis pubis.

The patient should be placed nearly in the same posture as that adopted in lithotomy; but the hands and feet need not be bound together, it being sufficient to let the assistants support the legs. The left forefinger, smeared with oil, is to be introduced up the rectum, where a portion of the distended bladder will be felt behind the prostate gland, and between the converging vasa deferentia. The vesiculæ seminales, which are on the outside of the vasa deferentia, are less exposed to injury. Behind the prostate gland, as Sir Astley Cooper correctly explains, there is a triangular space, which affords room for the instrument. In the fore part, it is bounded by the meeting of the vasa deferentia, which forms the apex of the triangle; the sides are formed by the vasa deferentia, which diverge as they pass from the prostate backwards; while the basis of the triangle is formed by the peritoneum, which is reflected from the posterior part of the bladder to the rectum. Taking advantage of this space of the bladder, which is not covered by the peritoneum, the trocar is introduced through it into the bladder, about three quarters of an inch behind the prostate gland. The instrument must not be introduced directly behind the prostate, as the vas deferens on one side or the other would certainly be wounded. If the trocar be carried three quarters or half of an inch behind the prostate, the vasa deferentia will be safe. (*Lectures, &c.* vol. ii. p. 311.) Here the surgeon is to let the end of his finger continue, until, with his right hand, and under the guidance of the left forefinger, he has brought to the same point the extremity of the curved trocar, the concavity of which is to be kept forwards. Great care must also be taken not to let the stilette project out of the canula too soon, that is to say, before the end of the tube has been placed exactly upon the spot at which the puncture is to be made. The bladder having been emptied, the canula is fixed with tapes, passed through the rings on the handle, and fastened in front and behind to a band applied round the body. It is to be further supported with a double T bandage. A stopper may be employed; or if the patient be on his side, the urine may be conducted from the tube into a urinal, by attaching to the canula a flexible catheter. When the patient has a motion, the T bandage is removed, and the canula raised and supported with the hand.

It is not necessary to retain the canula in the puncture, after the inflammation has consolidated the sides of the wound; for there is no danger of the aperture closing up, before another passage is made for the urine. Sir E. Home thinks that, after about thirty-seven hours, the canula may be taken out. (*Trans. of a Soc. for Med. and Chir. Knowledge*, vol. ii.) Indeed I am not acquainted with any fact, showing the ill effect of removing the canula early; for here the urine has only to pass through a mere opening, and not through a lengthened channel, like that which remains after the puncture above the pubes. The general safety and simplicity of tapping the bladder from the rectum will always recommend this method. When, however, the rectum is diseased, or there is much inflammation about the neck of the bladder, or the prostate gland is considerably enlarged, this plan is not eligible.

The objections made to the puncture through the rectum are three: first, the annoying tenesmus sometimes produced by the presence of the canula; secondly, the irritation and ulcerated state of the rectum occasionally resulting from the dribbling of the urine through it; and, thirdly, the possibility of a sinus being formed between this bowel and the bladder. (*A. Bonn, Bermerkungen ueber den Harnverhalt, &c.* Leipz. 1794.) Sir Astley Cooper knows of some cases in which such inconveniences followed, and in particular, one instance, in which the patient died of the subsequently diseased state of the rectum. Hence, the puncture of the bladder from the rectum is not a practice on which he bestows any commendation.

In the foregoing columns, I have briefly adverted to the proposal of cutting into the urethra behind the obstruction, instead of puncturing the bladder. This plan was first adopted and recommended by Sir Astley Cooper; and it afterwards had an advocate in Sir Charles Bell. Mr. Grainger, of Birmingham, also recommended cutting into the urethra, immediately in front of the prostate, and relieving the bladder by the introduction of a female catheter through the gland, or (if that could not be accomplished) by the division of its substance with a scalpel. (*Med. and Surg. Remarks, &c.* 8vo. Lond. 1815.) The operation of cutting into the membranous portion of the urethra, behind the stricture, seems to me one of the greatest improvements in modern surgery; for, as it is chiefly in cases of stricture that an artificial outlet for the urine is required, the new plan, which, as compared with a wound of the bladder, is a trifling injury, nearly obviates all necessity for puncturing the bladder in any way.

[While entirely coinciding with this view, and believing that the incision of the urethra in the perineum behind the stricture, is the *best possible* mode of relief, it is right to mention that it is an operation often attended with very considerable difficulty. Occasionally, perhaps, as in the case related by Sir A. Cooper, the urethra may be felt to dilate behind the stricture when the patient strains to pass water, and then the mere puncture of this swelling will suffice; but in the majority of instances, and indeed *always* if chloroform be employed, the surgeon must trust to his anatomical knowledge and discrimination of textures to discover the canal; no easy matter even in a healthy subject, but doubly difficult when it is surrounded by inflammatory infiltration, perhaps complicated with false passages, or even deflected from its natural situation. In consequence of this difficulty, some surgeons in London, and especially those attached to Guy's Hospital, have of late years again resorted to puncture of the bladder through the rectum. Mr. Cock has given the particulars of forty cases in which this operation had been performed, in twenty-one by himself, and in the remainder by his colleagues; and his conclusions are, that, in thirty-eight of these "it may fairly be said to have been perfectly successful in accomplishing the object for which it was adopted; and in many cases he believes that it materially tended to the restoration of the patient with a less amount of suffering, and at the same time more speedily and more effectually, than could have been effected in any other way. In no one of these cases was the operation, so far as he could judge, productive of any injury or ill consequence to the patient." Of the remaining two cases; in one, Mr. Cock failed in his attempt to reach the cavity of the bladder; in the other, he believes "that an injury was inflicted, which, although the patient was already in a hopeless condition, perhaps tended to hasten the catastrophe which was impending." The injury in question was an opening, found at the *post-mortem* examination, "exactly opposite to the recto-vesical puncture, and probably caused by the point of the trocar. The diameter of the pouch at this part was so small as to render such an accident the almost inevitable result of the operation." (See *Med. Chir. Trans.* vol. xxxv. 1852, p. 153.) This last case obviously suggests that the greatest caution should be used in resorting to puncture through the rectum when the bladder is not much distended with urine. Indeed, unless the distended bladder can be distinctly felt by the finger in the rectum, puncture in this situation does not deserve to be considered as by any means a safe operation. In the opinion of the writer, it is only applicable to extreme cases, and should be but seldom required.

When puncture of the bladder is really necessary, an exceedingly rare occurrence, the operation through the rectum seems to be preferable, *cæteris paribus*, to the operation above the pubes. It is, however, not applicable to cases of retention from prostatic disease, since the presence of the enlarged gland would render it more difficult and dangerous. In these latter cases, therefore, puncture above the pubes should be resorted to in preference. But in cases of stricture, where the surgeon can choose his operation, puncture through the rectum seems the simpler and safer proceeding of the two.]

Women rarely stand in need of paracentesis of the bladder; an occasional impossibility of introducing the catheter from a retroversion of the womb, and an obliteration of the meatus urinarius by disease, being almost the only cases ever placing them in this condition. The only method applicable to them, is the puncture above the pubes, with the exception of the plan of introducing the trocar directly from the vagina into the bladder; a practice which Sir Astley Cooper justly condemns, on account of its leading to the formation of an urinary fistula in the vagina, and a great deal of disease and irritation in that passage, from the contact of the urine.

Consult *Sharp*, On the Operations, chap. xv. and his Critical Inquiry. *Ambr. Bertrandi*, Trattato delle Operazioni di Chirurgia, accresciuto di note, &c. dai Chirurghi *G. A. Penchienati e G. Brugnone.* 8vo. Torino, 1802. *Bertrandi* was an approver of the puncture from the rectum: so was *Le Blanc;* Operat. de Chir. t. i. Mélanges de Chirurgie, *Pouteau*, Lyon, 1760, p. 500. L'Encyclopédie Méthodique, Partie Chirurgicale, art. Paracentèse de la Vessie. *Schmucker*, Chir. Wahrnehmungen, 2 th. No. 39; puncture from the rectum. *Sabatier*, Médicine Opératoire, t. ii. *Mursinna*, Journ. für die Chir., &c. iv. p. 46, 67. Cases of puncture from the rectum, and above the pubes. *Camper*, Demonst. Anat. Pathol. lib. ij. *Kloss*, Dis. de Paracentesi Vesicæ Urinariæ per intestinum rectum. Jen. 1791. *A. Bonn*, Anat. Chir. Bemerkungen über die Harnverhaltung, und den Blasenstich. Leip. 1794; prefers the puncture above the pubes. *J. Howship*, in Pract. Obs. on Diseases of the Urinary Organs, p. 214, 8vo. Lond. 1816; and in Treatise on Complaints affecting the Secretion and Excretion of the Urine, p. 412, Lond. 1823; thinks the operation from the rectum generally superior to the other methods. Sir *E. Home*, in Trans. for the Improvement of Med. and Chir. Knowledge, vol. ii. *Abernethy's* Surgical Observations, 1804. *John Bell's* Principles of Surgery, vol. ii. Œuvres Chir. de Desault par *Bichat*, t. iii. p. 315, &c. *W. Schmid*, Ueber die Krankheiten der Harnblase, &c. 8vo. Wien, 1806. *Richerand*, Nosogr. Chir. t. iii. edit. 4. *Hey's* Practical Obs. in Surgery, p. 430, edit. 2. Parisian Chir. Journal, vol. ii. p. 156, and p. 265. *S. T. Sommering*, Ueber die schnell und langsam todlichen Krankheiten der Harnblase, &c. Frankfurt, 1809. The author is an advocate for the puncture above the pubes, in preference to that through the rectum, which he thinks right only in one case, viz., when the bladder is so contracted that it does not rise out of the cavity of the pelvis, and the fluctuation of the urine can be felt in the rectum, but not above the pubes. In this opinion he is joined by *Langenbeck* (Bibliothek, b. iii. p. 719). *Callisen*, Systema Chir. Hodiernæ, t. ii. p. 277, &c. Chirurgische Versuche von *B. G. Schreger*, b. i. p. 211, &c. 8vo. Nurnberg, 1811, gives the preference to the puncture above the pubes. *Edward Grainger*, Med. and Surg. Remarks, &c. with Obs. on the different modes of opening the bladder in retention of urine, &c. 8vo. Lond. 1815. Dict. des Sciences Méd. art. *Ischurie.* 1818. Sir *C. Bell*, Surg. Obs. 8vo. part v. Lond. 1818. *C. Averill*, Short Treatise of Operative Surgery, p. 174, &c. Lond. 1823. *Sir A. Cooper's* Lectures, vol. ii. p. 306, Lond. 1825. *Malgaigne*, Man. de Méd. Opératoire, p. 680. *Alf. A. L. M. Velpeau*, Nouv. Elémens de Méd. Oper. t. iii. p. 960, 8vo. Paris 1832. *Edward Cock*, Cases of puncture of the bladder through the rectum. Med. Chir. Trans. 1852.

BLADDER, RUPTURE OF THE.

Many examples of this accident, occasioned by blows, or sudden violent pressure on the hypogastric region, and followed by fatal extravasation of urine, are upon record. The urinary bladder, in its empty and contracted state, lies so deeply in the male pelvis, as to be almost perfectly secured against any injury or accident, except that of a gun-shot wound, or a surgical operation. When, however, it becomes distended with urine, it rises up above the pubes, presses forward against the abdominal parietes, and is in a position much exposed to external injury. In this state also its coats are tense, expanded, and thin; conditions in which their tissue is more easily ruptured. Excluding from present consideration penetrating wounds and lacerations by spicula of fractures of the os pubis, the bladder is generally burst by violence, applied directly to the hypogastric region, as by a blow, or fall on this part, or the heavy pressure of a cart or carriage wheel. In the museum of University College are two specimens of ruptured bladder; in one the accident was occasioned in the following manner:— A man who had been drinking, and whose bladder was very full, went out of the house where his party was; but, it being dark, he struck the hypogastric region against a post, which he did not see. The consequence was the rupture of the bladder. The other specimen was taken from a fine young man, a patient of my own; the injury having occurred while the bladder was very full of urine, as he was wrestling with another person, whose knee in the fall made violent pressure on the abdomen, just above the pubes. Also the accident has sometimes been caused by a general concussion of the whole frame, such as a fall from a height, without any direct force acting on the vesical region itself. (See *Cusack's case* in *Dublin Hos. Rep.* vol. ii.) Again, the bladder may be ruptured by violent exertion, and repeated straining to empty it when over-distended, in consequence of some obstruction to the flow of urine, or during the violent efforts of parturition. Lastly, it sometimes gives way from gangrene, when it has been long in a state of forced distension, or when, being in a state of plenitude, it is subjected to the long-continued pressure of the uterus during a protracted labour, or, in the earlier periods of utero-gestation, to the pressure on it caused by a retroversion of the womb, as exemplified in the cases recorded by Dr. William Hunter. (*Med. Obs. and Inq.* vol. iv. and v. Lond. 1771; *Harrison*, in *Dublin Journ. of Med. Science*, vol. ix. p. 352.) In retention of urine, a rupture of the bladder from straining to empty it is not a common event. One instance of it is mentioned by Sir Benjamin Brodie (*On Dis. of the Urinary Organs*, p. 12), and another by Sir Everard Home (*On Strictures*, vol. ii. p. 240). But, as Dr. Harrison observes, it is doubtful, whether, in the latter case, the opening in the bladder was the effect of a sudden laceration caused by muscular exertion, or of some preceding ulcerative or gangrenous affection at the particular point where the organ gave way. Generally, however, in retention of urine from stricture, when the urine becomes effused, it is not from a rupture of the bladder, but from that of the urethra behind the stricture, or in the immediate vicinity of the prostate gland. (*Harrison*, in *Dub. Journ. Med. Science*, vol. ix. p. 352.)

It would appear from Dr. Harrison's investigations, that when the distended bladder in the male has been ruptured by a fall or blow on the hypogastric region, or by a general concussion, that portion of it which is covered by the peritoneum has very generally been the seat of rupture; the urine has consequently been effused in the abdomen, and the patient has been destroyed by peritonitis.

The following is the explanation offered by Dr. Harrison of the fact, that, when the bladder is ruptured by a blow, or general concussion, the laceration is almost always found in that part of the organ which is covered by the serous membrane. "The several tunics of the bladder allow of considerable distension, but least of all the peritoneal: when, therefore, the bladder becomes fully distended, and is then subjected to any sudden, or violent compressing force, this tunic, which is then tense, and comparatively unyielding, will crack, while the subjacent tunics, which are connected to it, will be torn along with it; whereas, in other situations, where cellular tissue occupies the place of the serous membrane, the coats of the bladder will yield considerably before they give way, or admit of laceration." (See *Dub. Journ. of Med. Science*, vol. ix. p. 371.) The bladder being pressed forcibly against the promontory of the sacrum in the male, seems to Dr. Harrison also to account for the rent being usually in the posterior region of that viscus. The rarity of the accident in females is ascribed by him to the greater size of the pelvis, the cavity of which is not so extensively occupied by the bladder when this is full of urine. "Nor (says he) does the bladder incline so much backwards as in the male; on the contrary, it inclines more forwards, and enlarges more in the transverse direction; while the uterus and its lateral broad folds, may assist to break the shock of any external violence applied to the hypogastric region, and so prevent the direct concussion of the bladder against the sacral promontory." (Vol. cit. p. 372.) The comparative infrequency of a rupture of the bladder in children and boys is referred to their rarely suffering the bladder to become much distended with urine, and, in part, to the smaller size of the sacral promontory, and to the bladder, when full, lying in early life more in the abdomen.

[The investigations of M. Houël, who has lately inquired into this subject, do not corroborate Dr. Harrison's statement that the rupture is almost exclusively at the posterior part of the bladder. M. Houël has collected thirty-seven observations of rupture of the bladder from external violence. Of these, fifteen only were at the posterior part; all, or nearly all, communicating with the peritoneal cavity. Twelve were on the anterior aspect, and without laceration of the peritoneum. Three were placed laterally, one with, two without, peritoneal communication. Two were at the summit of the bladder. In two the seat of the rupture was not stated, but it communicated with the peritoneal cavity. Three were double. The rupture, therefore, is nearly as frequent on the anterior as on the posterior aspect. Those on the posterior aspect are almost always accompanied by laceration of the peritoneum, and effusion of urine into the serous cavity: those on the anterior aspect ordinarily leave the peritoneum uninjured, and the fluid is effused into the cellular tissue of the pelvis. In the latter case, if the opening is large, the effusion is rapid and abundant, and the urine spreads widely beneath the peritoneum. It may reach posteriorly to the kidneys, anteriorly to the umbilicus. It has even been known to extend into the thigh, by passing through the obturator foramen. In nearly all such cases, peritonitis is rapidly developed, and the cellular tissue becomes extensively gangrenous. (See *Houël, Des Plaies et des Ruptures de la Vessie, Thèse de Concours*, 1857, and *Nélaton, Elém. de Pathol. Chir.* t. v. 1858, p. 160.)

Sometimes, when the rupture is small, or when there is any impediment to the free effusion of urine, so that it escapes but slowly, the areolar tissue, instead of being diffusely infiltrated, may become condensed into a sort of cyst containing the effused fluid, and communicating with the cavity of the bladder. In this case also, if the urine cannot readily return into the bladder so as to be drawn off through the catheter, it gives rise to inflammation, which soon becomes propagated to the peritoneum. (See *Nélaton*, loc. cit. p. 164.)

M. Houël, in addition to the thirty-seven cases from external violence, already alluded to collected seven instances of *spontaneous rupture*, that is to say, rupture from over-distension of the bladder when there was some mechanical impediment to its evacuation. Six of these were at the posterior, and one at the superior, part of the bladder. He speaks of them, however, as being nearly all *sub-peritoneal*, and of the effusion as having a tendency to become encysted, somewhat in the manner of the cases above described. (See *Nélaton*, p. 164.) Such a case, however, is only a partial rupture, extending through the mucous and muscular coats.

The remarks, both of Dr. Harrison and M. Houël, refer to rupture of the bladder occurring as a substantive injury, and not as the result of fractures of the pelvis, or accompanied by other complications. Rupture, or laceration, however, is occasionally caused by, or associated with, fracture of the bones in its immediate vicinity.

Mr. Prescott Hewett has related ten cases of ruptured bladder; in eight of which the pelvis was extensively fractured. Mr. Hewett's observations confirm the possibility of the cellular tissue becoming condensed so as to form a pouch containing the effused urine. In one patient who lived five days, and in another who survived twenty-three days, this was found to have taken place. (See *Transac. of the Pathol. Soc.*, and *Coulson On Dis. of the Bladder*, p. 234.)]

With respect to the diagnosis of the kind of rupture of the bladder now under consideration, it is observed by Dr. Harrison, that, as it is the effect of only two species of injury, the account of the accident will afford useful information. Thus, every case on record has been the result either of some force directly applied to the abdomen, or of a general concussion of the whole frame. In this latter case, the injury is more likely to be overlooked, particularly if the individual has suffered in any other and more obvious manner: hence, after such accidents, the attention of the practitioner should be early directed to the urinary discharge, and if there be any inability to pass the urine, and a desire to do so, the catheter should be introduced. When the rupture has been the effect of violence directly applied to the hypogastric region, the symptoms are more obvious. The patient himself is often aware of the accident: he knew that his bladder was full at the time of the injury; perhaps he felt it burst within him. Then the sensation of sinking and sickness, the pain in the abdomen, and the peculiar feeling about the præcordia, are all circumstances indicative of the rupture of some viscus. In addition to these symptoms, there will be a desire to make water without the power of doing so; great pain in the belly and perineum during the attempts; tension of the abdomen, the fulness being diffused, and not circumscribed as in common retention of urine. When a catheter is introduced into the bladder it meets with a peculiar resistance; and the urine flows through it, not in a stream, but as if it merely filled and overflowed the instrument slowly; at one time only in a few drops, at another in considerable quantity; "this difference depending on some alteration in the direction of the instrument, or in the degree of pressure with which it is pushed against the bladder, whereby the edges of the rupture must be separated, and more or less of the abdominal and pelvic urine be discharged." (*Harrison*, in *Dub. Journ. of Med. Science*, vol. ix. p. 377.)

In one case, recorded by Mr. Cusack, only a few drops of urine could be drawn off with the catheter on the day of the accident. On the next, no urine flowed at first; but, by changing the direction of the instrument, and on making pressure with the finger in ano, about three pints were discharged. On the third day, as all the symptoms continued unabated, the abdomen was punctured in the linea alba, midway between the umbilicus and the pubes; and a large quantity of clear urine escaped, and, at the same time, it flowed freely from a catheter in the urethra. The relief was only temporary, the patient having died delirious on the eighth day. On dissection, marks of intense inflammation were noticed in the hypogastric region, where the intestines were glued together into one mass. At first no urine was seen; but on breaking the adhesions and raising up the intestines, about a pint of it was sponged out from between the rectum and the bladder. "The pelvic portion of the peritoneum was completely coated with lymph; the bladder was contracted and empty; the rupture, about an inch in extent, was in its posterior part and right side, and in an oblique direction. (See *Cusack*, in *Dub. Hospital Reports*, vol. ii. p. 312.)

In the *post-mortem* examination of a case under Dupuytren, traces of severe inflammation were observed in the hypogastric region. Adhesion existed between the abdominal parietes and the bladder, and the sides of the latter and the adjacent viscera were all so agglutinated together, that a kind of pouch was formed, considerably advanced in organisation, whereby the urine was circumscribed, and effusion to any further distance prevented. (See *Archives Gén.* June, 1834, p. 294.) In general, the bladder, though the seat of injury, is itself but little inflamed, except at the posterior portion of its serous coat. (*Harrison*, in *Dub. Journ. of Med. Science*, vol. ix. p. 375.)

In the treatment, the principal indications are to withdraw, if possible, the effused fluid from the abdomen; to prevent any return or increase of such effusion; and to resist and subdue that unavoidable and very fatal affection peritonitis. With this view, any accumulation of urine in the bladder should be prevented by the introduction of an elastic gum catheter of full size with a long and large curve; and if, by changing its direction, or other manœuvres, its beak can be passed through the rent, or made to reach its vicinity so as to open it, a considerable quantity of urine may be drawn from the cavity of the peritoneum. Pressure with the finger in ano is also to be tried. (*Harrison*, vol. cit. p. 379.) In the case which I attended, a catheter of full size was kept continually introduced. In this way, we endeavour to lessen the exciting cause of the inflammation, which, however, is sure to follow the effusion of so irritating a fluid as the urine. Inflammation must therefore be resisted by local and general bleeding; calomel, opium, and mild saline purgatives given with the effervescing mixture. If the disease advance, and the pains in the abdomen become more intense, with swelling and fluctuation, ought the surgeon to perform paracentesis? This has been done in two instances, but without success. "The urine which is effused is principally lodged in the pelvic cul-de-sac, and is more or less confined to that region, partly from its depending position, and partly from the adhesions, which we have reason to expect, under proper and active treatment, may have been formed between the bladder and the adjacent viscera, at the upper orifice of the pelvis." This view led Dr. Harrison to consider cutting a small opening through the rectum, into this cul-de-sac, the best and safest plan for the discharge of the irritating fluid. Here a new cavity has been formed, coated internally like an abscess; and the opening is not to be regarded as extending into the general cavity of the peritoneum. The operation might be done with a trocar, or a long curved bistoury, with a sheath, and a cutting edge only on its extremity. The patient being in the recumbent posture, with his knees drawn up and somewhat separated, the finger of the left hand might be passed up the rectum, as far as possible, and pressed against its fore part. The catheter in the bladder might also assist in guiding the finger to the cul-de-sac behind that organ. The canula of a long curved trocar might next be passed along the finger, and, when its extremity had been placed against the fore part of the rectum exactly in the median line, the stilette might be pushed through it, and the peritoneum opened. Dr. Harrison conceived that the quantity of effused fluid would protect the small intestines from reach of the instrument; and he says, that in the cases which he has examined, he did not find any of their convolutions in the pelvis. Supposing this operation were ever attempted, ought the canula to be left in the part? or ought it to be withdrawn, and the catheter trusted to for the prompt discharge of the urine afterwards? The latter method is preferred by Dr. Harrison.

[Dr. Harrison was unaware of any instance of rupture of the bladder having had a favourable termination. Two cases of recovery, however, have subsequently been placed on record. The first, related by Mr. Chaldecott, was that of a man aged fifty, who, running across a street on a dark night, for the purpose of emptying his bladder, struck his hypogastric region against a post. He immediately fell down, and with great difficulty reached his home, about a hundred yards distant. Mr. Chaldecott saw him about half an hour afterwards. He was faint, and suffering severe pain over the abdomen, with desire, but no power, to pass his urine. A full-sized catheter was passed, but no urine escaped. He was seen eighteen hours after the accident by Mr. Aston Key, who introduced an instrument, and drew off about an ounce of bloody urine. By this time symptoms of peritonitis were present in an alarming degree. They were combated, however, successfully by leeches, hot fomentations, and opiates; the bladder regained the power of retaining its contents, for the catheter on each introduction brought away clear urine. Six days after the accident, he made an attempt to pass water by his own efforts, when he felt something give way, and a burning pain all over his stomach and bowels, as if boiling water had been poured over them. The same faintness and distress occurred as when the accident first happened, and were followed in like manner by peritonitis. The symptoms, however, again subsided under a repetition of the treatment, and he perfectly recovered. A curious circumstance in this case was the occurrence of a sharp attack of gout three days after the accident, although he had never before suffered from that complaint. This attack had nearly disappeared when the second effusion took place, but again became severe after its occurrence. (See *Lancet*, Oct. 1846, p.375.)

The second case is reported by Mr. Syme. A boy having attempted to leap over a railing, fell forwards, and violently struck his abdomen against a post. He immediately complained of great pain, and the abdomen became distended. A catheter introduced allowed the passage of about four ounces of bloody urine. There were all the symptoms of ruptured bladder, with great collapse. Leeches and fomentations were applied, and an opiate prescribed. For the next two days the distension of the abdomen increased, the catheter continued to draw off bloody urine. On the third day there was obscure fluctuation below the umbilicus, and Mr. Syme made an incision into the linea alba. A stream of fluid flowed out which was distinctly urinous. Two days afterwards the incision was enlarged, and a slough of cellular tissue escaped, coated with deposit from the urine. Mr. Syme then passed his finger into the wound, and felt a laceration of the bladder, where it was uncovered by peritoneum. This patient perfectly recovered. (*Lancet*, March, 1848, p. 289.) In one of these cases it will be remarked, the urine was effused into the peritoneal cavity; in the other it was infiltrated into the cellular tissue.

In a case of *encysted* urinous infiltration, M. Denonvilliers was fortunate enough to cause the sound to penetrate into the accidental pouch, and succeeded in curing his patient. (*Houël*, op. cit. p. 76, quoted by Nélaton.)]

(See *Boyer*, *Maladies Chir.* t. ix. p. 61; *C. Montague*, in *Med. Communications*, vol. ii. p. 284; *Cusack*, in *Dub. Hospital Reports*, vol.. ii p. 312; *Dupuytren*, *Archives Gén.* June, 1834, p. 294; *Johnstone*, in *Mem. of Med. Soc. of Lond.* vol. iii. p. 543; and, particularly, *Dr. Harrison's Cases and Obs.* in *Dubl. Journal of Med. Science*, vol. ix. p. 349; *Coulson*, *On the Diseases of the Bladder*, London, 1851; *Prescott Hewett*, in *Transac. of Pathol. Society*; *Houël*, *Des Plaies et des Ruptures de la Vessie. Thèse de Concours pour l'Agrégation*, Paris, 1857; *Nélaton*, *Elém. de Pathol. Chir.* t. v. Paris, 1858.)

[TUMORS OF THE BLADDER.]

[Tumors, both of an innocent and malignant nature, are occasionally developed from the walls of the bladder. Of the former class are polypoid tumors, composed of fibro-cellular tissue, covered by o prolongation of the mucous membrane, and attached by an elongated pedicle. Others, analogous in structure, and developed in the submucous tissue, have a broader basis of attachment, and form rounded or fungiform tumors, projecting into the interior of the bladder. In the museum of the College of Surgeons are several specimens of tumors of the bladder, most of them having narrow necks, and attached in the neighbourhood of the urethral orifice. (See case recorded by Mr. Savory, *Medical Times*, July 31, 1852, p. 106.)

Malignant tumors are more frequent than non-malignant tumors of the bladder. They may be of the medullary or scirrhus kind. The former are the more common, and form distinct tumors prominent in the cavity, while the latter, on the contrary, are usually diffusely infiltrated in the vesical parietes. Scirrhus cancer seldom affects the bladder primarily, but is communicated to it secondarily, in cases of scirrhus of the rectum in the male, or of the uterus in the female.

The diagnosis of tumors in the bladder is difficult. The symptoms resemble somewhat those of calculus: there is irritability of the bladder; pain in passing water; sometimes complete retention from the tumor obstructing the urethral orifice; after a time inflammation of the bladder and increased mucous secretion, and occasional hæmaturia. These symptoms will generally lead to the introduction of a sound, when perhaps the tumor may be felt, and some idea may perhaps be formed from manipulation with the sound of its size, situation, and consistence. The softness would usually serve to distinguish it from stone; tumors of the bladder, however, have been observed to become incrusted with urinary deposits; and in such a case, it seems almost impossible to avoid falling into error.

The possible co-existence of calculus with a tumor in the bladder also deserves to be remembered. Desault once, after the extraction of a stone, recognised in the bladder a pediculated tumor, and extracted it with the forceps. The patient recovered.

A distinction between innocent and malignant tumors must often be impossible. Malignancy may be inferred if the bleeding is copious and frequent; if the tumor increases rapidly in size, and if the patient's health rapidly suffers. Such a suspicion would be confirmed, if, on examining the urine, some of the débris of the tumor containing the cells peculiar to the cancerous tissue could be discovered.

The *treatment* of tumors of the bladder can seldom be more than palliative. Any attempt at extirpation is seldom advisable, even in non-malignant tumors; while, in malignant ones, it would be worse than useless. Instances, however, are not altogether wanting in which non-malignant tumors have been successfully attacked by surgical treatment.]

Mr. Warner has recorded a case, in which an excrescence growing from the inside of a young woman's bladder was successfully removed.

Mr. Warner, upon examining the parts with his forefinger, introduced into the meatus urinarius, discovered a considerable tumor, which seemed to be of a fleshy substance, and took its rise from the lower part of the bladder, near its neck. When the patient strained to make water, and the bladder was full, the excrescence protruded a little way out of the meatus urinarius; but, upon ceasing to strain, it presently returned. He then hindered it from returning into the bladder by passing a ligature through it, and endeavoured to draw it further out, which was found impracticable. Seeing this, Mr. Warner dilated the meatus urinarius on the right side, by cutting it upwards, about half way towards the neck of the bladder, when, by pulling the swelling forwards, he was enabled to tie its base, which was very broad. For three days a good deal of pain was felt in the abdomen. On the sixth day, the tumor dropped off. From the first day, the urine came away without assistance, and the patient perfectly recovered. The tumor resembled a turkey's egg in shape and size. (*Warner's Cases in Surgery*, edit. 4, p. 303.)

[M. Civiale seized a polypoid tumor of the bladder between the blades of a lithotrite. The instrument was closed, and the tumor broken down. This operation was not attended with much pain; there was a slight flow of blood, and during the day the tumor, in a state of disintegration, escaped with the urine. But another tumor of the same nature was discovered; this was seized in the same manner; it remained in the gripe of the instrument and was brought away with it. This patient recovered. (See *Civiale, Traité des Maladies des Organes Genito-Urinaires*, Paris, 1851, tom. iii. p. 171.)]

For a further account of tumors of the bladder, the reader is referred to *J. Howship, On Complaints affecting the Secretion and Excretion of Urine*, 8vo. Lond. 1823; *Coulson, On the Diseases of the Bladder and Prostate Gland*, London, 1852; *Civiale, Traité des Maladies des Organes Genito-Urinaires*, Paris, 1851; *Nélaton, Elém. de Pathol. Chir.* t. v. Paris, 1858.

Bladder, Wounds of.

Sword wounds, and those made by a bayonet or lance, may injure some part of the bladder, or even pass through both sides of this organ. In the latter case, the injury is usually fatal, as the urine escapes from the inner wound into the abdomen, and immediately excites mortal inflammation. Baron Larrey dressed on the field of battle several soldiers whose bladders were thus completely transfixed, and who all perished of inflammation and gangrene within the first forty-eight hours. However, he observes, that if the weapon enter the bladder at that part of its fundus which is not covered by the peritoneum, the case is curable, unless complicated with too much internal hemorrhage.

The surest criterion of these cases is the escape of the urine from the external wound; and its discharge may be either momentary, occasional, or continual; differences to be accounted for by the situation of the wound, and the changes which happen in the bladder. When the bladder is full, and its upper part is pierced, the urine will issue only just at the moment of the accident, and as soon as it is discharged the edges of the wound will come together, and may permanently close; especially if the urine can pass freely through the natural channel. But when this favourable condition is absent, the bladder becomes enormously distended again, the wound is opened anew, and the urine discharged once more from the external opening. The same things might happen if one were to withdraw too soon the elastic gum catheter which has been introduced, and by introducing the instrument again the urine might be diverted from the wound, and its natural course re-established. Lastly, Larrey observes, that, when the wound is situated at one of the lowest points of the bladder, the discharge of urine may be incessant, and be of more or less duration.

When the tract of these punctured wounds is extensive and not direct, abscesses form at different points where the urine passes. These abscesses Larrey directs to be immediately opened, and their recurrence prevented by the introduction of an elastic gum catheter through the urethra; one of the chief means of relief in all wounds of the bladder. Together with this treatment, he recommended frequent clysters, and sometimes cupping in the vicinity of the wound, or bleeding. (See *Mém. de Chir. Mil.* t. iv. p. 286, 287.)

The subject of wounds of the bladder is further discussed in the article Gunshot Wounds.

[The bladder is not unfrequently wounded by spicula of bone in cases of fractured pelvis. Such an accident is more serious than a wound of the bladder from without. In fact, there being no wound in the skin, it is very similar in its symptoms and consequences to a rupture of the bladder, with the additional complication of a fractured bone in its immediate vicinity. Such cases have been alluded to in speaking of rupture of the bladder.]

Bladder, Hernia of. See Hernia.

[Prolapsus of the Bladder.]

[Prolapsus of the bladder is a displacement which is occasionally met with in females. In this affection, in consequence of a relaxed condition of the vagina and vulva, the bladder gradually descends, pushing the anterior wall of the vagina before it, until at length it forms a tumor, which projects between the labia, and in extreme cases, even hangs pendulous between the thighs. The protrusion, therefore, consists of the bladder, covered and surrounded by the anterior wall of the vagina, and hence the name *vaginal cystocele* has been applied to it.

Prolapsus of the bladder is not a very common affection. It most frequently occurs after repeated or difficult parturition; rupture of the perineum, by removing a portion of the support which the pelvic viscera should receive, especially predisposes to it; occasionally, but more rarely, it happens in women who have not borne children. The swelling is soft and fluctuating; its size is variable, according as the bladder is or is not distended with urine. The transverse rugæ of the vagina are usually distinguished upon it, although they may be effaced if it is much distended. At its upper part is the orifice of the urethra, directed *downwards and backwards;* and when a catheter is passed into the bladder, it can be moved about in the interior of the swelling, at any part of which the point of the instrument may be made to project. If the finger is passed into the vagina beneath the protrusion, the uterus will be felt above and behind it, nearly in its natural situation, but with the os uteri directed backwards, in consequence of its anterior lip being drawn down by the stretching of the anterior wall of the vagina. This, together with the softness of the swelling, its diminution after micturition, and the absence of any appearance of os uteri upon it, readily distinguishes it from prolapsus of the uterus. It may be distinguished from prolapse of the *posterior* wall of the vagina with dilatation of the rectum (*vaginal rectocele*), by observing that in the latter case the vaginal passage is in front of the swelling, while in prolapse of the bladder, it is behind it. (See *J. B. Brown, On Diseases of Women*, Lond. 1854, p. 71.)

The sensation of bearing down is less than in prolapse of the womb, but it is in some women greatest in the horizontal posture; in the night, therefore, the patient is much annoyed with this sensation, which is frequently accompanied by a most distressing desire to make water. (See *South*, in *Transl. of Chelius*, vol. ii. p. 124.) A peculiar symptom of prolapse of the bladder is a pain referred to the navel, with a sense of tightness there; the pain being greatest when the bladder contains the largest quantity of urine, diminishing as the urine is voided, and ceasing when the bladder is nearly or entirely emptied. This symptom is referred by Sir C. Clarke to a stretching of the umbilical ligaments or remains of the umbilical arteries, and to the consequent dragging upon the navel itself. (See *Sir C. Clarke, On Dis. of Females*, part i. p. 130, and *South*, loc. cit.)

The urine is voided with difficulty, and the bladder is seldom completely emptied; hence decomposition of the urine takes place, the mucous lining of the bladder is irritated, and chronic inflammation of this membrane is added to the other annoyances and sufferings of the patient.

Treatment.—The ordinary treatment of this distressing condition consists in the use of astringent injections to improve the tone and remedy the relaxed condition of the vagina, and of pessaries to prevent the protrusion taking place. In addition to this, it is important to prevent any accumulation of urine in the bladder, by the frequent use of the catheter if the patient's unaided efforts are insufficient; or by confining her to her bed, in the prone position as much as possible, and retaining the catheter in the bladder.

These means, employed judiciously, and for a sufficient length of time, combined with a careful attention to the general state of the patient's health, may sometimes effect a cure, but more frequently they are merely palliative.

Of late years attempts have been made to obtain more certain and permanent relief by operative procedure. The operations practised have had in view, either the narrowing of the relaxed vagina, to prevent the bladder from being displaced; or the diminution of the vulvar aperture, to prevent its protruding externally. Most of these proceedings have been devised for the relief of prolapsus of the uterus, but they are nearly equally applicable to the condition now under consideration. Mr. South, in 1838, endeavoured to cure a prolapsus of the bladder on the principle first mentioned, by removing portions of the mucous membrane of the anterior wall of the vagina covering the tumor, and bringing the cut edges together with sutures. He first removed a transversely elliptical piece of membrane, an inch and a half broad, and about an inch in depth at its central and broadest part. Three platinum sutures were employed to bring the edges together. This operation proving ineffectual, Mr. South, about six months afterwards, removed a second elliptical piece of membrane, but with its long diameter in the vertical direction, commencing about half an inch below the neck of the womb, and terminating about the same distance behind the urethra. The piece of membrane removed was about an inch in width at its broadest part. Three sutures were used. This second operation materially checked the protrusion, and, although it did not prevent it altogether, it enabled her to undergo exertion which for some years previously she had been incapable of making. A full account of this case is given by Mr. South. (See *Transl. of Chelius*, vol. ii. p. 128.)

On the principle of preventing the escape of the prolapsed bladder externally, Mr. Lightfoot, of Newcastle-on-Tyne, performed in 1841 the operation suggested by Fricke, of Hamburgh, for the cure of prolapsus uteri. In this operation, the edges of the labia are pared from the fourchette to about two fingers' breadth from the anterior commissure, and the raw surfaces brought together and kept in contact by quill sutures. When union has taken place, a prolongation forwards of the perineum, and a corresponding diminution of the vaginal outlet, are the result. In Mr. Lightfoot's case, "three weeks after the operation, there was not the slightest prolapse, and when she was desired to strain violently, the rugæ of the vagina were seen, but did not protrude." (*Lancet*, vol. i. 1841—42, p. 322; and *South*, loc. cit.) Both Mr. South's and Mr. Lightfoot's patients were young unmarried women, who had not had children.

A very similar proceeding has been practised, on several occasions, in St. Mary's Hospital, by Mr. Baker Brown, in the year 1853, and subsequently. Mr. Brown, however, recognising the prolapse of the bladder to be due to the relaxation of the anterior wall of the vagina, not only produces the artificial prolongation forwards of the perineum, but endeavours, in addition, to contract the lower part of the vagina, by dissecting off longitudinally, just within the lips of the vagina, a piece of mucous membrane, about an inch and a quarter long, and three quarters of an inch broad. The upper edge of the part removed should be on a level with the meatus urinarius. The edges of the wound thus made, he brings together by three interrupted sutures. (See *Brown*, *On Dis. of Women*, p. 74, Lond. 1854.) Judging, however, from the plate accompanying Mr. Brown's description, and from his operations, as witnessed by the writer of this article, he is scarcely correct in speaking of the piece of membrane as "*within the lips of the vagina*," since it really belongs to the inner surface of the labia and nymphæ, which are not in any way distended by, nor do they form any part of the covering for, the protruded bladder. It is difficult to understand how the removal of a portion of membrane in this situation, and the union of the cut edges in the *vertical* direction, at right angles to the axis of the vaginal canal, can have the effect claimed for it, of "contracting the vagina laterally, so as to prevent the tumor from falling down from above." All the cases related in Mr. Brown's work are stated to have been attended with perfect success. He has, however, since mentioned, that one case of prolapsus of the bladder on which he operated has returned again after a second confinement. (See *Med. Times and Gaz.* March 13, 1858, p. 277.) For further details respecting the operations performed for the relief of vaginal protrusions by Messrs. Marshall Hall, Dieffenbach, Jobert, Fricke, Geddings, Brown, and others, and for the after treatment and management of such cases, the reader is referred to the articles UTERUS, PROLAPSUS OF, and PERINEUM, RUPTURE OF.]

[BLADDER, EXTROVERSION OF.]

[Numerous examples of this deviation from the natural conformation are recorded. The malformation consists of a congenital absence of the anterior wall of the abdomen at its lower part, and a similar absence of the anterior wall of the bladder. The ossa pubis, in the great majority of instances, are not joined in the usual manner at the symphysis, but are separated by an interval, varying in breadth in different cases, and only united by a ligament passing across this space. In consequence of this separation of the bones, the recti muscles diverge from each other below, and in the interval between them the mucous surface of the posterior wall of the bladder is exposed to view, on a level with the abdominal parietes, or sometimes forming a convexity forwards, in consequence of the intestines descending behind it into the pelvis and causing it to project. This surface is covered with mucous secretion; it is of a bright red colour, and bleeds readily if touched. Upon it will be observed the orifices of the ureters, usually placed upon two prominent papillæ, and about an inch apart. Through these orifices the urine exudes, in most instances by drops, slowly and continuously; though occasionally it has been observed to be discharged at intervals and in jets, the ureters having been dilated into receptacles capable of containing a certain quantity of fluid, and some degree of power to retain it having been present. The umbilical cicatrix is usually wanting; the point of entrance of the umbilical vessels in these cases being no doubt involved in the malformation. The pelvis is much weakened by the absence of union at the symphysis; the acetabula are widely separated; and an imperfect and waddling mode of progression is the result.

Extroversion of the bladder occurs in both sexes; but is much more common in the male than in the female. Mr. Earle could meet with but seven or eight recorded cases in the female, while he found at least sixty related of its occurrence in the male. And of nine cases which came under the observation of Mr. McWhinnie, only two were females.

The organs of generation have usually participated more or less in the deformity. The penis has sometimes been altogether wanting. More frequently it forms a short tuberculous projection. It is deeply grooved upon its upper surface, in consequence of the corpora cavernosa not being united in the median line; the floor of this grove is formed by the urethra, the upper wall of which is wanting, thus constituting the condition known as epispadias. Upon the floor of the urethra the fossa navicularis, the lacunæ, and posteriorly the verumontanum have been observed. In one case M. Nélaton, and in another Mr. T. Wakley, were able to distinguish on each side of the verumontanum the orifices of the ejaculatory ducts. The prostate is imperfectly developed, sometimes absent altogether, generally deficient in that part of it which should be situated above the urethra. The testes have usually been healthy, but of small size, and situated in a short and contracted scrotum.

Females afflicted with this malformation have at the same time more or less deformity of the generative organs: the clitoris is often divided, and the labia, instead of being united at the superior commissure, are widely separated, and continuous with the integument at the side of the protruding bladder. The deformity, however, has not always been to an extent sufficient to interfere with the procreative function. Two cases of pregnancy in females in this condition, followed by successful parturition, have been recorded. (See *Boyer*, *Traité des Mal. Chir.* t. ix. p. 5; and *Phil. Trans.* vol. xxxii. *Letter from Oliver to Dr. Mead*, quoted by Mr. McWhinnie, *Med. Gaz.* 1853, p. 366.)

Persons affected with extroversion of the bladder suffer greatly from friction of the tumor by the clothing, and from the continual dribbling away of the urine, which not only excoriates the parts over which it flows, but by keeping the clothes constantly wet, causes a highly offensive urinous odour. To alleviate these annoyances, therefore, some mechanical contrivance becomes necessary; and an apparatus, devised originally by Mr. Earle, but since modified in certain minor particulars, has been found to effect the objects desired very completely. It consists of a metallic bowl, which covers and protects the tumor and external organs, and is supported and maintained in its situation by bandages around the loins. The urine here collected flows through a funnel at its lower part, either into an india rubber bottle placed between the widely separated thighs, or down a vulcanised india rubber tube into a metallic reservoir adjusted to the inner side of the calf of the leg, and which can be evacuated at leisure by means of a stop-cock. For the female, the bowl will accomplish its object more completely, by being so constructed that it may enclose the posterior commissure of the labia. See Mr. McWhinnie, in *Lond. Med. Gaz.* March, 1850, p. 367, where a representation of this apparatus is given, and where an interesting account of the dissection of one of these cases will also be met with.

Certain attempts have been made to relieve these cases by operative procedure ; but, excepting in one instance, the results have not been of a nature to encourage future attempts. M. Gerdy thought of paring the edges of the skin on each side of the protrusion, and of bringing them together, so as to close in the bladder anteriorly; or if they would not readily meet together, to loosen the skin by dissecting it from the subjacent parts. Finding, however, that his preliminary efforts to compress the bladder backwards towards the abdomen were too painful to be borne, he was compelled to abandon the idea. He then thought of forming an artificial reservoir for the urine, by means of a metallic plate fitted to the anterior surface of the abdomen, but the papillæ at the entrance of the ureters interfering with the completion of his project, he excised one of these, and the consequence was that the patient was attacked with inflammation extending along the ureter to the kidney, which caused his death. (See *A. Jamain, De l'Exstrophie de la Vessie, Thèse Inaugurale,* Paris, 1845, and *Nélaton, El. de Pathol. Chir.* t. v. p. 150.)

In another case, M. J. Roux endeavoured to cover in the bladder by means of a flap of skin cut from the scrotum, which was considerably enlarged by the presence of two hydroceles, but the greater part of the flap sloughed, and no satisfactory result was obtained. (See *Union Méd.* 1853, p. 449, and *Nélaton*, loc. cit.)

In another, M. Ad. Richard cut from the abdominal wall a flap large enough to cover the exposed surface of the bladder, but the patient died eight days afterwards from peritonitis. (See *Gaz. Hebdom.* t. 1. and *Nélaton*, loc. cit.)

A somewhat analogous proceeding had been previously suggested by Mr. T. Wakley, in a case which came under his notice, but was not, the writer believes, ever carried into effect. The plan of operation proposed by Mr. Wakley seems much better adapted to accomplish its object than that of M. Roux or M. Richard. (See *Lancet*, March 15, 1851, p. 296.)

In 1851, Mr. Lloyd, in St. Bartholomew's Hospital, endeavoured to conduct the urine into the rectum, by establishing a recto-vesical fistula ; intending afterwards, when the passage of urine through the rectum was complete, to attempt to close the opening in front of the abdomen by paring the edges and uniting them by suture. A long trocar, armed with some threads, was passed through the posterior wall of the bladder from the rectum. The seton having been detached, the instrument was withdrawn, and the two ends of the seton, one projecting from the rectum, and the other from the vesical cavity in the abdomen, were tied in a knot. The patient died five days afterwards from peritonitis. At the *post mortem* examination, the trocar was found to have passed through the recto-vesical fold of peritoneum, which descended to the neck of the bladder, so as to be in contact with the imperfectly developed prostate gland. (See *Holmes Coote*, in *Medical Times*, Oct. 11, 1851, p. 381, and Oct. 18, p. 408.)

The only operation attended with any success was one performed by Mr. Simon, in St. Thomas's Hospital. In this instance Mr. Simon succeeded in establishing fistulous communications between the *ureters* and the rectum, by passing canulæ armed with threads from the ureter seen in the posterior wall of the bladder into the rectum. The patient, a boy, had some unfavourable symptoms, but ultimately recovered. (*Med. Times*, Oct. 18, 1857, p. 408.)

The writer is informed by Mr. Simon that this patient died about a year after the communication with the rectum had been established. The immediate cause of death was the formation of calculi (probably occasioned by the mucous irritation, for they were phosphatic) along the ureters, and up to the pelves of the kidneys. Mr. Simon states that the result would not deter him from repeating the operation in a suitable case, if he could see his way more clearly to the subsequent obliteration of the vesical ends of the ureters, for it was in this ulterior step that he failed.]

Refer.—The publications which contain the most ample information on the subject are a Gottingen inaugural dissertation entitled, *De Vesicæ Urinariæ Prolapsu Nativo*, by Dr. Roose, late professor in Brunswick, and a paper entitled, *An Attempt towards a systematic account of the appearances connected with that malconformation of the Urinary Organs, in which the ureters, instead of terminating in a perfect Bladder, open externally on the surface of the Abdomen, by A. Duncan, Jun.* in *Edin. Med. and Surg. Journal*, vol. i. In this last may be seen references to the most noted cases on record, both male and female. (See also *Handbuch der Pathologischen Anatomie, von J. F. Meckel*, b. i. p. 650. 8vo. Leip. 1812.) [*Breschet*, art. Extroversion, Dict. des Sciences Méd. t. xiv.—*Boyer*, Mal. Chir. t. ix.—*N. Geof. St. Hilaire*, Hist. des Anomalies d'Organization chez l'Homme et les Animaux, 3 vols. Paris, 1825—*W. Vrolik*, Sur quelques Sujets Intéress. d'Anat. et Phys. Amsterdam, 1832, and Cyclop. of Anat. and Phys. part xxxviii. Feb. 1850.—Clinical Lecture by *Mr. Earle*, Med. Gaz. vol. x. 1832. p. 8.—*M. Jamain*, De L'Exstrophie de la Vessie. Thèse Inaug. No. 15. Paris, 1845.—*Mc Whinnie*, Account of the History and Dissection of a case of Malformation of the Urinary Bladder. Lond. Med. Gaz. 1850. p. 360.—*Nélaton*, Elém. de Pathol. Chir. t. v. p. 141. Paris, 1858.]

BLADDER. WORMS DISCHARGED FROM.

Instances have occurred in which worms are stated to have been discharged from the bladder. Many are referred to in *Voigtel's Handbuch der Pathlogischen Anatomie*, b. iii. p. 337—342. An interesting example is recorded by Mr. Lawrence. (See *Med. Chir. Trans.* v. ii. p. 382, &c.) [The patient referred to by Mr. Lawrence continued to discharge worms from her bladder at intervals for many years — from 1806 to 1837. A description of these worms, named spiroptera hominis by Rudolphi, is given by Professor Owen, in the *Cyclopædia of Anatomy and Physiology*, part x. p. 133. art. *Entozoa.* Another case is recorded by Mr. Curling, in which numerous small round worms (dactylius aculeatus) were discharged from the bladder of a female child. (*Med. Chir. Trans.* vol. xxii. p. 274.)

Some of the cases recorded have probably been examples of the large round worm, strongylus gigas, which occasionally infests the kidney, and which may have descended along the ureters to the bladder. Kuchenmeister, however, believes that some of the older histories of cases may refer to membranous and polypous blood concretions, which from their round form were regarded as strongyli, and which had probably obtained their form from the ureters, and when they were smaller, from the tubuli uriniferi. From the rarity of the strongylus, he also sugests, that some of the larger ones may have been examples of the ascaris lumbricoides, or round worm; and the smaller ones, of the ascaris vermicularis, or thread worm, which inhabit the intestine, and which may have passed outwards into the bladder, in consequence of recto-vesical, or vesico-vaginal fistula. (See *Kuchenmeister*, *Manual of Parasites, Sydenham Society's Translation, by Dr. Lankester*, vol. i. p. 376.) The spiroptera, described by Professor Owen, are regarded by Bremser as examples of young strongylus gigas; and the dactylius aculeatus, described in Mr. Curling's case, are considered by Kuchenmeister as "undoubtedly only an animal of the family of the lumbricini, which had got accidentally into the urine." (Loc. cit. vol. ii. p. 100.)]

Hydatids.—Hydatids are sometimes passed by the urethra, but the case is exceedingly rare.

The following curious account of the *post mortem* appearances in an instance of this kind is given by Dr. Tyson, in the *Philosophical Transactions* for 1687:—"Therein, upon operation," says Dr. Tyson, "we discovered a very strange sort of cystes, or bags, of the exact figure of eggs, of several dimensions, some larger than goose eggs, others as big as hen eggs, to the number of twelve in all, and about eight of them whole, and replete with limpid serum; all of them loose and free, without the least adhesion, either to one another or the coat of the bladder. Nor could we imagine that this miserable patient could possibly make any water, but what happened upon the breach of some of these watery tumors, when the bladder was crowded beyond its dimensions. The ureters were of the largeness of the small guts in children, so that they could easily admit two fingers into their cavity. One of the vesiculæ being opened, had a large cluster of small ova, as big as grapes, all replete with liquor. All the rest contained nothing but serum."

In an example under Dr. Duncan, the hydatids discharged from the urethra were formed in the kidney. The symptoms were frequent desire to make water, and sometimes difficulty in making the evacuation, and pain about the hip, perineum and glans penis. The pain in the perineum was generally felt six or seven hours before each hydatid was expelled. The expulsion of the hydatids was promoted by exhibiting twelve minims of diluted muriatic acid thrice a day. The hydatids voided were of a globular shape, and of the genus acephalo-cyst, and varied in size from that of a pea to that of a pigeon's egg. Probably they had enlarged after their descent into the bladder. (See *Liverpool Med. Journ.* for July, 1834.)

[The hydatids discharged by the urethra have probably been originally derived from the kidney, in which organ these parasites occasionally have their habitation. They have probably been examples of the ordinary hydatid of the human subject, Echinoccus hominis or E. altricipariens of Kuchenmeister. According to Kuchenmeister, the structures called acephalocysts are nothing more than sterile hydatids, the *growth* of which has proceeded, but which have been disturbed in their *development*, and remain barren.

Dr. Sieveking has recorded a case in which hydatids were discharged from the urethra, by a male out-patient, æt. 21, under his care at St. Mary's Hospital. (See *Lancet*, vol. ii. 1853, p. 238.) Another instance came under the notice of Mr. Simon. (See *Lancet*, vol. ii. 1853, p. 291.) In both these cases, the hydatids had probably descended from the kidney, for in both their evacuation was preceded by an attack of pain in the loins and hypochondriac regions. Both perfectly recovered.] *James R. Lane.*

BLEEDING. By this operation is understood the taking away of blood for the relief of diseases. Bleeding is called *general*, when practised with a view of lessening the whole mass of circulating blood; *topical*, when performed in the vicinity of the disease, for the express purpose of lessening the quantity of blood in a particular part.

General Blood-letting is performed with a lancet, and is subdivided into two kinds; viz. the opening of a vein, termed *phlebotomy*, or *venesection;* and the opening of an artery, usually the temporal, or one of its branches, termed *arteriotomy*.

Topical Blood-letting is performed, either by means of a cupping-glass and scarificator, or leeches, or by dividing the visibly distended vessels with a lancet, as is frequently done in cases of ophthalmia. (See Arteriotomy; Cupping, Leeches, Scarification, and Venesection.)

BLEEDING. (See Arteries, Hæmorrhage, Ligature, Wounds.)

BLENORRHAGIA, or *Blenorrhœa* (from *βλέννα*, mucus, and *ῥέω*, to flow). A discharge of mucus. Swediaur, who maintained that gonorrhœa is attended with a mucus, and not a purulent, discharge, preferred the name of blenorrhagia for the disease.

[Several modern authorities have also adopted the term blenorrhagia in preference to gonorrhœa, which latter word signifies etymologically a discharge of semen, and is therefore incorrect. The word blenorrhagia, however, is not unobjectionable, since we now know that mucous membranes, when inflamed, can throw out a *truly purulent* secretion, and this is the real character of the discharge in gonorrhœa.] (See Gonorrhœa.)

BLEPHAROPTOSIS (from *βλέφαρον*, the eyelid, and *πτῶσις*, a falling down.) Called also *ptosis*. An inability to raise the upper eyelid. (See Ptosis.)

BLINDNESS. An effect of many diseases of the eye. (See Amaurosis; Cataract; Cornea, Opacities of; Glaucoma; Hydrophthalmia; Leucoma; Ophthalmy; Ptergium; Pupil, Closure of; Staphyloma, &c.)

BLISTERS. Applications, which, when put on the skin, raise the cuticle in the form of a vesicle, filled with a serous fluid. Various substances produce this effect; but the powder of cantharides is what is commonly employed. The blister-plaster is thus composed:—℞. *Cantharidis in pulv. subtilissimum tritæ* lbj. *Ceræ, sevi*, aa. ℥viiss. *Resinæ* ℥iij. *Adipis* ℥vj. To the wax, suet, and lard melted together, add the resin previously melted. Take them from the fire, and when they have become nearly cold, sprinkle in the cantharides, and mix.

When the blister is raised, and it is not wished to maintain a discharge from the blistered part, it is sufficient to make a puncture in the cuticle to let out the fluid; but, when the case requires a secretion of pus to be kept up, the surgeon must remove the whole of the detached cuticle with a pair of scissors, and dress the excoriated surface in a particular manner. Practitioners used formerly to mix powder of cantharides with an ointment, and dress the part with this composition. But such a dressing not unfrequently occasioned very painful affections of the bladder, a scalding sensation in making water, and most afflicting stranguries. An inflammation of the bladder, ending fatally, has been thus excited.

These objections to the employment of salves containing cantharides, for dressing blistered surfaces, led to the use of mezereon, euphorbium, and other irritating substances, which, when incorporated with ointment, form very proper compositions for keeping blisters open, without the inconvenience of irritating the bladder.

The favourite application, however, for keeping open blisters, is the powder of savine, which was brought into notice by Mr. Crowther, in the first edition of his book on the White Swelling. He was led to the trial of different escharotic applications, in the form of ointment, in consequence of the minute attention which caustic issues demand; and, among other things, he was induced to try powdered savine, from observing its effects in the removal of warts. Some of the powder was first mixed with white cerate, and applied as a dressing to the part that had been blistered; but the ointment ran off, leaving the powder dry upon the sore, and no effect was produced. Mr. Crowther next inspissated a decoction of savine, and mixed the extract with the ointment, which succeeded better, for it produced a great and permanent discharge. The following is the formula for unguentum sabinæ in the Ph. Lond. 1851 : — ℞ *Sabinæ recentis contusæ* lbs. *Ceræ Albæ* ℥iij. *Adipis* lbj. Mix the savine with the lard and wax melted together, then press out through a linen cloth.

On the use of the savine ointment, immediately after the cuticle raised by the blister is removed, it should be observed, says Mr. Crowther, that experience has proved the advantage of using the application lowered by a half, or two thirds, of the unguentum ceræ. An attention to this direction will produce less irritation and more discharge than if the savine ointment were used in its full strength. He found fomenting the part with flannel wrung out of warm water a more easy and preferable way of keeping the blistered surface clean, and fit for the impression of the ointment, than scraping the part as has been directed by others. An occasional dressing of the unguentum resinæ flavæ he found very useful in rendering the sore free from an appearance of slough, or rather, dense lymph, which is sometimes so firm in its texture is to be separated by the probe with as much readiness as the cuticle is detached after blistering. As the discharge diminishes, the strength of the savine dressing should be proportionately increased. The unguentum sabinæ must be used, in a stronger or weaker degree, in proportion to the excitement produced on the patient's skin. Some require a greater stimulus than others for the promotion of the ischarge, and this can only be managed by the senations which the irritation of the ointment occasions.

Instead of keeping a blister open, it is frequently a judicious plan to renew the application of the emplastrum cantharidis, after healing up the vesication first produced, and to continue in this manner a succession of blisters, at short intervals, as long as the circumstances of the case may demand. Where the skin is peculiarly irritable, and, particularly in young children, where the emplastrum cantharidis sometimes acts so violently as to produce sloughing, or in any cases where the plaster produces strangury and irritation of the urinary organs, I am informed that the inconvenience may be avoided, and the cuticle raised very well, if a piece of silk paper be interposed between the plaster and the integuments. Dr. A. T. Thomson recommends for the same purpose a piece of thin gauze, wet with vinegar, and applied smoothly and closely over the plaster. (*Dispensatory*, p. 717, ed. 2.)

"In applying blisters to infants," says Dr. Cumming, "we must take particular care not to allow them to remain on for more than three or four hours. When a blister is applied for a longer period, excessive general irritation is apt to be induced; and such is the delicacy of the infant's skin, that the blistered parts not unfrequently become gangrenous. Under such circumstances, the death of the child has been sometimes the consequence. Though vesications may not have formed at the time when the blister is removed, they generally take place after the application of the dressing. In some habits the blistered surface takes on an unhealthy action, and runs into eating and irritable ulcers, which are long in healing. In such cases, I have found an emollient poultice, when the inflammation is considerable, and afterwards the black and yellow washes, the most useful applications. In infants of an irritable habit, it will sometimes be advisable to dilute the blistering plaster with an equal quantity of the emplastrum ceræ." (*Dr. Cumming*, in *Trans. of Assoc. of Coll. of Physicians, Ireland*, vol. v. p. 55.)

The nitrate of silver has been used for making blisters, as particularly recommended by Mr. Higginbottom. It causes less irritation, and its effects are more prompt than those of cantharides. It may also be used in persons in whom cantharides produce strangury. It excites a copious discharge, without heat or pain after the first few hours, and the vesicated part heals about the fifth day, no ulceration having been occasioned. (See *Higginbottom, On Nitrate of Silver*, p. 161.)

[The acetum cantharidis is sometimes employed for producing rapid vesication. It may be conveniently applied with a sponge, producing a blister in five or ten minutes.

Where a slighter and more prolonged counter-irritation is desired, Brown's cantharidine tissue, or blistering paper, is a very convenient and cleanly application.]

[BLOOD, ACIDITY OF.]—[An alkaline condition of the liquor sanguinis being essential to the fluidity and to the circulation of the blood, the most ample provisions have been made to preserve this condition. Acids absorbed or developed in the blood are either destroyed by oxidation, as generally happens with the vegetable acids, or eliminated in a simple or neutralised state by the secreting organs. These operations of the *vis medicatrix naturæ*, in the healthy state of the blood, and in all ordinary cases, are more rapid than those which contribute to the absorption or development of the noxious material, so that, although the natural alkalinity may be temporarily diminished, the liquor sanguinis is prevented becoming neutral or decidedly acid. Nevertheless, this circumstance occasionally happens. Dr. Prout found acid blood in a man who died in St. Bartholomew's Hospital with enlarged liver and spleen, the cavities of the heart and adjacent vessels being enormously distended with clots, and the blood coagulated throughout the body. The clots had a loose texture, and consisted, almost equally, of a red and a nearly colourless portion intermixed and adherent to each other; the latter being of a bright, light, lemon-yellow hue, and soft and opaque, somewhat resembling baked custard; the former much softer and looser, the greater part of a dingy, chocolate-brown tint, with a broken-down appearance. Some of the large veins were as if filled with pus; the substance of the brain being extremely vascular, and its vessels containing a fluid of the same nature. This blood was acid, Dr. Prout never having "even heard of acid blood before;" the acid resided chiefly in the custard-looking substance, which possessed most of the properties of albumen, but Dr. Prout could not make out its nature; it was not hydrochloric, phosphoric, nor any other fixed acid.

Scherer found the blood acid, repeatedly, in puerperal fever. He states that it contained free albumen instead of albuminate of soda, so that the acidity was due to a free acid, and lactic acid was separated from the exudations. Lehmann thrice observed an acid reaction; in a case of pyæmia affecting a man, and in the blood of two women, one six the other ten weeks after delivery. (*Physiol. Chem.* vol. i. p. 97.)

A tendency to acidity in the blood would appear sometimes to be attributable to an arrest of those transformations in which amylaceous matters are converted through lactic acid into carbonic acid and water, or to the development of oxalic acid, or the non-elimination of lithic acid. Acids absorbed or developed enter into combination with the normal constituents of the blood, as the carbonate or basic phosphate of soda; they diminish the alkalinity of the secretions and of the system generally; hence, they may produce morbid secretions from the kidneys and skin, and diseases of these organs. As remedies they are useful where there is an excess of alkalinity in the blood and secretions, and injurious in an opposite condition, and may produce lithic acid deposits. The development of an acid in hæmatosis, or a failure of this process in maintaining the necessary degree of alkalinity, or the absorption of an acid in primary or secondary assimilation, is not only connected essentially with the production of rheumatism, gout, gravel, vesicular and pustular cutaneous eruptions and other affections, but may result in the formation of coagula in the heart or vessels during life, and an arrest of the circulation of blood, and is very probably the immediate cause of death in some cases. Alkalies and alkaline salts tend to counteract the acidity of the secretions by neutralising the acids in the blood. (See Blood, Coagulation of, during life. Blood, Pathology of. Lithiasis. Oxalæmia.)

Henry Ancell.

[BLOOD, ANHYDROUS.—*Inspissated Blood.*—*Choleraic Blood.*]—[A large quantity of water, with albumen and salts, being drained through the alimentary canal in cholera, the blood left in the vessels is of high specific gravity, and often contains more than double the usual proportion of solid constituents; in which state it is dark, thick and viscid, often presenting the appearance of tar or treacle. This state increases as the disease progresses, and although the red corpuscles may remain intact, and susceptible of aëration, the production of animal heat is arrested, the blood ceases to be capable of circulation, its flow through the capillaries fails, and it accumulates in the heart and large vessels. On *post mortem* examination, at St. Mary's Hospital, we found this blood dark and treacly, but becoming cherry red on dilution, and there were extensive coagula throughout the venous system. Colourless fibrinous clots occurred in the right auricle and ventricle, and mixed clots in the pulmonary artery, the internal and external iliac and femoral veins, all down the lower extremities to the smaller ramifications of the tibial veins about the ankles, and in the brachial veins about the elbow joints. (See Blood, Coagulation of, during life.) This anhydrous state must not be regarded as the essential morbid condition, since the salts are drained off. The blood also contains urea in excess, and the proportion of fibrin has been found to be reduced.

An excess of organic and plastic materials in the blood, and a deficiency of water, may result from too great repletion, profuse watery discharges, as in the colliquative sweats of phthisis, and from other causes, and often requires the attention of the surgeon, more especially in the treatment of inflammations and febrile attacks; but it constitutes a part only of more complicated pathological states treated of in various articles in this Dictionary. (See Blood, Pathology of. Hyperinosis. Plethora.)] *Henry Ancell.*

[BLOOD, COAGULATION OF, DURING LIFE.]—[That organised growths and fibrinous concretions, formerly known as "polypi," may form in the heart and blood-vessels during life, was pointed out by Morgagni, and confirmed by Haller, Corvisart, Laennec, Andral, Hope, Baron, and others. But great difficulty has been met with in determining the nature of these substances, and in distinguishing between coagula formed in the blood at the period of, or subsequent to, death, and those produced in various diseases so as to occasion symptoms, or to become the immediate cause of death. Their bearing and importance in practical surgery have not been generally appreciated, but the recent observations of Dr. Hughes, Mr. Paget, Dr. Kirkes, Dr. Richardson, and other writers of our own and foreign countries, have developed some important facts, and very much extended our views on the subject generally.

There are three pathological conditions to be distinguished:

1. Organised growths, to which the term *polypi*, formerly employed, was most applicable, occur in the heart, in the form of warts, vegetations, or polypoid masses; sometimes more or less nearly filling one or more of the cavities. They are firmly adherent to the valves or walls, are vascular, and may exist for years. They sometimes appear to have taken their origin from a pathological change in the lining membrane, as irritation and the consequent deposit of fibrin, rendering it rugged. When formed they may be the cause of a further deposit from the blood by their mechanical action,

but it is still a question, in almost all cases, whether they were not originally mere deposits of fibrin, which have subsequently become organised. They are certainly not so frequent as formerly supposed, since it has been shown, that masses presenting the appearance of vascularity are often coloured only with blood and are devoid of vessels. The signification of these growths, as such, to the surgeon, is totally different from clots and concretions, since the state of the blood, or of the membrane, from which they proceed, may have been temporary or quite local, although the mechanical effects of organised and inorganic masses are similar. As organised growths they are not treated of in this article.

2. Coagulation of the blood may occur in the heart or blood-vessels just as in extravasated blood. It was held at one time, that this could only take place at or a short time before death, but the converse is now known to be true. In *Dr. Bright's Hospital Reports,* cases are recorded in which coagula were distinctly observed in the jugular and subclavian veins ten or twelve days before death. Clots were met with which could be moved from one part of the basilic vein to another. In one case recorded (*Edinb. Med. and Surg. Journal*, vol. liii.), a solid, greyish-white, perfectly formed clot, one inch and a half long, was pressed through an orifice made for bleeding six weeks before death, and after death almost all the vessels contained coagulated blood and fibrinous clots. Coagulation of the blood entire is by no means so frequent an occurrence as a mere deposit of fibrin, but it may happen in any part of the vascular system without necessarily resulting in death. The condition of a blood clot found in the vessels after death, as to density and general characters, is in many cases a measure of the state of the blood in these respects as it circulated during life.

3. Fibrin may be separated from the blood as it circulates, and may concrete into masses of various forms and dimensions, or in layers, cylinders, or tubes. It may block up the cavities of the heart or blood-vessels, but its aggregation in this form must be a progressive process. This is a much more frequent occurrence than the coagulation of the blood entire.

In some cases these circumstances may combine in the production of solid masses in the heart and vessels. There may be an organised growth forming a *point d'appui* for the deposit of fibrin, and ultimately coagulation of the blood, or a fibrinous deposit mixed with a blood clot.

It has been held that the formation of clots and concretions only taking place a very short period before death, they are the consequences of the dying state. No doubt this is often the case, but in many instances they are clearly shown to be the immediate cause of death, both rapid and protracted, and sometimes of sudden death, even in morbid conditions which at the time gave no indications of a fatal tendency.

The appearances presented by coagula, whether produced before, at the period of, or subsequent to, death, are extremely various. They depend on the condition of the blood, and the states of the system which give rise to them, and are modified by the period at which the coagulation takes place before death, and the part of the vascular system in which they occur. As in blood drawn from a vein, they may be firm or loose, diffluent, grumous, or tar-like; they may consist of a buffy clot containing no red corpuscles; in colour they may be red, white, or yellowish, or red externally, and white internally, or the converse; they may form in irregular masses, in concentric layers, or as hollow tubes; and they may be loose or attached to the lining membrane, the attachment varying greatly in extent and degree; and the membrane may exhibit an increased vascularity or may be perfectly smooth and polished. Cases of "highly vascular polypi," in the auricles and ventricles, have been described, which in their origin are no other than blood clots; and, as occurring in the large vessels, they are often described as being extremely vascular, covered with membrane, and interspersed with spicula of bone; or as buffy clots "bloodshot from entangled red corpuscles." The period antecedent to death at which coagula were formed is not only indicated by these appearances, but also by the state of decomposition of the clots, their tendency being to degenerate, and to be subsequently removed by the circulating current. Clots are sometimes found firm at the outside, soft within, and containing serum. Old fibrinous coagula soften in the centre, and are converted into a dirty, fawn-coloured or reddish-brown material; the softening sometimes extending through the whole mass, with the exception of a thin layer at the circumference, forming a kind of cyst; or the interior may be more like pus, and the whole may resemble an abscess. These pseudo-cysts or pseudo-abscesses may burst and discharge their contents, which must then be mixed with the circulating blood. Or the clot, being thin, may be broken up gradually, and its debris may mix with the blood in larger or finer particles, and may act mechanically on being conveyed to distant parts, either obstructing vessels or forming nuclei for new coagula; or the products of the blood clot may poison the blood and produce typhoid and other symptoms.

When large soft clots are found in the heart, the aorta and vena cava containing a fluid in which there is no fibrin at all, when they contain little or none of the colouring matter of the blood, although adherent to the walls of the heart, when colourless fibrin, more or less similar to the buffy coat of the blood, is placed at that part of the clot, which, in the position of the body is at the highest level, the under part becoming gradually more deep-coloured and less firm, the blood was fluid at death, and the clots were formed at the period of death or subsequently. The qualities which these clots present are nevertheless a measure of those of the blood during life.

When the coagula adhere firmly to the heart or vessels; when the membrane to which they are attached is rough, vascular, sprinkled with bloody spots, or otherwise diseased, or they consist of fibrinous masses modelled to the containing parts, or grooved by currents of blood, or forming perfect tubes enclosing a column of blood and resembling an additional coat to the vessel, or presenting concentric layers; when a firm, white, fibrous layer is found entirely detached from a dark purple or mixed coagulum, filling up a cavity; and when changes, the result of degeneration or organisation are observed in one clot and are absent in others, in almost all these cases the blood has coagulated a considerable period before death.

The causes of the coagulation of the blood during life, and of the deposit of fibrin, are in some instances sufficiently manifest, and in others involved in considerable obscurity. Retardation or stagnation of the current will operate as a cause, independent of any morbid quality, and in any condition of the system or of the vessels, provided the blood has not lost its coagulating power. Thus, in divided vessels, stagnation leads to obliteration by the combined effect of the coagulation of the blood, and the contraction of their parietes. In sacculated aneurisms retardation or stagnation results in the deposit of fibrin in layers, the quantity being greatest, in aneurismal pouches generally, at the point where the current is most feeble. Protracted syncope may lay the foundation for cardiac concretions and clots in the vessels, even in persons previously quite healthy. In suspended animation and in various exhausting diseases, and at the close of many fatal diseases, where the blood has not lost its fibrin, and the patient is a long time "sinking," the languor of the circulation promotes coagulation in the heart and large vessels. A clearly ascertained cause of a deposit of fibrin, acting mechanically, is the presence of foreign substances, whether dead or living, as the spicula of bone-earth, or the development of some product, accidentally, in the heart or vessels ; as a deposit of lymph, forming a projection from an inflamed lining membrane, or an organised substance. Such substances become nuclei for the formation of clots as the "living and actively moving" blood passes over them ; and it very often happens that vessels containing clots exhibit signs of inflammation of the parietes. Inflammation of the blood-vessels promotes the coagulation of the blood they contain. Pus, and tuberculous and cancerous deposits, have also been detected in the vessels in connection with clots, under circumstances which leave no doubt that they have been the causes of coagulation. Impressions conveyed to the blood through the nervous system appear also, under circumstances, to have a direct effect in producing coagulation. Schrœder Van der Kolk found, on breaking down the substance of the brain and spinal marrow, while the blood was still moving in the vessels, that clots were present a few minutes after the experiment; thus, whether the result of retardation of the blood's current, or of an electrical, or a direct nervous influence, exhibiting to the surgeon one of the effects of shock on the system.

Morbid conditions of the blood itself also lead to the same result in many surgical diseases. Of these a state of intense molecular activity, to which some writers have applied the term "inflammation," where there is a great excess of fibrin, is one of the most frequent, particularly if the rapidity of the current should not be maintained, in which case the process is identical with coagulation and the formation of a buffy coat out of the body. In conditions of the blood where the fibrin is relatively increased, owing to a diminution of the watery element, coagulation is very liable to occur, as in the profuse perspirations of phthisis, or after colliquative diarrhœa, or in cholera where the blood is inspissated. In the latter disease clots occur in the heart, pulmonary artery, aorta, iliac, tibial, axillary, and gastric veins of the same subject, and the writer has drawn a clot from the brachial vein before death. To these causes may be added the development of acid and other animal products, or the retention of effete materials, or the introduction of various foreign substances and poisons into the blood, either acting, as before described, mechanically, so as to excite fibrillation, or producing diseases, the results of poisoning of the blood. All the circumstances of disease by which the circulation is materially retarded, promote these effects and the morbid states of the blood produced by poison. Fatal coagulation may occur during protracted syncope and in debilitated states of the constitution, even when the proportion of fibrin is reduced, or its contractile power diminished, and this would probably happen more constantly in diseases of extreme debility if it were not that the blood is itself more essentially diseased, and loses the whole or nearly the whole of its coagulating power before death. (See BLOOD, PATHOLOGY OF. SPANÆMIA. TOXICOHÆMIA.)

Clots and concretions may occur in any part of the vascular system. From physical causes the heart is the most frequent site. One cavity, as the right auricle, may be completely filled with a concretion, and contain very little trace of fluid blood, or a clot may extend from the auricle to the corresponding ventricle, preventing the action of the tricuspid valve, or into the pulmonary artery forming a plug ; or it may form in the ventricle or the pulmonary artery alone. Sometimes the smaller pulmonary vessels contain long filaments. The deposition of fibrin may commence in the extreme capillaries, just as in the case of an artery tied by a ligature, and it may be limited to these vessels without any clot being formed in the larger vessels or in the ventricle. Concretions occur in the same manner on the left side of the heart attached to the walls or valves, but not quite so frequently in the left auricle. In the arch of the aorta they are almost always hollow cylinders, sometimes extending from the ventricle a considerable way down the aorta, and into the vessels arising from its arch ; or they may commence above the aortic valves, and may fill up nearly the whole of the thoracic and abdominal aorta. Concretions thus situated, if formed during life, are often the immediate cause of death, but they occur also in the more distant parts of the vascular system, as the basilar, brachial or femoral arteries, plugging up the main trunks, or closing up vessels at their origin. The whole of the arteries in the inferior half of the body have been found choked with fibrinous masses. (*Fuller*, *Lond. Med. Gaz.* 1847.) They occur also in the vena cava, iliac veins, emulgent veins, and the venous system generally, and of late pathologists have recognised similar concretions in the vessels of the vital organs. Masses of yellow fibrinous substance often obstruct those of the kidneys, spleen, and brain ; they are regarded by many as deposits of fibrin from the blood, giving rise to the pathological condition known as "capillary phlebitis." Even petechiæ and ecchymosed and congested spots of small size occurring in various parts of the body, which, on minute inspection, are found to have a yellowish central point, are regarded in the same point of view.

It will thus be apparent that coagulation during life, does not, in a large proportion of cases, depend upon any structural lesion of the heart or blood-vessels, and there are many cases on record in which it has occurred, both in children and adults, as a primary disease of the blood without any complication. (*Med.-Chirurg. Review*, vol.

xx. p. 551.) This disease may be chronic or acute. In a very large majority of cases, however, the coagulation occurs during the progress of other diseases. In any case it is most important, when possible, to form a correct diagnosis, and to study the symptoms produced. These consist, in the most marked cases, of a very sudden and unexpected invasion of alarming cardiac symptoms, frequently masking those of the original disease, and implying some serious impediment to the free circulation of the blood. The special train of symptoms depends on the position, form, and character of the deposit. The *right auricle* being by far the most common site, when this cavity is filled the abdominal venous system becomes congested, the right ventricle deprived of blood, the lungs absolutely blanched, and often emphysematous, and the arteries comparatively empty. (*Richardson.*) When the aggregation takes place gradually a peculiar and distressing dyspnœa occurs, not produced by an arrest of respiration, even in diseases of the air passages or pulmonary organs, as croup or pneumonia, but by a portion of the current of blood to the lungs and nervous centres being cut off. Emphysema of the lung frequently occurs, particularly in children. There is diminution of the arterial circulation owing to the left heart being imperfectly supplied with blood, so that the pulse is small and intermitting; there is coldness of the surface of the body, general marble-like pallidity, with the more vascular parts, as the lips and centre of the cheeks, often of a leaden hue from stagnation in the venous system; general muscular prostration, the limbs and muscles being in continued restless motion; loss of mental power, involuntary excretions, gasping respiration after failure of pulse, and death. In the more sudden cases the patient, previously exhausted, on rising or making some muscular movement or strain reclines or falls breathless, feebly convulsed and dead. This may result from the pulmonary artery being suddenly blocked up with a cylinder of fibrin. Sometimes the symptoms may extend over many days, or even months, and anasarca may supervene as a consequence of the obstruction. When the clot is formed on the *left* side of the heart, or in the *aorta*, there is tumultuous action, with a frequent, small, irregular, and unequal pulse, congestion of the lungs, suffocative dyspnœa, sense of weight or pressure in the region of the heart, expectoration sometimes mixed with blood, the surface of the body becomes leaden coloured, the body cold, and there are violent convulsions and coma preceding dissolution. These symptoms also may extend over many hours or occur suddenly. If the coagula occur on *both sides of the heart* the symptoms consist of violent vascular action, increasing irregular and confused action of the heart, increased heat of the body, and sudden and excessive dyspnœa, followed by agony from intolerable sense of suffocation, occasionally nausea and vomiting, general restlessness and distress; then cooling of the surface, convulsive tremblings, rapid prostration, coma, and death. Concretions occurring in the *pulmonary artery and its ramifications*, or both in the artery and veins, where the pulmonary capillaries are obstructed, or where no such obstruction exists, may form a permanent but not a perfect obstruction to the current of blood through the lungs, and death occurs with the signs of asphyxia more or less complete. Rapidly fatal asthmatic attacks often owe their origin to these pathological conditions. Death with the symptoms here described often results from coagulation of the blood, and the formation of concretions in pneumonia, croup, pulmonary apoplexy, and œdema of the lungs, and sometimes sudden death is produced by this cause in such diseases after convalescence has been established. Similar symptoms are produced in diseases attended with poverty of blood, as typhoid fever, in death from exposure to cold, in the cold stage of intermittent fevers, and during protracted syncope. (*Paget*, *Med. Chir. Transac.* vol. xxvii. p. 163. *M. C. Baron*, *Rech. sur la Coagulat. du sang dans l'Artère Pulmonaire. Richardson*, *On the Cause of the Coagulation of the Blood*, 1858.)

There are other effects of the coagulation of the blood in the vessels, not immediately compromising life, more particularly described in different parts of this Dictionary. It has been long known, that when a principal artery is blocked up by a coagulum, a general disorganisation of the structures it supplies is produced, and when a principal vein is the site of a clot, œdema occurs in the parts beyond. The deposit of fibrin also very frequently constitutes an essential part of the reparative processes in injuries and diseases. (See ANEURISM. HÆMORRHAGE.) The transmission of masses of clot or particles of fibrin from one part of the vascular system to another, with all the force of the blood's current, may suddenly block up either large or small vessels. Dr. Kirkes and Mr. Paget have confirmed the opinion, formerly entertained, that concretions on the valves or in the interior of the heart are readily detached, and thus conveyed to the brain and other organs. If large, they may suddenly block up large arteries, and so cut off the supply of blood to an important part, or in smaller particles they may be arrested by vessels of less size, and give rise to various effects, these being dependent, in a great measure, upon the side of the heart from which the masses or particles have been detached. Even the fibrin in the "capillary phlebitis" of the kidneys and other organs, and the fibrinous points constituting petechiæ, this author refers to a similar source. Obstruction by a plug of fibrin from the aortic valves may suddenly obstruct the carotid or vertebral arteries, and produce congestion and headache, or lead to hæmorrhage, exudation, convulsions, or paralysis. The middle cerebral artery has been found blocked up at the angle whence it proceeds, thus appearing to lead to softening of the portion of the brain supplied by that artery. Coagula in the iliac or femoral arteries, whether produced in these vessels or brought from a distant part, will lead to loss of pulse and animal temperature, loss of sensation, paralysis, œdema, erysipelas, and even gangrene in the limb. (*Med. Chir. Transac.* vol. xxxv. p. 281.)

Coagula in the heart or vessels may undergo successive changes into fibro-cellular tissue and the formation of vessels in their substance, as occurs in inflammatory exudations, or may give rise to irritation of the parts with which they are in contact, and to inflammation and suppuration; and a most important consideration relates to the products of their chemical decomposition. The coagulated blood must be separated into serum and clot. The serum has probably no injurious effects; its constituents would either be assimilated by the liquor sanguinis or separated by the secreting organs. The clot, however, as we have seen, is subject both to mechanical disintegration and chemical decomposition, and the latter may result in deleterious or poisonous compounds. Thus, when, from any cause whatever, blood coagulates in the vessels, as it does after parturition, and in low states of the system, or may be excited to do by various stimuli, coagula may develope poisons capable of producing effects on distant organs, or of generating fever, or erysipelas, or of determining the gangrene of a part.

In forming an opinion whether the blood has a tendency to coagulate in any particular case, the surgeon has to consider its actual condition, more especially as respects an absolute or relative excess of fibrin, the state of its circulation, and the absence or presence of substances calculated to excite coagulation. In many instances the act of coagulation is the result of combined agencies, as the absorption of a poison into blood with a languid circulation generally, or a total stagnation in any particular part; or the arrest of a secretion, and the accumulation of effete matter, as of urea, with a general excitation of the molecular actions in the blood and congestion in a part; or a relative excess of fibrin with debility, exhaustion, and sinking; or a morbid condition of blood, or retarded circulation, supervening on disease of a vessel. The occurrence is incidental to so many diseases that no uniform plan of treatment can be laid down for its cure or prevention, but it may be stated generally, that remedies which maintain the current of the blood in its full force throughout all the organs, and those which prevent remora, or congestion or stagnation in parts, are calculated to prevent this serious pathological condition, and that alkalies and many saline medicines have a similar effect. It is not certain whether any medicines are capable of dissolving coagula when once formed, but this effect has been attributed to alkaline medicines generally.

A knowledge of this tendency of the blood to coagulate and form concretions in the heart and vessels, during life, is of the utmost importance in the prognosis of surgical diseases, and it should influence the treatment in many important respects. Owing to the modifications which loss of blood produces in the blood remaining in the system, bleeding, indicated in the earlier stages of inflammatory diseases with entonic action and absolute excess of fibrin, is contraindicated in the latter stages with exhausted vital power and only relative excess of fibrin. In the first instance, it is calculated to prevent fibrinous deposits and their fatal results, and in the latter to promote them. Dr. Richardson has well remarked, that in croup, for instance, death may result from either of two causes. Where the symptoms are clearly those of asphyxia, dependent on obstruction of the air passages, the operation of tracheotomy may be advisible, but if the air enters the lungs with moderate freedom at each inspiration, and indications of emphysema are present with symptoms of obstruction at the heart, the operation would be useless and unwarrantable. In another class of cases, where a deposit of fibrin may take place from waste of the fluid constituent of the blood, as from profuse perspirations, colliquative diarrhœa, and the like, increasing relatively the proportion of fibrin and producing weakness and languor of circulation, as in cholera, consumption, and other diseases, the use of appropriate diluents, as whey, is indicated, and the avoidance of further depletion by bleeding, purgatives, and other remedies. To consider the actual condition of the blood as respects its tendency to coagulate, the influences which promote or retard that effect, and the results of its coagulation during life, may be laid down as an aphorism in the treatment of all surgical diseases. (*For the Bibliography, vide* art. Blood, Pathology of.)] *Henry Ancell.*

[BLOOD, CRYSTALLISATION OF.—*Hæmatoidin in the blood.*] — [Virchow first described crystals in extravasated blood, of a rhomboidal or oblong rectangular figure, yellowish-red, or of a pink or ruby colour, sometimes verging to black. They have been observed in the coagula of aneurismal dilatations and obliterated vessels, in abscesses, in extravasations in the brain, and the skin, in the blood of the spleen, and in the Graaffian vesicles. They may form within, or external to, the vessels, and within, or external to, the red corpuscles, and are regarded as a proteine compound in connection with hæmatin. This tendency of the organic constituents of the blood to crystallise during life appears to be associated with some pathological condition of the blood, but we are unable at present to define its nature. The crystals often occur in connection with fat, and may be suspected where we find fatty matter punctated with blood. Tetrahedral colourless crystals have also been observed by Robin and Verdeil in the serum of blood.] *Henry Ancell.*

[BLOOD, PATHOLOGY OF.] [Physical deviations from the healthy state exhibited by the blood were recognised by the best observers from the earliest periods, and although about the commencement of the present century, and for some time subsequently, it was denied that the fluids can be the seat of disease, yet, by the aid of chemical and microscopical investigations, a modified humoral doctrine is now firmly established. The morbid affections of the blood, either as respects its material constitution, or the molecular actions and changes to which it is subject, can only be understood in their relations to its variable conditions in health, but it does not come within the scope of this work to enter into the physological details. It has been truly remarked, that in the zoological series, the chemical and vital composition of the free fluids and fixed solids of the living organism stand in direct and intimate relation to each other, the liquid and solid parts being "invariably and necessarily linked into union by an inherent agreement of general properties." The organic materials engaged in the fabrication of the solids are produced, or prepared in the fluids, and "what is not or has not been present in the fluids can never constitute an integral part of the solids." (*The Blood, its Chemistry, Physiology and Pathology, by T. Williams, M.D. Brit. and For. Rev.*) So also, as a general proposition, before the materies morborum of whatever nature, can produce their effects on the solids, they must be dissolved in the fluids. The nutritive fluids and more stationary solids exist in their simplest state in the lowest extreme of the animal scale, increasing in complexity as that scale ascends, and the red blood of the mammal is not only the most complex of these fluids, but of all organic substances. This is shown by the variety of its proximate principles, the number of elements of which they are composed, and their high combining equivalents. Chemically considered, blood consists of gases, water containing chloride of sodium and many other saline and mineral substances in solution, albumen, fibrin, crystallisable and uncrystallisable oleaginous principles, a number of undefined substances classed as extractives, and colouring matters ; these exist, during life, as a liquid vitalised plasma or liquor sanguinis, and organic corpuscles, which together constitute the blood. This remarkable fluid receives and elaborates the materials for the nutrition of every structure in the body, and, also, either for renovated use or elimination, the effete particles set free by the disintegration of all the tissues. It is continually supplied with substances which serve as fuel for the production of animal heat. In it the operation of the laws of the mutual convertibility of the physical and vital forces is pre-eminently exhibited; and some of the most energetic of the inorganic elements of matter, the oxygen of the atmosphere especially, become fixed and arranged into compounds. It is not only in constant rapid motion, as a mass, at a rate of from twelve to sixty feet per second, but this movement imparts an intestine motion, by which each corpuscle moves and is kept separate from the rest; and it is the seat of molecular transformations, " the union and disunion of its elements being ceaseless, and never subsiding into the quiescence of chemical solution." It is possessed of an inherent life, and is above all other substances during life " the active locomotive state of organised matter as contradistinguished from the more passive and sedentary solid." (*Dr. Williams*, lib. cit.) It contains both binary and quaternary compound radicals, and various isomeric or conformable bodies, as the hydrocarbons and protein ; many of the substances which enter into it passing through progressive metamorphoses both ascensive and retrograde. It is capable of homologous catalysis, having a power of assimilation within itself ; its organic principles producing like organic principles, and, as in vegetable organisms, it exhibits allotropic transmutations of its constituents. Its red and white corpuscles are in a continual state of disintegration and renewal, being reproduced very rapidly when their number is greatly diminished, provided the liquor sanguinis contain the proper materials. The organic bases of the solids, represented chemically by albumen, fibrin and fatty principles, as also their inorganic elements, are derived from the blood plasma ; and, although, in the act of nutrition, these principles are modified, this act may almost be defined as the transmutation of these substances into the solid structures. Many of the processes continually taking place in the blood are of the nature of eremacausis or combustion, by which it maintains its own temperature ; this being, in the human body, about 100° 6′ to 101° 75′ Fah., which is essential to the continuance of its own vital processes, to the reciprocal interchange of molecules between the intravascular liquor sanguinis and the extravascular parenchymatous fluids, and to its circulation. The blood is accordingly one principal site of the developement of animal heat. Free electricity appears also to result from most of these processes ; as from the union of oxygen with carbon, the eremacausis of hydrogen, phosphorus and sulphur, or the decomposition of chloride of sodium ; and the acidity of the muscular fluids with the alkalinity of the blood gives rise to myriads of electric currents (*Matteucci*, *Liebig*). A sound condition of the vital organs, the regular and energetic performance of their functions, the developement of the nervous and muscular powers, of consciousness and thought, are maintained only by an unceasing supply of healthy blood. When the blood fails to undergo its active metamorphoses and the continual change of matter common to it and the organised solids, it dies.

So long as the constitution of the blood is in harmonious relation to that of the more stationary organs and structures, the proportions of its chemical constituents and organic principles varying only within the physiological range, and its vital functions being energetically and regularly performed, it may be regarded as healthy. But apart from the recorded observations of surgeons of all ages, the more precise investigations of modern physiologists and chemists have proved, incontestably, that it is subject to the most remarkable changes in these respects ; and that the deviations from the chemical and physical standards of health, detected on analysis, are unequivocal exponents of functional disturbances and organic diseases of the blood itself while it circulates in the vessels. In the different temperaments, deviations from the physiological standard of the constituents of the blood influence surgical cases. Thus, in the sanguine temperament, the solid constituents and the corpuscles are in excess, and in the lymphatic temperament they are diminished, corresponding with the most marked differences of constitution. These operate as predispositions to certain affections, and modify the vital processes, both reparative and destructive, in injuries, operations and diseases. The developement and nutrition of every organ and tissue being dependent on the presence in the blood of a substance which may be regarded as its analogue, every deficiency in quantity, or defect of composition, in such analogue, is essentially a diseased state of the blood. So again, Treviranus remarked that " each single part of the body, in respect of its nutrition, stands to the whole body in the relation of an excreted substance ; " and accordingly, the failure, not only of any organ of secretion, but of any tissue in its nutrition, to remove the particles which are prepared there for ulterior use or for elimination, may become the cause of a diseased condition of the blood. Morbid conditions of the blood, produced by these and numerous other causes, which will be adverted to in the progress of this article, may give rise to functional disturbances in any part of the system, and lay the foundation of organic diseases in the solid structures. Diseases may originate in the blood, or may be disseminated and propagated in every living tissue through the blood, and although they may frequently commence in the more solid structures, and this is particularly the case with some surgical diseases, yet, whether their origin be in the solids or the fluids, " they cannot be long limited to either, but must be very quickly extended to both." The symptoms, progress, and terminations, of almost all the diseases that come under the treatment of the surgeon, the healing of wounds, the results of accidents and operations, and the action of remedies, are directly influenced by the quantity of blood circulating in the body, by its distribution to particular parts, and by its healthy or diseased condition. The disorganisations and diseases of the solids produced by morbid conditions of the blood are often of the most malignant and fatal character ; and when the vitality of the blood itself is destroyed instantaneous death is the inevitable result.

Morbid states of the Blood may be referred to: — 1. Changes of constitution in relation to the quantity existing in the vessels. 2. Changes in relation to its motion and distribution. 3. Modifications as respects its elementary constituents. 4. Modifications in the proportions and chemical and vital qualities of its proximate constituents. 5. Pathological states from the retention or absorption of substances developed in the processes of hæmatosis, secretion, and nutrition. 6. Pathological states produced by substances totally foreign to the economy, formed in the blood itself, or introduced by absorption, respiration or otherwise.

1. *As to quantity.*—The production of a greater quantity of blood than necessary for the purposes of respiration, nutrition, and secretion, is a primary pathological condition to which some individuals appear to have an inherent tendency ; it is also frequently the result of too great repletion combined with inactivity, and other causes, and often operates as a permanent source of excitation of the solids, and as a predisposing cause of many diseases. A diminution of blood in the system, owing to direct loss, starvation, and other causes, is also a primary pathological condition. Excess or deficiency of blood in the vessels may be general or local ; but the quantity cannot be increased or diminished without some change taking place in the composition and vital qualities of the fluid. When hæmorrhage, for instance, proceeds from an open vessel, the blood remaining in the system undergoes a rapid diminution of density, owing to a considerable diminution in the proportion of its red corpuscles ; the liquor sanguinis also becoming somewhat more dilute, but the proportion of fibrin being little or not at all affected. This is owing to the absorption of aqueous and parenchymatous fluids from the tissues, which commences the moment the blood is abstracted, and is probably the result of diminished pressure and increased rapidity of current. Abstinence and exhausting diseases have similar results. The effects produced by the blood in excess or deficiency on the organs of circulation, the nervous system, and the functions of life, depend, in great measure, on these modifications, which must be taken into consideration in connection with the effects of alteration of volume. The circulation in the capillaries depending on other influences besides the action of the heart, a preternatural accumulation of blood may take place in these vessels, both in the subjects of an excess or of a deficiency of blood in the vascular system generally, and in this case also the qualities of the blood become changed. These pathological conditions are treated of under their respective heads. (See Anæmia, Hæmorrhage, Hyperæmia, Plethora.)

2. *As to motion and distribution.*—The movement of the mass of blood in the vessels throughout the body being essential to its functions, and necessarily related to the activity of respiration, nutrition, and secretion, morbid conditions of the blood itself, and a disturbance of the functions of life, may be produced by any cause which accelerates, retards, or arrests these movements, or any cause which disturbs the equilibrium of the circulation in the different parts of the body. The action of stimulants, or inordinate exercise, for instance, accelerates the motion of the blood, and increases its fibrinous quality. All the causes which produce a languid motion, either generally or in particular parts of the circulation, or an arrest of the current of blood, may lead, by chemical reactions, to a disturbance of its vital constitution, or to coagulation and a separation of clot and serum, even in the living vessels. Disturbance of the circulation in the capillaries often produces an accumulation of a larger number of red and white corpuscles in a vessel — one of the conditions of congestion. These corpuscles become grouped together into masses, and apply themselves to the walls, displacing the parietal layer of the liquor sanguinis, and taking on a retrograde and oscillatory motion, which becomes gradually weaker until a complete stasis is established. During the formation of such a stasis, and subsequently, the endosmotic and exosmotic functions of the vessels are changed, the qualities of the blood altered, and pathological transudations supersede physiological cytoblastemata. Stagnation of blood, especially after extravasation, results ultimately in its death and decomposition, and occasionally in granulation or crystallisation. (See Blood, Coagulation of ; Blood, Crystallisation of ; Hyperinosis ; Necræmia.)

3. *As to the elementary constituents.*—A preponderance or deficiency of some of the elements may constitute, or be essentially associated with, disease of the blood. Analysis has at present furnished but few facts. *Oxygen*, one of these elements, when received into the blood, never remains passive ; inhaled in excess it increases the quantity of fibrin ; and by making an animal breathe in a free current of oxygen gas, a state of active hyperinosis is artificially produced, and fibrinous clots are deposited in the heart and blood-vessels. (*Richardson*, lib. cit. p. 71—80.) Excessive oxygenation of the protein compounds of the blood is produced directly, by the oxygen of the air, during increased activity of the respiration, and especially in certain states of the atmosphere. A deficiency of some of those principles with which the oxygen respired ought to combine, as the hydrocarbons of the food, or substances prepared for oxydation by the organs as the blood passes through them, as the sugar of the hepatic blood, also leads to the same result. Again: there may be a deficiency of oxygen in relation to these substances. A deficiency of *iron* exists in chlorosis and anæmia ; and the former disease is cured by the addition of this element to the blood. In this case, want of iron corresponds with a diminution of red corpuscles, and iron cures the disease by increasing this organised constituent. In practice, the proportion of red corpuscles is more readily estimated than that of the iron ; hence we look to the corpuscles as the exponent of the condition of the blood. A deficiency in the assimilation of *lime* is the foundation of a deficiency of bone-earth, in various diseases of the bones, and is sometimes the cause of the non-union of fractures. *Nitrogen* and *hydrogen*, in the form of *ammonia* or its salts, occur in excess in various diseased states of the blood. The influence of ammonia has been investigated by Dr. Richardson (lib. cit.) who believes that the blood owes its fluidity during life to this alkali holding the fibrin in solution, and that the separation of ammonia is the cause of coagulation. Ammonia is most probably produced synthetically during the destructive metamorphoses of the nitrogenous

principles received into the blood, any excess being prevented during health by the action of the secreting organs. (See Blood, Superalkaline; Spanæmia; Uræmia.) Other elements must vary in proportion; but pathology has not in many instances furnished data to build our practice on the simple indication of excess or deficiency of an element of the blood.

4. *As to the proximate constituents.*—Changes in the proportions of the proximate constituents have been more generally observed: they are frequently the exponents of more complicated morbid conditions, and are of the utmost practical importance.

The proportion of *water* to the solid constituents may be in excess or deficiency, and the specific gravity of the blood altered in a very remarkable degree. The proportion has been found as high as 871, or even 887, parts in 1000, in some cases of chlorosis and carcinoma, and as low as 480 parts in 1000 in malignant cholera. Hence the terms "poverty of the blood," and "inspissation of the blood." But the water, either of the blood (liquor sanguinis + corpuscles), or of the liquor sanguinis or corpuscles viewed separately, may be increased or diminished. As a general rule, the proportion of water to the solids in the liquor sanguinis corresponds with the proportion in the corpuscles, but in some cases the liquor sanguinis contains a smaller proportion of water to its own proper solids than usual,—the blood, as a whole, being watery, owing to the small proportion of red corpuscles; and in some cases the specific gravity of the corpuscles alone is affected. In the leucophlegmatic temperament the proportion of water is absolutely increased, and this increase often occurs to such a degree as to constitute a true state of disease. (See Hydræmia, Spanæmia.)

While absorption and imbibition, by which water is conveyed into the blood-vessels to maintain their plenitude, may promote a state of poverty of blood, as a primary pathological condition, they render a spissitude a much less frequent, if not an exceptional case. When profuse discharges occur, as in diabetes, there is very frequently at the same time a craving for liquids, the volume of the blood being maintained by the fluids ingested. Nevertheless, a smaller proportion of water exists in some temperaments as compared with others, and a great degree of spissitude may occur in disease. This has been observed in individuals, during a cholera epidemic, a thin alkaline and coagulable serum, and the salts of the liquor sanguinis, at the same time passing off by the kidneys or skin; and in cholera, a large quantity of water from the blood with albumen and salts, are drained through the alimentary canal, so that the fluid left in the vessels becomes inspissated. (See *Blood, Anhydrous.*)

The proportion of *fatty matter* is liable to great variations. Lehmann fed a horse for three days with starch diet alone, by which the proportion of fat was greatly reduced, both in the arterial and venous blood. An access of fatty particles exists after every full meal containing it, as shown by an opalescence of the serum. This turbidity, partly attributable, however, to albumen in an imperfectly combined state, usually increases for several hours, and often amounts to a milkiness, after which it gradually subsides; and before the next meal, if the interval be sufficient, the liquor sanguinis recovers its transparency. The proportion of fatty matter must thus be liable to rapid changes, owing to its more or less rapid absorption, and the state of the respiratory, nutritive, and eliminating functions. The proportion found in the blood has varied from ·2 in a normal transparent condition, to 117 parts in 1000.

An accumulation of cholesterine and other fatty matters, and a more permanent opacity of the serum, has been observed in some diseases. This is said to be the case at the commencement of most acute affections, and particularly in inflammation of the liver, lungs, and peritoneum, and in chronic diseases of the liver, attended with cholæmia, where a complete retention of bile has been produced by biliary calculi and other causes. It has been observed also in cholera, albuminuria, and the early stages of tuberculosis.

The blood is liable to a still more decided oleaginous condition, in which the serum presents a perfect resemblance to milk, cream, or pus; and this has sometimes occurred where none of the above mentioned diseases existed. (See Olæmia.)

The importance both of oil and albumen to the nutritive processes is now well understood. It has been suggested that the oily matter is converted into albumen, and if this be one of the metamorphoses effected in the blood, an explanation is afforded of the tendency to adipose deposits, and to the fatty degeneration of tissues in states of debility. At all events, some error in the sanguineous assimilation of fat is associated with various pathological states of frequent occurrence in surgical practice. All kinds of cells and cell growths undergo what is called "fatty degeneration." Muscular fibre, both in the heart and in the voluntary muscles, often appears to be transformed into fat. A similar occurrence takes place in the large blood-vessels (*atheroma*); in the smaller vessels and capillaries; bones; cartilages; in the nerve cells of the brain, constituting softening (*Dr. J. Hughes Bennett*, p. 355); all the glands; pulmonary tissue; cornea; lens; even in the placenta; and in various pathological exudations. From the universality of these transformations, and from the fact that the constituents of blood, exuded or extravasated, exhibit this change, there can be no doubt that the vital chemistry is primarily at fault. The complicated affinities exerted between the calcareous salts and the oleaginous and albuminous molecules appear to be arrested.

A morbid condition of the blood of this kind is associated intimately with some of the most important diseases treated of in this Dictionary; as diseases of the arteries, leading to the formation of aneurisms; diseases of the bones, of the brain, the eye, and the ear; fatty accumulations in cysts, fatty growths (*Lipoma*), &c.

A deficiency of fat in the blood is said to occur in confirmed tuberculosis. There is certainly a deficiency in the system when pulmonary phthisis or any of the local forms of this disease have proceeded far; and it is probable that during hectic fever the hydro-carbons are consumed too rapidly to allow of the assimilation of fat for nutritive purposes. (See Tuberculosis.)

The proportion of *albumen* contained in the blood is from 68 to 71 parts, and in serum from 79 to 98 parts in 1000; and this constituent varies less than any other; for, although the serum is said sometimes to contain more than double its normal quantity, rendering the fluid extremely viscid, the accuracy of this statement is doubtful. Alterations in the proportion of albumen are, however, of the utmost importance. It is relatively increased by all causes that diminish the water of the liquor sanguinis, or the red corpuscles, and is accordingly in excess in cases which are attended with profuse discharges, as in cholera and dropsies, and after the use of drastic purgatives; unless, as sometimes happens, it passes off with the discharge, or with some of the secretions. Andral and Gavarrett found the albumen absolutely increased in acute rheumatism, pneumonia, pleuritis, tonsilitis, phthisis, cerebral congestion, erysipelas, and other affections, the increase varying from 4 to 34 excess in 1000; but in no disease being constant and characteristic. In chlorosis, it has been found in excess from 14 to 20 parts in 1000.

The proportion of albumen has been found diminished in diseases attended with defective nutrition and atrophy, in the latter stages of typhus, in dysentery, diseases from malaria, scurvy, remittent fevers, and dropsy from various organic affections; and in the original attacks of most diseases where the appetite is lost, and where nutriment has been withheld as a remedial measure. In diseases of the heart, Becquerel and Rodier found very little variation till dropsy set in, after which the albumen rapidly diminished, from which circumstance it may be inferred, that dropsical effusion is promoted by a deficiency of this constituent.

It is in Bright's disease of the kidney that a dimunition of the albumen of the blood appears to be essentially related to the disease. The density of the serum sinks from 1029—31, to 1019—20; and in one case Dr. Bostock found it as low as 1013. According to Andral, the diminution is exactly proportionate to the quantity of albumen in the urine. In this disease one of the most important functions of the kidney also nearly ceases, and there is an accumulation of urea in the blood.

The albumen of the blood of the vena portæ, as first received into the circulation, is in an imperfect state designated "albuminose," by M. Mailhe (*Carpenter's Principles of Physiology*, p. 163), and "incipient" albumen, by Dr. Prout. In different parts of the vascular system, in disease, there are probably variations depending on the proportion of alkali with which the albumen is combined; where the basic albuminate of soda ought to exist the neutral is found; and since, in these states, albumen passes freely through organic membranes, it is probable that mal-assimilation of albumen is intimately concerned as a cause of its transudation through the kidneys and other tissues, in albuminuria, cholera, and dropsies.

The *fibrin* differs chemically from the albumen in being more highly oxydised, and possessed of the power of fibrillation when the blood is brought to rest. Its quantity and quality may be judged of, in some degree, by the dimensions of the coagulum in connection with the contractile power and ultimate density of the clot; but its quantity can be accurately determined only by analysis. A redundancy of fibrin occurs in various states of the system, as after parturition, and throughout the early period of lactation, and in various diseases, particularly ardent fever, entonic inflammation, and rheumatic fever. Its quantity may be increased, in proportion to the solid constituents taken collectively, to above four times its usual amount; from 2·5 parts, its average normal standard, it has been found, in pneumonia, as high as 10·5 parts in 1000. A redundancy of fibrin gives the blood a tendency to coagulation within the vessels, and frequently occurs as one of the most prominent characteristics of a primary pathological condition. (See HYPERINOSIS.)

A deficiency of fibrin occurs in many diseases; it renders the blood less coagulable, but not in a degree proportionate to the loss of fibrin, as much is due, in the character of this process, to the vital qualities of the fibrin. This deficiency is met with in some diseases in which the respiration has been interfered with during life, as those which prove fatal by asphyxia, or obstructive heart disease. It may be reduced to a mere trace, so that the blood is no longer coagulable, as in some malignant diseases.

When the vital qualities of the fibrin are deteriorated, and the fibrin weak, the blood clot does not contract in the usual degree, coagulation is retarded, the coagulum does not hold the red corpuscles uniformly suspended until the contraction is complete, the corpuscles are very unequally disseminated in the clot, there being a gradual increase in number from the uppermost to the lowest meshes, and the density of the clot is gradually diminished in a corresponding degree. The organising qualities of the liquor sanguinis, in this diseased condition, are weak; the nutritive blastemata share in this debility, and also the reparative exudations after operations and injuries and in diseases generally. When the blood contains mere traces of a feeble fibrin no clot is formed, and the corpuscles subside, with a few flocculi, as a dark or blackish sediment, and if the fibrin lose its vitality *in toto*, the blood remains altogether fluid.

The quality of fibrillation in the liquor sanguinis appears to be very easily affected by various external and internal influences. Measured by the amount of fibrin obtained from the blood by analysis, cerebral congestion diminishes it, and when this is relieved by bleeding, it again rises; an effect probably due to increased respiration. (*Andral.*) The blood is often fluid, or very imperfectly coagulated, or the coagula are very soft and friable, after death from heart disease, in cyanosis, where the venous and arterial blood is mixed, and a portion of the latter, as it passes from the arterial to the venous system is not oxygenated, and in death from the exhaustion of violent muscular exercise. The fibrin is deficient, or deteriorated, or both, and the blood often prevented coagulating, from the action of various poisons, as carbonic acid, hydrocyanic acid, sulphuretted hydrogen gas, carburetted hydrogen, arsenious acid, oxalic acid, digitalis, and alkalies. This state occurs also in adynamic fevers, purpura hæmorrhagica, scurvy, and many malignant diseases, giving a tendency to effusions, hæmorrhages, petechiæ and vibices, and constituting one of the most important characteristics of more complicated diseases of the blood. (See HYPERINOSIS, SPANÆMIA, TOXICOHÆMIA.)

Not only well marked changes in the proportions of these constituents of the liquor sanguinis, but the proportions which the two varieties of corpuscles bear to each other, and to the fluid in which they are formed, nourished, circulate, and decay, differ to a very great extent; and these differences also constitute important features in some severe and complicated diseases of the blood.

The *colourless corpuscles* have been long known to increase in number in inflammatory blood, although not constantly, and in the vessels of an inflamed part, and this increase is most frequent in persons of weak health and in certain diseases, as tuberculosis. Denis observed an increase in the buffy coat of inflamed blood; the white corpuscles approaching in appearance to pus corpuscles, and the exudations from blood of this character having a great tendency to corpusculate and to form pus. Bennett and Virchow have shown that the blood may be loaded with white corpuscles for months and even years, to the extent of five times their usual quantity, and that such condition is not at all connected with inflammatory disease of any organ. These observers differ as to the true nature of the white corpuscles in these cases, whether they are the usual white corpuscles of the blood or of the character of pus or mucus globules. This condition is often associated with organic disease of the spleen, liver, or lymphatic glands. (See Leucocythæmia.)

The proportion of *red corpuscles* floating in the living vessels has been determined by ascertaining the proportion of dry corpuscles in extravasated blood. It is liable to very great variations in disease. An excess, as a general rule, represents an absolute increase of the organised part of the blood, in other words, an increased quantity of red blood in the system. The proportion may be one third more than the average, constituting eminently rich blood. When this increase corresponds with a healthy state of the liquor sanguinis, as respects the condition of its albumen, fibrin, and other constituents, and a healthy state of the nervous system, it is accompanied by an augmentation of animal heat, a full firm pulse, increased sensibility and muscular irritability, and great mental energy, and the whole quantity of blood in the vessels is increased. (See Plethora.)

But the vital powers of the blood are not at all times proportionate to the absolute or relative number of red corpuscles. An excess of red corpuscles with a deficiency of fibrin, and of the natural viscosity of the liquor sanguinis, is associated with various dangerous conditions; since, together with, and probably as a consequence of, the more liquid and less plastic character of the liquor sanguinis, the nutrition of the finer capillaries suffers and there is a liability to cerebral and other hæmorrhages. Again, blood with an excess of red corpuscles, circulated slowly, developes less heat than with a smaller quantity circulated more rapidly (*Dr. J. T. Simon*); and when red blood is made in excess beyond a certain point its direct effect is to oppress the heart and vessels, and to diminish the energy and rapidity of its own circulation. In some pathological states also, where the red corpuscles are relatively increased to a great extent, owing to the loss of the fluid constituents, as in cholera, their integrity is damaged and the energy of their functions destroyed. The red corpuscles are very frequently deficient. They may be reduced to one-sixth the usual quantity rendering the blood so poor as to resemble coloured water. When moderately deficient, the colour is bright red, whereas it becomes darker than natural when they are in excess. The corpuscles being deficient, and the proportion of fibrin remaining the same, are essential characteristics of the blood in chlorosis. (See Chlorosis.) A deficiency occurs also constantly in anæmia, scurvy, tuberculosis, cancer, and the advanced stage of Bright's disease, and has been observed in diabetes mellitus, acute purpura, aneurismal dilatation of the heart with dropsy, lead poisoning, and various cachectic states. A total destruction has been observed in malignant scarlatina with purpura, and in acute purpura with jaundice (*C. B. Williams, Principles of Medicine*, ed. 2, p. 115), and various poisons introduced into the liquor sanguinis may occasion their rapid disintegration; the colouring matter, in extreme cases, being dissolved, and scarcely any entire corpuscles remaining. A morbid condition of the albuminous constituent of the liquor sanguinis appears to occasion a diminution of the number of corpuscles, and in most of the cases here cited the deficiency corresponds with a deficiency of fibrin, two characteristic of some of the most fatal blood diseases. (See Spanæmia, Toxicohæmia, Tuberculosis.) Deficiency of red corpuscles with increase of fibrin has been observed in Leucocythæmia. (*Dr. J. H. Bennett.*)

The *alkaline salts* of the blood vary considerably in disease. How far an excess or deficiency of these salts, as a whole, or of any salt in particular, may be the cause or the effect of various affections is unknown. An excess of chloride of sodium is produced by salt diet, but only to a very slight extent, the extra quantity being eliminated by the kidneys almost as rapidly as absorbed. An excess of the alkaline salts has been detected, during the progress of acute exanthemata, in typhus, albuminuria, dropsy, and hydræmia, and even to the extent of double the average amount in malignant intermittents and endemic dysentery. This excess both of the chloride of sodium and of the carbonate of the alkalies has the effect of keeping the fibrin dissolved and of retarding or preventing coagulation. By increasing the density of the liquor sanguinis it modifies the condition of the red corpuscles, as seen by their bulging and becoming more concave. Chloride of sodium being intimately connected with the transmutations of organic principles in the blood, any change in its proportion may exert a very powerful influence over them, and such changes are found in some of the most fatal disorganisations of the blood.

The alkaline salts have been found greatly diminished in severe inflammations (*Denis, Lehmann*), increasing the tendency of the blood to coagulate. Dr. Garrod was led to the conclusion that a deficiency of potassa, or of its salts, is the proximate cause of scurvy; but although this may be true of the disease as it appears in some cases, it cannot be so in others, since the general deterioration of the blood which induces the symptoms of scurvy differs as the disease has been observed under different circumstances. Lehmann states that the salts are diminished in the serum of cholera blood, but Garrod found, although a large quantity passes off by the bowels, that the quantity of water evacuated is larger, and the percentage of salines is rather increased than diminished. A deficiency of alkaline carbonates lowers the temperature at which albumen coagulates, and has a tendency to remove a portion of alkali from the albuminate of soda, whereby a portion of albumen becomes separated in a finely granular form, and produces a degree of turbidity of the serum. (*Phys. Chemis.* vol. ii. p. 205.) A diminution of alkali also lessens the action of oxygen on the constituents of the blood.

The *earthy salts* never accumulate to any extent, although there is sometimes a deficiency owing to inadequate supply or defective assimilation. Thus, during pregnancy, the appropriation of these materials in the growth of the fœtus, often reduces them to a nullity in the urine, and fractures recurring at this time may remain ununited. In rachitis the same thing probably happens, and softening of the bones may be induced by a deficiency of calcareous salts or their elements derived from the food. Most diseases of the bones indicate a deficiency of bone earth, but whether from defective supply, or defective organisation, is not certain.

The *extractive matters* of the blood are an indefinite group of substances always present, and probably containing many compounds undergoing progressive and retrograde changes, particularly the products of the metamorphosis of azotised tissues, as uric-oxide, urea, cystine, creatine, and the like. They have been observed in excess in some diseases, as puerperal fever and scurvy, and have been suggested as the causes of skin diseases and other affections, but there can be no practical application of generalisations of this kind, owing to the heterogeneous character of the mass. The effect of the accumulation of particular substances, as urea, which in the healthy state is removed by the kidneys as rapidly as it is formed, will be treated of under another head.

Not only variations in the proportions, but differences in the physical and vital qualities, and chemical combinations of the constituents of the blood, indicate diseases both of the blood itself and of the animal economy generally. This has been incidentally stated of the albumen and fibrin. *Specific gravity* of the mass of blood does not aid the pathologist much, since an increased proportion of one constituent, as of the corpuscles, is often coincident with a diminished proportion of other constituents, as of the fibrin or albumen. The *colour* of the blood as it flows in superficial parts is much more significant. A preternaturally dark blue colour, for instance, indicating that the relations between the blood and air are imperfectly maintained in the lungs (see Asphyxia); great pallidity, corresponding with a deficiency in quantity, or great poverty of blood (see Anæmia, Hydræmia); an extremely florid state, marking increased circulation and rich blood (see Hyperinosis, Plethora). The various hues of the liquor sanguinis contributing to the colour of the tunica adnata, lips, gums, and external surface, are also typical of morbid states of blood; as from the yellow colouring matter of bile (Cholæmia); the greenish, livid, blackish, or dirty colour of the skin in cachetic diseases; the icteroid, pale lilac, saturnine, and other hues, in many diseases to which females are liable; the peculiar bright pink tint on a pallid basis, in consumption. They indicate particular morbid conditions, aiding the surgeon in forming his indications for the treatment of surgical diseases. (See Chlorosis, Cancer, Tuberculosis, Toxicohæmia.) The *temperature* of the blood is liable to frequent variations within a limited scale, and to great variations occasionally. It has been observed as high as 110° Fah. in fever, and as low as 86° in cholera. The *odour* of the blood, and the escape of odoriferous principles into its halitus, constitute another class of symptoms; hence acid, ammoniacal, putrid, earthy, cadaverous, and many other odours of a specific character, in various cachexias, diatheses, and diseases; as in gout, rheumatism, eruptive and other fevers, malignant and gangrenous affections, tuberculosis and insanity. Changes in the degree of *viscidity* is another circumstance of the utmost importance. The experiments of Poiseuille show that a certain degree of viscidity is favourable to the motion of liquids through capillary tubes, and any material alteration in the proportions of the constituents of the blood, modifying the natural viscidity, conduces to obstruction in the capillary vessels and effusion of fluid through their parietes. (See Hydræmia, Hyperinosis.)

That the physical and vital endowments of the corpuscles undergo modifications is shown by their specific gravity being liable to changes. (*C. Schmidt.*) It was observed to range from 1·1025 to 1·1027 in cholera; and was 1·085 in dysentery; 1·0845 in albuminuria; and 1·0855 in dropsies. (*Lehmann*, p. 176.) They are rendered brighter, diminished in size, and their outline and central mark become more distinct by superoxydation. They are paler or darker in proportion to the quantity of colouring matter which they contain. They are acted upon by the degree of viscidity of the liquor sanguinis, or by foreign agents, including medicines or poisons, introduced into the blood, and may be expanded or contracted, flattened, jagged, starred, indented, distorted, or granulated; these changes modifying the colour of the blood, and being often produced by concentration or dilution of the liquor sanguinis, and by modifications in the exosmose and endosmose of the parietes of the corpuscle. When the water of the blood is much diminished, as in cholera, or during excessive perspiration, they are diminished in size and granulated; becoming larger and smoother when the liquor sanguinis is diluted. They have been observed to be completely destroyed in some fatal diseases, as pyæmia and malignant scarlatina. (*Williams's Principles of Medicine.*)

As the coagulation of the blood is one of its most remarkable physiological phenomena, so the coagulation of human blood with a buffy or colourless coat on the surface of the clot, is one of the most remarkable of its pathological phenomena, which has induced surgeons to pay great attention to this process. Deviations from the usual mode of coagulating are very frequently indicative of disease, both of the solids and fluids. The process may be hastened, retarded, or prevented, by numerous causes. The contraction of the clot, after coagulation, may also be more or less firm, or rapid, or may be prevented by various circumstances; many of which are pointed out in works on physiology, and must be borne in mind when estimating the condition of the blood in surgical diseases.

A buffy coat, as a symptom of disease, may be produced by any circumstance which, retarding coagulation, allows of the subsidence of the red corpuscles before fibrillation takes place. Observation has shown that, whenever the vital actions are increased, whether the fibrin be the product of the active metamorphosis or a mere solution of materials received into the blood, its quantity is increased, and coagulation retarded, the red corpuscles are then liable to sink in the liquor sanguinis before the clot is formed, and, although the subsequent contraction of the clot may be extremely firm, the upper portion is found to consist only of fibrin, colourless corpuscles, and a portion of serum, forming a buffy or fibrinous crust; and when the white corpuscles have been increased by any cause, they may constitute as much as one half of the bulk of this crust. Hence this appearance presents itself generally in blood drawn during inflammatory fever, and entonic inflammation, in healthy subjects. (See HYPERINOSIS.) On the other hand, the existence of a small quantity of fibrin, and the deterioration of its quality, by which the viscidity of the blood is diminished, favours the subsidence of the red corpuscles, and although coagulation may begin early, it is at first so weak, and the contraction so feeble, that a subsidence of the corpuscles takes place just as when the coagulation has been retarded, and a buffy coat may be formed. This occurs in many diseases of debility and low states of the system. (See SPANÆMIA.) So, also, an increase in the specific gravity of the red corpuscles, or a diminution in the density of the liquor sanguinis, or both, or any circumstance which promotes the aggregation of the corpuscles, and their disposition to form nummular masses, (since the resistance to a solid sinking in a fluid diminishes in proportion as the surface of the solid diminishes), lead to the formation of a buffy coat. Thus a buffy coat occurs in diseases of the most opposite nature, and owing to the dilution of the liquor sanguinis and the increased proportion of white corpuscles, it is also often formed after a second or third venesection, or repeated losses of blood.

The surface of the buffy coat may be concave or plane, or even convex when it depends on an excess of fibrin. Since the layer of buff encloses no red corpuscles, and generally but few foreign elements, the fibrin contracts more closely than the fibrin of the clot beneath it, producing a tendency to contract within a smaller diameter. This tendency being resisted by the connection of the buffy with the red clot, the margins of the latter become expanded, and are drawn upwards, while the contractile power of the fibrin, taking greater effect in proportion to the distance from the resistance, a concavity is produced in the clot, and the coagulum becomes *cupped*, an appearance frequently observed in entonic inflammatory diseases. When the fibrin is deficient or defective, the surface of the crust remains plane, or becomes convex, the crust being, at the same time, soft, and often of a greyish white colour. These effects often depend, in part, on an excess of colourless particles, or on vescicles of fat; a condition of the buffy coat which presents itself in inflammatory diseases in debilitated habits.

The tendency of the corpuscles to sink, and to the formation of a buffy coat, has been observed to be increased in blood deficient in salts with a relative increase of albumen; in blood that is dark from being rich in iron; and in blood with watery liquor sanguinis. On the other hand, when the corpuscles are pale and rich in fat, their tendency is to sink slowly, and a buffy coat is not so readily formed.

5. *The absorption or retention of substances developed during the processes of hæmatosis.*—Organic compounds formed in the blood, or introduced from the tissues, produce pathological conditions of this fluid under a great variety of circumstances. They may be products of indigestion or malassimilation, or the results of an arrest of the ascensive or descensive metamorphoses of various organic substances, whether those received by the blood from the disintegrated tissues, or those introduced with the ingesta. They are frequently definite compounds formed during the transpositions of the elements of complicated organic principles into more simple substances, previous to elimination; and the more perfect the processes of eremacausis and secretion—the action of the lungs, liver, skin, kidneys, and other depurating organs, the less likely are such substances to present themselves in the blood. Morbid conditions under this head are extremely various, and intimately associated with some of the most fatal diseases that occur in surgical practice. The following arrangement will indicate the scope of this part of the subject, and assist the student in his reference to the most important diseases. *a.* Blood diseased from the absorption of crude or deleterious substances formed in the alimentary canal during primary digestion. (See TOXICOHÆMIA.) *b.* From an arrest of the molecular transpositions of the substances conveyed into it. Sugar, lactic acid, uric acid, urea, hippuric acid, creatine, creatinine, volatile fatty acids, and many odorous substances, regarded by chemists as products of the retrograde metamorphoses of the organic principles of the blood, have in many instances been detected in morbid blood. (See BLOOD, ACIDITY OF; GLUCHÆMIA; OXALÆMIA.) *c.* From the retention of substances prepared for elimination. If the secreting cells of the kidneys, liver, or skin, fail to secrete bile, urea, and other substances prepared for excretion, or if the lungs and skin fail to excrete carbonic acid gas, or the cells of the mammæ milk, these materials, or their analogues, accumulate, and the blood becomes diseased. (See ASPHYXIA, LITHIASIS, URÆMIA, CHOLŒMIA.) *d.* From the reabsorption of the secretions or their products. A failure of secretion and a failure of excretion are two different things. If the secreting cells of the liver fail, the blood is not depurated of the materials which in the act of secretion constitute bile; but if the excretory ducts become obstructed, this substance may be reabsorbed, either as bile or as some new compound. (See CHOLÆMIA.) *e.* From materials supplied from the tisssues, and resulting from malassimilation in secondary digestion. *f.* From the absorption of pathological products. The blood is very often contaminated by the absorption of its own exudations. When pus is not evacuated externally, the pus corpuscles separate into granules, and are ultimately dissolved, and the fluid is reabsorbed, and mixed with the blood. These products undergo a series of transformations, and are ultimately excreted by the lungs, kidneys, or skin. In their progress through these changes they often excite the blood, and increase its active metamorphoses, as shown by an increase in the quantity of fibrin or of urate of ammonia, and other products. So also the fluids of tubercle, cancer, or any morbid growth or exudation, may mingle with the fluids of the parenchyma and be conveyed back into the blood as molecules and granules, with inherent tendencies to evolution. (*Van der Kolk.*) Not only do these materials produce the most marked symptoms, as the hectic fever resulting from the absorption of tuberculous ichor, but they may be developed into substances or structures similar to those from which they are originally derived, or secondary growths, as

in cancer. (See Cancer, Pyæmia, Tuberculosis.)

6. *The presence of materials foreign to the animal economy.*—These may be organic or inorganic substances, introduced into the blood by absorption or otherwise. Many poisons, and a great variety of medicines, some of which are also virulent poisons, are absorbed, and may be detected in the blood or the secretions, either in their original state, or after having entered into new chemical combinations. These foreign agents may increase or diminish the molecular activity of the blood, or may modify the proportions of its constituent parts, and produce complicated morbid processes in the blood itself; or, without any appreciable change in the blood, may be conveyed to all parts of the economy. Alcohol, chloroform, prussic acid, for instance, and most mineral and many vegetable substances, are thus detectable in the blood. A very large proportion of the diseases affecting the animal economy is produced by poisons in the blood. This subject, with the laws which regulate the action of poisons, is of the highest interest to the surgeon, and is treated of fully in the Art. Toxicohæmia.

These morbid conditions of the blood constitute prominent features in many of the maladies, acute and chronic, to which the animal economy is liable. In some cases they are the consequences of accidents and diseases, occurring locally, or originating in vital organs, or in the nervous system; in others, they are primarily and essentially related to the proximate cause of the disease. An excess of materials in direct relation to the secreting functions of particular organs, or essential to the nutrition of particular tissues, becomes a cause of hypersecretion or hypernutrition, 'and of diseases of the organs of secretion and nutrition; an increase of salts produces diarrhœa or diabetes; a continuous increase of urea produces hypertrophy of the kidney, as shown by the fact that when one kidney is destroyed, the renal cells of the other are augmented in number, and the organ enlarges; an increase of hydrocarbonaceous material leads to an increased formation of adipose tissue; and an increase of the proteine compounds to hypertrophy of muscular organs. A deficiency in some essential constituent of the blood is one of the most usual causes of *debility*. When this deficiency is of a nature to disturb the nutrition of the nerves or the muscles, it impairs their functions, and thus causes debility. In the debility of fevers and of chronic diseases of the blood, the nutritive materials become exhausted. In like manner a diminution, either of the quantity of blood or in the proportion of its nutritive or eliminatory materials, produces deficiency or suppression of secretion or of nutrition, and local or general atrophy, or degeneration of tissue; the particular kind of degeneration, as that which developes fat, depending upon the predominating constituents of the morbid blood. So also exudations depend on morbid conditions of the blood. They are fluids which separate from the mass of blood, and transude through the vessels, in disease, and are contradistinguished from the blastemata of healthy blood; and although they depend, in part, upon the state of the capillary vessels through which they exude, whether dilated or contracted, elongated or relaxed, modifying the flow of blood through their channels and upon the state of the pores in their parietes, and although they may also be influenced by nervous impressions and electrical agencies, and also by the chemico-vital qualities of the parenchyma in which they occur, they are also very materially dependent on the actual state of the blood. These exudations are of the most variable nature; they either become solid, or remain fluid in the tissues, and may or may not be organisable; they comprise a liquor puris, a liquor canceris, a liquor tuberculosis, and they form the nidus or basis of morbid deposits, accumulations, and growths, as pus, molecular fibres, fibrous layers, granules, tubercle, cancer, fatty collections, parasitic vegetations, black pigment constituting an element of melanosis, glutinous masses constituting colloid cancer, accumulations of margarine or cholesterine, masses of mineral matter, calcareous masses, phosphate of lime. The whole of these depend on the inherent composition of the exudation, and this again on the state of the blood. When blood, otherwise healthy, becomes inflamed and stagnates in a part, the exudation developes itself into healthy pus, which differs somewhat according to the tissue and seat of the exudation; in a tuberculous state of the blood, the exudation developes imperfect pus, the pus corpuscles are irregular and misshapen; and cancerous blood leads to exudations in which cancer cells are developed. Diseased blood, by attenuating the blood-vessels, or producing a morbid condition or degeneration of their coats, and rendering them weak or brittle, lays the foundation for aneurism. So also morbid states of the blood exhibit themselves in the most marked manner in pathological processes set up as the consequences of injuries, determining their nature and results, whether the adhesive or suppurative process set in, the character of the pus, the nature of an abscess or of an ulcer, and the tendency to healthy nutrition or to gangrene,—the whole depending mainly on the state of the blood.

In like manner, morbid conditions of the blood act as predisposing causes of many local diseases. The vital fluid, deviating from its normal state, or containing foreign substances, may, under ordinary circumstances, circulate through the organs, often for a considerable time, without deranging their functions or disorganising their structures, although liable to operate as a predisposing cause of numerous local affections. When the blood is healthy, the nervous powers and the vigour of the organic functions enable the system to resist the effects of the ordinary existing causes of disease, such as changes of temperature, exposure to excessive heat or cold, damp, draughts of air, or the effects of the depressing passions, and the like; when, on the contrary, blood contains an excess or deficiency of its elementary or proximate principles, or has been rendered impure by foreign materials, such influences become the true exciting causes of numerous diseases of particular structures or organs. It is thus that one person is morbidly susceptible of the influences in question, and others invariably resist them. Many individuals are habitually liable to "take cold," on exposure of the surface; when the blood is thrown upon internal parts, if both blood and structure be healthy, the vital dynamics are sufficient to avert any ill consequences; if either be in an unhealthy state, some morbid action is liable to be set up. Hence, if the blood be too saline, or too viscid, or too fibrinous, or contain alcohol, or lactic acid, or other stimulating or irritating particles, congestion, irritation, or inflammation of the mucous or fibrous membranes, or of the parenchymatous organs, may be the result; thus, an unhealthy state of the blood acts as a predisposing cause of pneumonia, rheumatism, bronchitis, and other affections.

This principle is well illustrated in excessively fibrinous blood. Dr. Moseley, a very accurate observer, records (*A Treatise on Tropical Diseases*, p. 102) that, in the neighbourhood of Kingston, Jamaica, in the months of January, February, and March, 1799, there was not one shower of rain, and the sea breezes were violent. Of the many hundreds whom he bled, there was not a person of either sex, or of any colour, whose blood was not sizy, and the prevalent disease was rheumatism. We may infer from this statement, that an extremely dry state of the atmosphere, with cold winds, increased the vital activity and the oxygenation of the blood, so as to render it exceedingly fibrinous, and that the blood in this state constituted a predisposition to rheumatic attacks, on exposure to the occasional or exciting causes of that disease.

But diseases are often seated primarily and essentially in the blood. Whenever, in constitutional affections, organic lesions or functional disturbances occur in various parts of the body, as in scrofula and syphilis, or are widely scattered over a surface, as in the exanthemata or chronic cutaneous diseases, or occur in many distant parts in similar structures, as in joints affected with rheumatism, they depend entirely upon some morbid condition of the blood, and very frequently on a special morbid matter in that fluid. The dependence of local diseases on a diseased state of the blood, and the specific and distinctive character of blood diseases, are well illustrated by tuberculosis and syphilis, maladies which present a very large proportion of the cases coming under the special cognizance of the surgeon. The one probably depending upon some change in the oleaginous and proteinform constituents, and the other, upon the reception of a poison from without; the symptoms, progress, sequelæ, and medical and surgical treatment of their constitutional, and local manifestations being totally different. So, also, the modifications produced in the blood, and in the nutrition of the tissues, by numerous foreign agents, ay the foundation for many of the diseases described in this Dictionary, as where rheumatic matter produces diseases of the joints, or cataract; or where poisons produce amaurosis, or cancerous matter cancer. Absorption of the poison of glanders, of animal matter from a wound received in dis-ection, inflammation and the formation of pus n a vein, surgical operations, injuries of the head, ompound fractures, inflammation of the sinuses of the dura mater, the bursting of abscesses in the iscera, produce diseases which must be considered as essentially seated in the blood, and are charac-erised, in their general effects, by fever of a typhoid character, and secondary affections of various emote parts; particularly of the joints, synovial membranes, cartilages, subcutaneous and intermus-ular cellular tissue, the lungs or the liver. These re generally of an inflammatory character, quickly erminating in effusions of liquor puris. In their ffects they resemble those of animal poisons ab-orbed from without.

The blood may be directly affected or totally eprived of its fibrillating quality for instance, or oagulation may be greatly deteriorated and retarded, by electric and nervous shocks, asphyxia, the inhalation of poisonous gases, poisons absorbed, and many other influences. Its chemico-vital qualities may be disturbed, its circulation interrupted, or coagulation produced in the vessels, by the introduction or development of solid particles, as pigment granules (See BLOOD, PIGMENT GRANULES IN). Air may be developed within or introduced into the vessels with fatal consequences (See PNEUMATHÆMIA); or, as the immediate and essential result of morbific agents, the vitality of the blood may be totally destroyed. (See NECRÆMIA.)

Thus the most important considerations having reference to the blood continually arise in surgical practice. Resistance or non-resistance to morbific agencies depends not only on its actual composition and vital condition, but on its quantity and the activity of its circulation. Whether a poison be absorbed in any particular case may depend on the state of the blood in the part of the body to which the morbific agent has been applied. When the pressure in the vascular system is in excess, impeding motion in the capillaries, endosmotic action diminishes and is less certain; thus plethora counteracts absorption. When the pressure is weak, absorption is promoted; hence debilitated individuals often receive into the blood the materies morbi which would be resisted by those in good health. This is all the more important, inasmuch as a morbific agent absorbed slowly will often be decomposed or excreted without any injurious effects, whereas, if absorbed rapidly, the most violent effects may ensue. As the blood is constantly undergoing changes by the reception of new materials and the elimination of the old, and does not remain the same from one hour to the other, and as very considerable changes sometimes take place, more or less suddenly, so the character of local diseases is liable to alterations. Exudations and effusions may at one time abound in elements which do not exist at another. Various kinds of exudation may thus be mixed. Tuberculous matter may be mixed or alternate with simple inflammatory exudation. A glandular enlargement, or fibrous growth the result of a blow, emits a simple inflammatory exudation, the blood becoming cancerous after the lapse of time, and pouring out a liquor canceris, may cause them to "degenerate" into cancer; or the materials supplied by the blood being changed, tubercle or cancer may be superseded by fibrous, fatty, or calcareous elements. Again, urinary deposits and the formation of calculi, depending on morbid states of the blood, exhibit changes and alterations in their characters corresponding with changes in the state of the blood. All the elements of which these substances consist and most of their compound principles are first contained in the blood, and are subject to highly complicated decomposing and recomposing affinities and transpositions, which overrule the more simple affinities of inorganic nature; but they are no sooner removed from the blood than ordinary chemical affinities come into play, and they are highly disposed to crystallise.

Diseases of the blood may be acute and rapidly developed, giving rise to acute affections, as hæmatitis and pyæmia, and becoming the cause of rapid or even sudden death, as in necræmia; or chronic, coming on insidiously and unobserved, until some disorganisation or functional disorder manifests itself, as in tuberculosis, cancer, albuminuria, cirrhosis of the liver, and valvular disease of the heart. They may be primary, the symptoms and mode of expression of the disease depending on the cause, the nature of the morbid change, and the effect on the nervous system, as in the exanthemata, glanders, fevers, and hemorrhages; or secondary and consecutive, being the result of some local process, as when a disease in the whole mass of blood is produced by matter absorbed from a part. They may terminate in the restoration of the blood to a healthy state, as when a morbid poison is eliminated, or a morbid process exhausted or counteracted; or by one morbid condition passing into another morbid condition, as in cases where the poison of syphilis is expelled and mercurialism superinduced; or in the destruction of life through the brain, or some essential part of the nervous system, the lungs, or the heart, or by a general loss of vitality in the blood itself.

The *causes* by which a diseased state of the blood is produced, as may be collected from the facts already stated, are extremely numerous. The following may be mentioned as the most prominent. Excess or deficiency of the ingesta, either liquid or solid, as a whole, or of one or more of the essential staminal principles of food; unwholesome diet, as decomposing animal and vegetable substances, often developing poisons; impure water; and especially the abuse of alcoholic fluids; any influence producing excessive or defective action of any secreting organ by which the blood may be impoverished, or its molecular changes disturbed by the retention of effete materials; vitiation of the air respired, and alterations in the relations between the food and the air, in particular too high or too low a degree of oxydation; anything tending to weaken or derange digestion in any of its stages throughout the alimentary canal, or to produce excess or deficiency in the nutrition of organs or structures, thereby either exhausting the blood of particular elements, or producing accumulations therein, or derangements of the secondary digestion of any kind, or of the destructive metamorphoses of effete organised tissue; loss of any considerable quantity of blood; the introduction of substances foreign to the economy by absorption through the tegumentary membranes or with the air respired; any influence causing the retention of secretions intended for elimination or for special uses in the economy, or the resorption of their elements or constituent principles; the developement of any disease in the tissues, during which vital and chemical reactions take place, furnishing abnormal constituents to the blood, as from discharges in inflamed, ulcerated, or sphacelated surfaces, or the products of the dissolution of pus, mucus, fibrin, tubercle, or cancer; anything which produces the detention of a quantity of blood by remora or stagnation, as in the venous channels of the spleen, the blood from which, in certain diseases, has been found impaired, being poor and anæmic, and the red corpuscles destroyed, damaging or poisoning the whole mass on its return into the circulation; in females, the retention or resorption of the menstrual discharge, the lochia, or the milk, or their constituents or products, the secretions or the effete materials, which ought to be excreted during the periodical depuration, acting as poisons, or inducing anæmia and cachexia by contaminating the whole mass; the occult effects of solar and perhaps lunar influences, of electricity, shock, nervous and mental impressions, and the powers of nature generally, any of which may exert a direct, or, through the nervous system, an indirect influence upon the entire mass of blood, or upon a portion of it in some part of its circuit. Hence, diseases of the blood are the results of accidental or habitual errors in the relations of the animal economy to the inorganic world as respects air, food and drink, the egesta, exercise and rest, sleep and watching, and the passions. These causes may operate suddenly or insidiously, rapidly or slowly. Their effects are often wholly unsuspected by the individual. So great is the influence of habit in blunting the sensibility to impressions acting continuously on the nervous system, that, as in the case of breathing habitually a vitiated air, individuals may be subjected to them with comparative impunity, until the red corpuscles, the fibrin, and other essential constituents, are damaged and reduced in quantity, and until the blood has become impoverished in the highest degree, and insufficiently vitalised any longer to sustain efficiently the functions of life.

The *treatment* required for the correction of morbid states of the blood and for the cure of those diseases, which depend on, or are intimately associated with, diseased blood, is best considered in connection with the history of each disease, or of those primary pathological conditions which are separately considered, and have been referred to; but there are a few general remarks which may here be appropriately made.

The vis physiologica, or "vis medicatrix naturæ," is remarkably active in the blood, as shewn in the very great tendency which exists towards the re-establishment of a better condition, when from any cause the healthy state has been disturbed. The laws regulating imbibition and absorption sufficiently indicate this. If the vessels be too full, as in plethora, absorption is diminished. If they contain too small a quantity of blood it is increased. In its passage through secreting organs superfluous water is rapidly discharged, so that, unless in extreme cases of disease, dilution never occurs to the extent of dissolving the corpuscles. When the red corpuscles are reduced in quantity from a deficiency of iron, the absorption of this element from the alimentary canal is extremely rapid, and the blood quickly recovers its normal state. The introduction of minute portions of foreign substances quickly excites molecular actions and reactions both in the blood and tissues through which it permeates, by which such substances are either destroyed or eliminated. The spontaneous recovery of the blood from a state of disease is remarkably exhibited in cases of fever. Simultaneously with the subsidence of the disease, the proportion of fibrin augments independently of nutritive matter introduced into the system. In the case of poison introduced from without also, whether the poison remain in the blood, or be appropriated by the tissues, there is an invariable tendency in the blood to liberate itself, and this is often successful by the efflux of time alone. When fatal results occur they are attributable either to the violent disturbance of the functions of organs, or to the rapid disorganisation of structure not allowing time for elimination, or to the destruction of the vitality of the blood itself. The cessation of the action of poisons is often obviously attributable to the removal of the poison from the blood.

Our indications in the treatment of blood diseases are drawn from our knowledge of the laws of the animal economy in these respects, and of the causes which may have produced the disease. When they depend on, or are associated with an excess of blood, or of any of its constituents, or upon general excessive molecular activity and vitality of this fluid, measures have to be adopted by which the morbid excess may be corrected. A low diet, or abstinence, by withdrawing the nutritive pabulum, is not only a most powerful means by which the quantity of the blood may be diminished, but leads to a rapid modification of the proportions of its constituent parts. Dilution with aqueous fluid has an analogous effect, and also promotes the elimination of effete particles resulting from excessive hæmatosis. The abstraction of blood diminishes the pressure in the vessels and the force of the heart. All these measures rapidly lower the density of the blood remaining in the body by absorption from the tissues, impoverishing the fluid generally, and especially reducing the proportion of the red corpuscles, although the proportion of fibrin frequently remains unaffected. They are indicated where there is increased molecular activity and increase of fibrin, or excess of albumen, and increased viscidity of blood. In diseases depending on malnutrition and excess of any particular principle derived from the blood, as those which consist of fatty accumulations, everything which has a tendency to augment the principle in excess ought to be avoided; hence, in the instance mentioned, everything which augments the fatty matter, as rich food, hydrocarbonaceous potations, or leads to imperfect respiration and oxydation of the hydrocarbons, ought to be avoided.

One of the simplest principles of treatment is to *replenish* the vessels with blood when it has been wasted by accident or disease (See TRANSFUSION), or to restore any of its constituents that may be defective. For the latter purpose, direct injection of a saline fluid into the veins has been resorted to; which, although hitherto almost always unsuccessful, involves an operation the surgeon may be called on to perform. (See VEINS, INJECTION OF.) Hunger and thirst are the natural sensations by which in health, and sometimes in disease, or in some of its stages, the diminution or exhaustion of some of the constituents of the blood is manifested, and in surgical practice it is most essential to regard the requirements of the patient thus indicated. A proper system of diet for the maintenance of a sufficient quantity of perfectly well constituted blood, and to restore any of its elements or principles that may have become exhausted, is of the greatest importance, and sometimes the only necessary general treatment. The formation of red corpuscles is promoted by a full animal diet and exposure to air and light, and in the most marked degree, by the use of iron and of cod liver oil. The demand for aqueous, albuminous, saccharine, or oleaginous principles, has to be regarded in reference to the nutrition of the mucous, muscular, and nervous tissues, and the supply of fat, in anæmia, atrophy, debility, and other diseases. Any deficiency of the saline, earthy, or mineral constituents has to be restored, as chloride of sodium, earthy phosphates or sulphates and iron. Some of these are supplied more readily by animal, some by vegetable food, and others in solution in water, and other beverages. Thus, according to Liebig, wheat flour is deficient in lime, and a defect in the formation of bones, from want of this earth, may be remedied by the use of lime water, or leguminous plants; or a deficiency of phosphate of lime by milk, or of sulphur by eggs By the restoration of particular elements or compounds, we may excite molecular changes and the production of more complicated constituents, as where iron produces an increase of colouring matter and red corpuscles.

So also many medicines are employed as *restoratives*. Where we have reason to believe that the blood is alkaline, owing to a deficiency of acids, as in some fevers, we give acids; where an acidity of the secretions indicates a deficiency of alkalies; these remedies are administered, and if particular cases of scurvy can be shown to depend on a deficiency of the salts of potassa, as stated by Dr. Garrod, those salts would be administered for the cure of the disease. None of these restoratives, however, can prove efficient, unless the vital powers of the fluid are sustained; and where deficient oxygenation is concerned in an unhealthy and impoverished state of the blood, the excitement of the respiratory functions with an ample supply of pure air is indicated.

A very large proportion of the medicines employed in surgery are taken into the blood, and either act upon this fluid, or are conveyed by it to produce their effects on different parts of the economy. Being in the blood, they have "local access" to all the organs. These medicines, or their active principles, are dissolved either by the water, as most saline substances, or by the acid of the stomach, as the carbonates and oxides of metals, and other mineral substances soluble in acids, or by the alkalies of the bile and pancreatic juice, as oils and resins, and probably sulphur and iodine, or by the pepsic principle, as albuminous substances; and are absorbed, in most instances, with very little change. As respects many of these medicines, the blood acts as a vehicle by which they are conveyed to particular tissues and parts of the body, as the nerves, glands, or muscular fibres. Of these a large class are appropriately designated *eliminatives*. They pass out of the blood, through the glands, at the same time exciting the natural functions of these organs. They not only increase the secretion of a gland, but they tend to depurate the blood by the elimination of foreign materials. They are employed both for the purpose of promoting or recovering the functions of a gland, as when cathartics are given in constipation, or diuretics in suppression of urine; and to eliminate a poison or morbid material, and thus resolve a blood disease, as mercury in syphilis, colchicum in gout, and cathartics in some skin diseases. They are employed also to diminish excessive action of one gland by the increased action of another, as when diaphoretics are given to counteract congestion of the kidneys, or as antiphlogistics to drain away and diminish the quantity of the proper materials of the blood. This effect is somewhat analogous to blood-letting, as where cathartics are used in inflammatory disorders, and for the purpose of purging the blood.

There can be no doubt that certain substances taken into the blood destroy or neutralise foreign agents, or counteract morbid processes in this fluid. Neutral salts which act as solvents of fibrin cut of the body, have the power of diminishing the amount of this substance in the blood, and also of diminishing its viscidity and counteracting the tendency of the red corpuscles to aggregate; hence their utility in inflammations and febrile disorders. Some medicines are known as antidotes, alteratives, or *catalytics.* (*Headland.*) The diseases in which they are employed are blood diseases, and each medicine of this class has a specific action. Antisyphilitics, antiscorbutics, antiarthritics, and many other groups are of this nature. Mercury counteracts the morbid actions in the blood produced by the syphilitic poison, its effect is shown by a diminution of the proportion of fibrin and of corpuscles, and it also promotes absorption, prevents effusion, and acts on the secreting organs as a powerful eliminative. Iodine enters the blood, reappears in many of the secretions, and promotes absorption ; it counteracts the morbid process obtaining in scrofulous blood, but like mercury, if continued for a long time, is capable of producing a special disease of the blood. These diseases are frequently under the eye of the surgeon, and are known as mercurialism and iodism. (See HYDRARGYRUM, IODINIUM.) Arsenic also acts on the blood, and if given in excess produces a special blood disease. Hence, the employment of mercury, iodine, and arsenic, in syphilis, scrofula, and lepra, all blood diseases. The changes produced in so complicated a fluid by foreign agents are at present very little understood. Chemical affinities do not take place in the blood as they do in any known fluid in the laboratory, else mineral salts would be precipitated by alkalies, and nitrate of silver would be precipitated by the hydrochloric acid, whereas it is deposited as an oxide in the tissues. Many of these medicines are known to enter into new combinations in the blood. Thus sulphur combines with hydrogen and oxygen, and passes off as sulphuretted hydrogen and sulphuric acid. Nitro-hydrochloric acid and chlorate of potassa promote the oxydation of substances by virtue of chlorine, which, aided by the decomposition of water, is the most powerful oxydising agent known. Iodine is converted into iodide of potassium, benzoic acid into hippuric acid, turpentine into a volatile oil having the odour of violets. Many of these blood medicines act also as diuretics, and pass off by the kidneys either in the form in which they are introduced, or as new combinations.

When, in surgical practice, an effect is required to be produced on the brain or nervous system by opium and other narcotics, it must not be forgotten that such medicines are taken into the blood and may reappear in the secretions ; thus, an infant may be narcotised by the milk of the mother ; so also a powerful sedative effect may be produced by hydrocyanic acid acting by the blood throughout the nervous system, or anæsthesia by aconite, or depression of the force of the heart by digitalis. Some medicines, as this last, may accumulate in the blood, producing a very moderate action for a time and violent effects suddenly. By inhalation, again, the surgeon introduces chloroform into the blood, which, by its action on the brain and nerves, temporarily annihilates sensibility, and enables him to perform the most painful operations while the patient is unconscious. (See ANÆSTHESIA. *Also various articles on Materia Medica. Headland's Essay on the Action of Medicines*, 1855.)

Thus, we have illustrated the importance of blood diseases in practical surgery, and it will be sufficiently obvious, that even in maladies of local origin, produced by accident, or causes acting primarily on the nervous system, or in any way disturbing the functions or organisation of particular tissues, or vital parts, the surgeon who aspires to be successful in his treatment, or to improve the art, must not overlook the condition of the blood in any case. The question of the propriety of performing any particular surgical operation, as amputation after injury, may turn on the state of the blood. Should mortification depend on a poison, absorbed or generated, it would be useless to amputate until the poison is eliminated, and the cessation of the progress of the mortification is the best proof of the absence of the poison, and the recovery of the blood from its effects. Local disease, or disease of particular structures, will run a favourable or unfavourable course, and terminate successfully or unsuccessfully, according as the molecular and organic constitution and vital power of the blood is or is not sustained. As respects every remedy employed to excite or diminish, or to modify the action or condition of an organ or tissue, we must take into consideration its effect on the blood, whether the disease for which it is prescribed be a blood disease or not, and even where the blood is expected to act as a mere vehicle conveying the remedy to the part to be acted on, we must not overlook the probable or contingent effects of the remedy on the vital fluid itself. By neglect or error in the important indications derived from the blood, which present themselves in all diseases, we may convert a mild and benignant into a malignant and fatal affection, or we may aggravate or perpetuate a local disease, or induce acute inflammation or inflammatory fever, or typhoid fever, or erysipelas, or promote the absorption of purulent sanies and other blood poisons. We may produce those fatal results which it is our special object to avert. These remarks apply to a very large proportion of the diseases treated of in this Dictionary as *Abscesses*, *Amaurosis*, *Aneurisms*, *Burns*, *Cancer*, *Cataract*, *Contusions*, *Cutaneous Diseases*, *Diseases of the Bones*, *Joints*, *and Bursæ*, *Diseases of the Ear*, *Dislocations*, *Dropsy*, *Erysipelas*, *Fevers*, *Fistula*, *Fractures*, *Gangrene*, *Gonorrhœa*, *Gunshot Wounds*, *Hydrophobia*, *Inflammation*, *Ophthalmia*, *Tetanus*, *Tuberculosis*, *Tumours*, *Urinary Calculi*, *Venereal Disease*, *Wounds*, *&c. &c.* The special pathology of the blood is more particularly detailed under many of these heads, and especially under the more specific morbid conditions of the vital fluid referred to throughout this article.]

Henry Ancell.

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[BLOOD, PIGMENT GRANULES IN.]

[Not only do peculiarities of tint in the blood, or in the liquor sanguinis, correspond with various morbid states (see BLOOD, PATHOLOGY OF), but solid pigment has been observed in certain diseases. In ague, granules and flakes, exactly resembling those found in the blood of the dead body, have been seen in abundance in that obtained from the prick of a finger. (*Brit. and For. Rev. Oct.* 1854.) In various diseases they have been observed, in the state of black, or occasionally brown-yellow, brown, or very rarely red, granules or flakes. They are united together by a clear hyaline substance; and, in rare cases, pigment-cells occur. In all the cases investigated, they were found in the blood of the heart, and sometimes in other organs, as the liver, and especially the spleen. The capillaries appear to be sometimes choked by them; and especially they have been observed blocking up the cerebral capillaries—the finest in the body (*Kolliker*)—to the extent of giving a dark slate-grey aspect to the grey substance, and sometimes producing punctiform hemorrhages. They appeared to be sometimes outside the vessels, and between the cells; and have been observed also both within and external to the vessels of the cortical substance, and in the Malpighian capsules of the kidneys, in the lungs, and in the lymphatic glands.

This pathological condition has been observed in intermittent fever and diseases of the spleen, in patients who have died comatose or paralytic, sometimes with and sometimes without fever; in cases of albuminuria, in dropsy without kidney disease, and in cases where the patient died of some disease which appeared to be totally unconnected with the existence of such a substance. In many cases the patients have died suddenly with cerebral or typhoid symptoms.

Little notice has been taken of this condition of the blood by our own pathologists ; but the readers of this work will not fail to collate some of the above facts with those recorded by Dr. Kirkes and Mr. Paget relating to the passage of minute coagula into the capillaries. (See BLOOD, COAGULATION OF, DURING LIFE.)] *Henry Ancell.*

[BLOOD, SUPERALKALINE.] [An excess of basic material increases the natural alkalescence of the blood. This may arise from an insufficient supply, or a defective formation of, acid constituents; or it may be produced by the too rapid and complete oxydation of the acids, leaving the alkaline bases in excess. The blood may become alkaline also from the retention and oxidation of effete nitrogenous substances, which are converted into ammonia or its carbonate. Excessive alkalinity is inferred from an alkaline condition of the urine, the cutaneous excretions, and the pulmonary exhalations ; by the blood corpuscles often being crenate, or otherwise misshapen, deficient in colour, and irregularly agglomerated, and in several cases partially dissolved ; and by the blood being more fluid than usual. It may be produced by the use of alkalies. Dr. Bostock examined the serum of the blood of a young lady who had taken soda in excess for a considerable time, and found it much more alkaline than ordinary, from an unusual quantity of uncombined alkali. (*Med.-Chir. Trans.* vol. v.) In diseases attended with loss of appetite and abstinence from food, and when the body is exhausted by fatigue and abstinence, the alkalinity of the blood has a tendency to excess, owing to the acids being, for the production of animal heat, oxidised more rapidly than their bases are excreted. When the kidneys fail to secrete urea, this substance is converted, by oxidation, into carbonate of ammonia, and may thus render the blood alkaline.

It may also result from a decomposition of stagnant blood or of pus in putrid abscesses, or in the blood itself, or from the decomposition of urea contained in the bladder. A superalkaline state of the blood promotes the deposition of phosphates in the urine.

Superalkalescence of the blood may be a primary morbid state or a consequence of some disease. Dr. Huxham records the case of a gentleman who habituated himself to the use of carbonate of ammonia, so that he would at length eat it in a very remarkable manner. He brought on fever; profuse hemorrhage from the intestines, nose, and gums; every one of his teeth dropped out; he wasted; his muscles became as soft and flabby as those of a new-born infant; he broke out all over his body in irritable pustules; his urine was excessively high coloured, turbid, and very fœtid; and he died in the highest degree of marasmus, and tabid. Huxham compared the effects to those which result from the bite of a viper. When ammonia is developed in the blood more rapidly, as the effect of disease, the condition identifies itself with typhoid symptoms, or with the effects of ammonia taken in poisonous doses;—there is the dry, dark tongue, involuntary action of muscles, from subsultus to violent convulsions, aberration of the senses, or insensibility and coma, resulting in death; and after death the blood is found fluid, resembling the lees of port wine, strongly ammoniacal, feebly or not at all coagulable, and the corpuscles misshapen or partially dissolved.

A superalkaline condition of the blood must be regarded by the surgical practitioner as the exponent of more complex derangements (see Blood, Pathology of; Spanæmia; Uræmia; Hyperinosis); and it is important, in the treatment of wounds and surgical diseases generally, to keep a strict watch on the chemical reactions of the secretions and exhalations from the kidneys, skin, lungs, and other organs, and of the blood itself; since an excess of alkalinity may afford the earliest indication of a tendency to dissolution of the blood and the death of the patient. The best mode of counteracting this tendency has not been determined. Neutral salts composed of vegetable acids sometimes tend to increase it, being decomposed by the oxydation of the acid, and the carbonic acid formed thereby excreted by the lungs; the alkali or its carbonate, if it fail to pass off in the secretions, remains in the blood. Acids appear to be most clearly indicated, and were most relied on by the older practitioners. When absorbed into the blood, they enter into combination with alkalies, and tend at once to reduce the quantity of free basic matter in the system. The mineral acids are most powerful, and this is probably the modus operandi by which they produce beneficial effect in typhoid and putrid fevers.] *Henry Ancell.*

BOIL. (See Furunculus.)

BONES, EXCISION OF. This operation is sometimes applicable to the articular portions of bones, but still more frequently to other parts of them. The circumstances under which it is practised for the removal of diseased, or very severely injured joints, and the plans then to be adopted, will be hereafter considered. (See Joints, Excision of.) Neither shall I dwell at present upon the removal of the projecting ends of broken or dislocated bones; nor upon sawing off the extremities of old ununited fractures; subjects noticed in the account of *Dislocation* and *Fracture*. In the articles Amputation, Gunshot Wounds, and Joints, Excision of, I have called the reader's attention to the praiseworthy method of cutting down to, and removing, all loose splinters of the os brachii, and even the sharp end of that bone itself, from certain gunshot injuries of the shoulder, so as frequently to obviate the necessity for amputating the limb. The cases demanding the removal of portions of the skull, and the manner of accomplishing it, will be described under the head Trephine. Towards the conclusion of the observations upon Amputation, some account has already been given of the *excision of certain bones of the hand and foot*. It is difficult, as M. Malgaigne observes, to lay down any precise directions for the *excision of the bones of the tarsus*. The following plan was adopted by Moreau, the father, for an extensive caries:—Over the cuboid bone, there was one ulcer an inch in diameter; and another between the third and fourth metatarsal bones, resulting from an incision made a few days previously for the discharge of an abscess. A probe penetrated into the cuboid bone. An incision was made along the outer side of the foot, and extended across the ulcer, from the posterior third of the fifth metacarpal bone to above the anterior tuberosity of the os calcis; and, as the incision already made for the abscess could now be made serviceable, this and the other incision were conjoined by a transverse one, and the square flaps reflected. The diseased bones were thus brought into view, and it was necessary to remove the cuboid, the third cuneiform, the posterior end of the fourth metatarsal bone, the inner side of the extremity of the fifth, and the articular surface, by which the os calcis is united to the cuboid bone. The tendon of the peronæus longus was preserved. The flaps were then laid down, and united with two sutures. The patient, who was young, got completely well. The vacancies, occasioned by the extrication of the bones, were filled up by a substance which afterwards ossified. In the end, the patient was able to walk well; the foot having assumed its natural shape and motions. (See *Malgaigne*, *Man. de Méd. Opér.* p. 243.) The operation of removing the metacarpal bone of the thumb, or the metatarsal bone of the great toe, is not deemed by Mr. Liston an advisable proceeding; because the rest of the thumb or toe is left without support, and is useless. He has seen cases treated in this way; but the result was unsatisfactory. However, Monro removed *the whole of the first metatarsal bone* on account of caries, and M. Barbier did the same thing at the Val de Grâce after a dislocation of the bone; and, in each case, the result was in every respect successful. (See *Malgaigne*, op. cit. p. 243.) The *extraction of the metacarpal bone of the thumb* has been performed with success by M. Roux and M. Blandin. The thumb was at first shortened and useless; but gradually became capable of executing all its natural movements. (See *Malgaigne*, *Man. de Méd. Opér.* p. 232.) An incision is to be made along the radial edge of the bone, and to extend about half an inch beyond each of its articulations. Then the integuments and extensor tendon are to be detached from its dorsal, and afterwards the muscles from its palmar surface. While an assistant holds aside the lips of the wound, the surgeon opens the outer side of the carpal joint with the point of the knife, cuts through the tendon of the long abductor, which is inserted into the metacarpal bone, and then carries the knife completely through the joint. He now tries to dislocate the bone outwards, and to pass the knife along its inner side, so as to effect its total detachment from the muscles. Lastly, the articulation with the first phalanx is opened by cutting in succession the internal and external lateral, and the anterior, ligaments. The radial artery may be avoided; but, were it wounded, the application of a ligature to it would be attended with no difficulty. The wound is to be brought together, and the thumb supported in its natural position with soft pads placed in the palm. (See *Malgaigne*, op. cit.) *Excision of the anterior portion of the first metatarsal bone*, seems to M. Blandin advantageous, because, when the rest of it can be saved, the foot remains with a more solid support. A flap is formed at the inner side of the bone, with the base backward. The bone is exposed to the point where it is intended to divide it; sawn perpendicularly to its axis; then detached from its connections, from behind forwards; and finally disarticulated from the phalanx. With respect to the phalanges of the other four toes, amputation is commonly preferred to excision of them: and so it is to excision of the heads of their metatarsal bones. (*Malgaigne*, op. cit. p. 242.) Although, the *excision of the metacarpal bone of the index* and *little fingers* may easily be performed by cutting along the outer margin of it, M. Malgaigne is probably correct in stating, that such an operation, in consequence of the subsequent shortening of the finger, would leave after it as much deformity as amputation would produce, and even greater weakness of the hand. This observation is not applicable, however, to the *excision of the metacarpal bones of the middle and ring fingers*, which will still retain their connection with the contiguous ones, and the strength of the hand be preserved. An incision is made along the dorsal aspect of the bone, by the side of the extensor tendon, which should not on any account be divided, and the disarticulation is to be begun at the knuckle. (See *Malgaigne*, *Man. de Méd. Opér.* p. 233.) [It is desirable to avoid opening the carpo-metacarpal joints of the fingers as they generally communicate with other synovial surfaces. When, therefore, the entire disease can be removed by cutting through the metacarpal bone close to the joint, this latter operation should be preferred. The metacarpal bone having been completely exposed and the soft parts detached from it, the cutting pliers should be used to divide the bone; it should then be disarticulated at its phalangean extremity.]

The removal of dead, or softened and carious portions of the *carpal and tarsal bones*, Mr. Liston admits, is sometimes successful; but operative interference with these, or with more extensive and formidable articulations, is not advisable, unless the soft parts be not largely involved, and the general health tolerably good. If the ligaments, bursæ, and cellular tissue are much affected, Mr. Liston considers the chance of the discharge ceasing, and of the return of health, entirely hopeless. Amputation above the diseased parts will still be indispensable; and, in consequence of the more reduced and deranged state of the constitution, this second operation is less likely to answer than if it had been undertaken earlier. (See *Liston's Elem.* part iii. 398.) It is right to mention, however, that after necrosis of the first phalanx of the thumb, and the extraction of the fragments, M. Velpeau has known the part regain its motion. If an incision were necessary for the removal of this phalanx, it should be made along the radial side of the thumb, and the metacarpal articulation, which is the looser one, being opened first, the phalanx should then be luxated outwards, and dissected out. (See *Malgaigne*, *Man. de Méd. Opér.* p. 231.) In a few cases, Mr. Liston has removed several of the *tarsal and carpal bones;* as practised by Mr. Dunn of Scarborough (see AMPUTATION), in others, one, or a portion of one, with success. In one instance, the greater part of the *astragalus was taken away along with the ends of the tibia and fibula.* There remained a large opening across the joint, through which a seton was passed to promote the gradual and piecemeal discharge of the remaining portions of diseased bone. The articulation could be seen through. The seton was gradually diminished, and the aperture closed. The foot was preserved, and the leg was somewhat shortened; but the limb proved extremely useful, though the ankle retained little power of motion. Mr. Liston, as well as many other surgeons, has also trephined the *os calcis*, and *removed* large portions of it. He has likewise taken away the *cuboid bone*, *along with the bone of the metatarsal bone or bones*, in connection with it. In some of these cases an excellent cure followed; in others, amputation of the foot was afterwards necessary. (Vol. cit. p. 400.) Examples of the *removal of extensive portions* of the *os calcis* are reported by Hey, Moreau, and M. Roux. In University College Hospital, there was a young woman, in 1835, from the outer part of whose os calcis Mr. Liston removed a considerable piece with a trephine. The case was a scrofulous caries. Some amendment followed; but the caries penetrated too far to admit of complete removal in this manner. A fine specimen of the same thing was lately put into my hands by Mr. Morton, of University College, the part having been finally amputated in the Newcastle Hospital.

In one case, where the *scaphoid bone* of the carpus was dislocated by an injury, occasioned by machinery, Sir Astley Cooper successfully removed that bone. The rule proposed by him for any analogous case, is to take away one, or even two, of the carpal bones, if displaced; but, if the mischief is greater, to amputate.

Excision of the whole of the fibula with the exception of its head, was performed by M. Seutin. The particulars are contained in M. Malgaigne's Manual. Many arteries required ligature, and amongst them the posterior tibial. The external popliteal nerve was also divided. As the tibia was slightly affected, the cautery was applied to it. In two months the wound was healed, and, in four, the patient could bear nearly as well on this leg as on the other.

I am not disposed to bestow much commendation on such an operation as the *excision of the ribs*, notwithstanding the high and respectable authorities which may be quoted in sanction of it, with the exception of its performance in cases where a sequestrum is nearly or entirely loose. The most remarkable excision of the ribs yet recorded is that performed by M. Richerand in 1818, on a medical officer, who was afflicted with cancer of the thorax. The middle portion of four ribs was removed to the extent of several inches. It was also necessary to extirpate the contiguous part of the pleura, which was very much thickened, and transformed into a cancerous substance. Thus, the pulsations of the heart, within the pericardium, were brought completely into view. The case afterwards went on favourably for a time; but in the end proved fatal by a return of the cancerous disease. I scarcely need advise British surgeons not to attempt any similar operation, where the disease of a rib, or indeed, of any other bone, is the effect of a primary cancerous affection of the soft parts. Such an experiment must inevitably terminate in the return of the original malignant disease, unless the patient's accelerated death happen not to leave sufficient time for this result. These observations are directed chiefly, however, to the particular case here specified; for, as the excision of portions of ribs has been performed by several eminent surgeons with success, I conclude that circumstances may occur in which the plan is justifiable. Not to lay any stress upon the instances of the practice in ancient times by Galen, Aymar, Sediller, Lecat, Ferrand, &c., it has been twice resorted to subsequently to Richerand's operation, and with success, by Attadini in Italy; also in the Hospitals Beaujon and La Charité at Paris; and by Dr. Mott of New York. The operation consists in extending the incision through the soft parts beyond the extent of the diseased portion of the rib, both in front and behind, and then, after detaching the bone from the pleura at the point where it is intended to divide it first, it may be sawn through with one of Hey's saws, or, what will be more convenient, divided with a pair of cutting pliers. The divided end of the bone should then be inclined outwards, and separated from its connections, so as to facilitate the safe division of it beyond the opposite extremity of the disease. A principal thing in the operation is to avoid injury of the pleura as much as possible. [In 1836, Warren removed three inches of the seventh, and two inches of the sixth ribs with their cartilages, in a case of hard immovable tumor connected with these ribs, which had existed for four years. The patient did well. In 1837, he also removed successfully two inches of the ninth rib with a portion of its cartilage, for an osteosarcomatous tumor of considerable size originating from that rib, but attached also firmly to the seventh, eighth, and tenth, ribs. In both these cases the diaphragm was exposed. (*South's Translation of Chelius*, p. 1006, *c. note.*)]

In 1825, the *excision of the radius* was accomplished with complete success by Dr. R. Butt of Virginia; and in 1826, M. Velpeau had a case in which he was desirous of practising a similar operation, on account of disease entirely restricted to that bone; but the patient preferred amputation. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. i. p. 565.) An incision is made along the outer and anterior part of the radius. The edges of the wound are to be held apart, and the muscles detached from its anterior and posterior surfaces, a little below its middle part, where it is most superficial; a chain saw is to be used, a director is now being introduced at the ulnar side of the bone, will serve to convey the chain saw behind it. In the place specified the bone is sawn through, and the two fragments carefully dissected out. If sufficient room were not obtained for the action of the saw by the longitudinal incision, a transverse one should also be made. (*Velpeau*, ib.) A strong pair of cutting forceps would divide the radius with less difficulty than a chain saw.

[The *shaft of the ulna* may be removed in the same way, the external incision being made along the posterior angle of the bone, the soft parts detached, the bone divided near its centre, and each half disarticulated separately.]

In an example of *necrosis of the outer third of the clavicle*, M. Velpeau removed the scapular portion of it. Two incisions, in a crucial form, and four inches long, were made, the flaps raised, the acromio-clavicular ligaments and some parts of the origin of the deltoid and trapezius divided. The bone was then raised with a lever passed into the joint, and its detachment completed. M. Malgaigne conceives, that a better plan would be to make first an incision, parallel to the clavicle, but a few lines below it, and ending at the acromion, and then another shorter one at a right angle with this extremity of the first, so as to form a triangular flap. Instead of a chain saw, the clavicle may be very safely divided with one of Hey's saws, or a pair of cutting pliers, care being taken to pass a flexible copper spatula under the part.

The *sternal end of the clavicle* was removed many years ago by Mr. Davie, a surgeon of Bungay in Suffolk, on account of its being displaced backwards, and dangerously compressing the œsophagus; in consequence of the scapula being forced very much forwards by a deformity of the spine. (See Sir *Astley Cooper, On Dislocations.*) In this operation a piece of leather was placed under the bone to protect the subjacent parts from the saw. The interclavicular ligament was torn through, so as to free the sternal end. The patient was alive six years after the operation, and in good health.

The *whole clavicle* affected with osteo-sarcoma, was *removed* by Dr. Mott of New York. The tumor was of the size of two fists, and reached upwards nearly to the hyoid bone, and angle of the jaw. A semilunar incision, with its convexity downwards, was made below the swelling, from one end of the bone to the other. Another incision was next made above the tumor, from the acromion to the external margin of the internal jugular vein. The platysma and a portion of the trapezius having been divided, a director was passed under the bone, near the acromion, and a division here effected with a chain saw. Not being yet able, however, to displace the tumor, Dr. Mott, with the aid of a director, extended the first incision, inwards; and having applied two ligatures to the external jugular vein, and cut it through in the interspace, he next divided the clavicular portion of the sterno-mastoid muscle, and found it necessary also to tie and divide the internal jugular vein. The subclavian vein and thoracic duct were separated from the diseased parts with the handle of the scalpel. Lastly, the great pectoral muscle, the costo-clavicular ligament, and the subclavian muscle having been divided, the disarticulation of the sternal end of the clavicle was accomplished. The bleeding required forty ligatures for its suppression. In six weeks the wound was nearly healed, and the patient afterwards, with the aid of a mechanical substitute for the clavicle, retained the power of moving the limb, with but little impairment.

[Mr. Travers removed the entire clavicle in a boy ten years of age for a tumor involving nearly the whole bone. The boy recovered the full and free use of the arm. (*South's Translation of Chelius*, p. 1003.)]

The *excision of the scapula*, to a greater or lesers extent, has been performed on several occasions. In one instance a considerable portion of the scapula was removed by M. Janson, on account of a tumor involving it. Two semi-elliptical incisions were made, so as to circumscribe the swelling; as much skin as possible was dissected up and saved: the tumor and bone were then detached from their connections in every direction, as low down as the fossa subscapularis. The attachments of the trapezius, supra and infra spinatus, having been divided, and the portion of the bone above the spine ascertained to be sound, all the other diseased part was sawn off, and the shoulder joint left uninjured. One more incision was necessary to expose the whole of the tumor, and facilitate its excision. The wound was altogether six inches in breadth, and nine in length. The motion of the shoulder was preserved. A large tumor of the scapula was removed more than twenty years ago by Mr. Earle; but, as the disease returned, Mr. Skey removed it a second time, together with the greater part of the scapula. The disease however, being of a malignant character, again returned and proved fatal. Several cases of this description have been lately met with in the hospitals of this metropolis. One was in University College Hospital, under Mr. Liston. I heard of another in the Westminster Hospital.

[On the 1st of October, 1826, Mr. Syme removed the whole of the scapula for fungoid disease, implicating the entire bone. The following account of the operation is taken from the Medico-Chirurgical Transactions, vol. xl. p. 108, where the case is thus described by Mr. Syme. "The patient being fully under the influence of chloroform, and placed on her right side, I made an incision from the acromion process transversely to the posterior edge of the scapula, and another from the centre of this one directly downwards, below the lower margin of the tumor. The flaps thus formed being reflected without much hæmorrhage, I separated the scapular attachment of the deltoid, and divided the connections of the acromial extremity of the clavicle. Then wishing to command the subscapular artery, I divided it with the effect of giving issue to a fearful gush of blood, but fortunately caught the vessel and tied it without any delay. I next cut into the joint and round the glenoid cavity, hooked my finger under the coracoid process, so as to facilitate the division of its muscular and ligamentous attachments, and then pulling back the bone with all the force of my left hand, separated its remaining attachments with rapid sweeps of the knife. The vessels requiring ligature having been tied, the edges of the wound were stitched together and covered with dry lint, a bandage being lastly applied round the chest to give proper support, and keep the arm in its place."

"Everything went on favourably after the operation, and a great part of the wound healed by the irst intention. The discharge, which was at first ather copious and thin, in the course of a few days diminished to an amount so small, as to remove all apprehension of its exhausting the patient. At he end of a fortnight the discharge was reduced to little more than sufficient for staining the bandage, so that it seemed as if complete recovery would very soon be accomplished. But through an opening about an inch in length, where the edges of the transverse incision remained ununited, the head of the humerus could be seen still covered with its cartilage, which however, in the course of another week began to disappear, and to give place to granulations gradually extending from the neck over the convexity of the bone; while the cavity at the same time contracted until the humerus and clavicle came nearly in contact, and the shoulder, especially when viewed in front, assumed a wonderfully natural appearance. The patient, who from an early period after the operation had with difficulty been restrained from using the arm too freely, again and again declared that it was in no wise inferior to the sound one, and it appeared indeed that through the support afforded by the clavicular portion of the deltoid, together with the action of the pectoralis and latissimus dorsi, the limb would be able to execute a fair degree of motion."

"While the local state of matters was thus proceeding in the most favourable and satisfactory manner, it could not escape observation that the patient's strength did not improve in a corresponding degree. On the contrary, without any reason that could be discovered, except old age, she gradually became weaker and more emaciated, though still retaining appetite for food, and performing her bodily functions with so much appearance of health as still to encourage the hope of ultimate recovery. But towards the end of November, symptoms of sinking suddenly presented themselves, and terminated in death on the 1st of December."

Mr. Jones, of Jersey, has also recently removed the entire scapula and part of the clavicle in a case of caries combined with necrosis affecting both these bones. The patient was a young girl between 14 and 15 years of age. At the time of the operation the textures covering the shoulder were generally thickened and puffy, and tender to the touch. Several fistulous openings led to exposed bone at various points of the scapula and clavicle. The discharge of matter was profuse and offensive, and the girl's health and strength were rapidly failing. Under these circumstances, on the 19th of May, 1858, Mr. Jones proceeded to remove the diseased bones. "An incision was first made along the whole extent of the spine of the scapula, and carried an inch beyond towards the mesian line of the back; another incision was then made to meet this along the upper border of the bone down to its inferior angle. The integuments were raised by careful dissection and by this process the whole bone was fairly exposed." The acromial end of the clavicle being softened and altered by disease, an inch of the bone was removed. The posterior scapular was the only vessel which required a ligature. The head of the humerus was found healthy and covered by its natural cartilage. The wound healed entirely by granulation, and the patient made a good recovery. At the end of a month she could sew without pain or difficulty. Seven months after the operation she could raise her arm twelve inches from her side, and could support it horizontally from the body with very slight exertion. She could use the limb for all the ordinary purposes of daily occupation, the power of rotation, however, was lost. She could raise her hand to her mouth and to the opposite shoulder, but not to her head. There is no wasting of muscles on the chest and back, and when the patient is dressed very little deformity is perceived. The head of the humerus is easily felt moving freely in its new bed, and not the slightest pain is felt on any amount of motion. (See *Medical Times and Gazette, January* 1, 1859, p. 21.)]

[*Resection of the Scapula and Clavicle together.*] [These bones have been several times removed together for necrosis, and for malignant disease after the arm had been previously amputated at the shoulder-joint. Chelius has collected the following interesting and instructive cases in which this operation was performed.

"In 1818, a patient consulted Mussey of Cincinnati about a tumor connected with the thumb, for which the first metacarpal bone was removed. Several years later, pain attacked the humerus, which became greatly enlarged, and in 1831 the arm was amputated at the shoulder-joint. In 1836 the same disease appeared in the shoulder, and accordingly Mussey undertook the complete removal of the scapular and clavicle in September 1837. The tumor was round and prominent, measuring horizontally over the summit, from the anterior to the posterior margin of its base, fourteen inches, and vertically, from the upper to the lower margin of its base, ten inches. The integuments were dissected away from the clavicle, that bone disjointed from the sternum, its sternal extremity elevated and detached from the subclavius muscle, so as to admit the finger of an assistant being passed under it to secure the subclavian artery. The subsequent steps of the operation consisted in plain, *coarse*, and sometimes rapid dissection. Having tied the subclavian artery, Mussey divided the accompanying vein, when a bubble of air passed into the latter, which caused the patient instantly to swoon, and he was roused with much difficulty from this state of collapse. The immense wound, with flaps of seven or eight inches in extent, united by adhesion, and became consolidated and sound, *literally* without the formation of a *teaspoonful* of pus. In less than three weeks the patient was dismissed and he rode home in a stage-coach between thirty and forty miles, and remained sound and well in November."

"In 1841, Rigaud of Strasburg amputated a man's arm at the shoulder-joint, for disease of the *humerus*. The man recovered and remained well for eight months. A tumor was then found growing from the *scapula*, and Rigaud removed the whole of this bone, together with the outer extremity of the clavicle in 1842. In two months the parts were healed, and the man remained well in July, 1844."

"M'Clellan of Philadelphia removed the *scapula* and clavicle from a boy. The patient recovered after the operation, but died from a return of the malignant disease in another part. Gilbert of Philadelphia is also reported to have removed the *scapula* and clavicle."

In 1847 Mr. Fergusson removed the scapula and the sternal half of the clavicle for disease of those bones; the humerus and the glenoid cavity of the scapula had been previously removed for extensive caries. "Ten or twelve fistulous openings communicated from the surface with the carious bone, which seemed to be so extensively diseased that Fergusson considered it best to remove the whole bone. An incision was made beginning an inch and a half from the sternal end of the clavicle, along that bone to the *acromion;* room was thus made to apply a saw to the middle of the bone. An incision was next made, in the course of the spine of the *scapula* nearly to the base. The first cut was then exended down into the *axilla*. The posterior flaps were now partially dissected off the thickened mass covering the *scapula;* the anterior next raised, then the *m. pectoralis minor*, next the *m. trapezius* were cut through, and the bone being forcibly pulled outwards, was soon severed by the division of the other muscles and tissues. The anterior attachment of the *trapezius* had been in part divided when making way for the saw on the clavicle."

"Gaetani Bey, in the case of a boy fourteen years old, who had been severely wounded in the shoulder, by the discharge of an old piece of artillery, which exploded whilst remelting, amputated at the shoulder-joint, removed the whole blade-bone, which had been broken into several pieces, and cut off the acromial end of the collar-bone. In about two months the wounds were healed." (*Chelius, Translated by South*, p. 1004.)]

EXCISION OF THE SUPERIOR MAXILLARY BONE.

In the article ANTRUM, certain states of disease of this cavity are noticed, in which the only chance of cure depends upon the entire removal of the upper jaw-bone itself. I allude to osteo-sarcomatous, fibrous, and other tumors, which originate within the antrum, and by enlargement produce such an impairment of, and pressure upon, the surrounding organs and textures, as must ultimately prove fatal, unless a bold attempt be made to extirpate every part of the osseous texture, serving as a place of attachment to the swelling. Merely excising the alveoli, and front of the antrum, and then attacking the tumor with the knife, cautery, or caustic, generally fails. Baron Dupuytren was led to suspect that, by the excision of the upper jaw-bone, its total extirpation might be performed with a successful result. He was induced to form this opinion from the consideration of the examples on record, where the patients recovered after most severe mechanical injuries of the face, and necrosis, occasioning the destruction of the bone. Camper mentions a case, in which the whole of the bone came away, in consequence of necrosis, and the patient was cured. Acoluthus is stated, indeed, to have actually removed the upper jaw-bone for a tumor of the face, as long ago as 1693. Bidloo and Desault also anticipated Dupuytren in the belief, that the upper jaw-bone might be successfully extirpated, though they never undertook the operation themselves. The bulletins of the Faculty of Medicine at Paris prove that Dupuytren removed, at all events, the greater part of the bone, in 1824; but, as MM. Pillet and Gensoul contend, probably not the whole of it. M. Velpeau states that, in 1824, Mr. Rogers of New York removed both upper jaw-bones, as far back as the pterygoid processes, and this without making scarcely any incision through the lip. (See *Nouv. Elém.* t. i. p. 549.) In 1826, Mr. Lizars also advocated the removal of the whole of the upper jaw-bone, and he performed the operation with success, in 1827, 1828, and 1830. In May, 1827, M. Gensoul, surgeon to the Hôtel Dieu, at Lyons, removed every part of this bone, together with the whole of the palate bone, on account of a fibro-cartilaginous tumor, and the patient got completely well. (See *Velpeau, Nouv. Elém. Méd. Opér.* t. i. p. 247; *Jh. Gensoul, Lettre Chir. sur quelques Maladies Graves du Sinus Maxillaire, &c.* p. 18. 8vo. Paris, 1833.)

In this work, M. Gensoul states that, several years previously, he had known patients die of very tedious operations, undertaken for the removal of cancerous and other tumors of the antrum. Reflecting on the fate of these unfortunate individuals, he was led to conclude, that others, labouring under similar disease, might be cured by an operation, which consisted in freely denuding the antrum and upper jaw-bone, so as to be able to divide the sound parts, instead of meddling with the diseased ones, and of searching for the precise limits of the disease in the midst of blood and the remains of the affected textures. In short, he was induced to think, that the same principle should be acted upon in this operation as is followed in others, undertaken for the extirpation of cancerous tumors in general.

If the face of the skeleton be examined, it will be seen that the upper maxillary bone is fixed to the others only at three principal points: — 1. By means of its nasal process, and at its connections with the os unguis and ethmoid bone. 2. By means of the orbitar process of the malar bone, as far as the spheno-maxillary fissure. 3. By means of the connection of the upper jaw-bone to its fellow, and to the palate bone. There is, indeed, a point of contact behind with the pterygoid process and palate bone; but this readily gives way on depressing the upper jaw-bone towards the mouth. In attacking these different points, no large vessel is injured; the trunk of the internal maxillary artery generally escapes, and, if wounded, may be readily tied, as was exemplified in the removal of the whole of the superior maxillary bone, performed by Mr. Liston in University College Hospital, on the 27th Feb. 1836. If the hæmorrhage during the operation were to be greater than calculated upon, the carotid artery might be compressed against the transverse processes of the cervical vertebræ. As for nerves, the only one of consequence necessarily divided is the superior maxillary: but it may be easily cut through before the bone is displaced, and then the laceration of it avoided, if judged advisable. This proceeding is strongly advocated by M. Gensoul; but, in the operations which I have seen performed, no preliminary division of the trunk of this nerve was practised, yet no ill consequences were the result.

The patient should be seated in a chair, with his head inclined backwards, and supported on the breast of an assistant. One of the incisor teeth is to be extracted at the place where the division of the bone is to be effected below. An incision is now to be made from the inner canthus of the eye down to the upper lip, which is to be cut through opposite the canine tooth; and another incision may then be made from a point five or six lines to the outer side of the external angle of the eye, down to the termination of the first. This will leave the parotid duct safe below it. The flap is next to be raised up as far as the lower border of the orbit. This plan is more simple, and less disfiguring, than that of M. Gensoul, who, after the first incision has been made, makes a second from the level of the nostril to a point about four lines in front of the lobe of the ear; and then a third, extending from a point five or six lines behind the external angular process of the os frontis, down till it meets the termination of the second cut. The quadrilateral flap, thus formed, is then reflected on the forehead. M. Velpeau prefers an incision commencing at the commissure of the lips, and carried outwards, and then upwards towards the temporal fossa. This would not, however, expose the bone sufficiently for the section of its nasal process, for which purpose the perpendicular cut, from the inner canthus down to the upper lip, is very necessary. When the tumor is large, the circular sweep of the knife, as advised by M. Velpeau, and long ago practised by surgeons in this country, has advantages. The bone having been denuded, the next step is to divide the connection of the malar bone with the external angular process of the frontal, and immediately afterwards the zygomatic process of the malar bone. These excisions are best accomplished with Liston's cutting forceps, which should have long powerful handles. The next thing is to divide the nasal process of the superior maxillary bone, and the connection of the latter bone with the os unguis and os planum. For this purpose, one blade of the forceps is put within the orbit, the other within the nose, and the section accomplished. This having been effected, and a cut made under the lower part of the palate, the upper jaw-bone is divided with the same instrument, at the place where the incisor tooth was extracted, together with the palatine process and palate bone, at the symphysis. The bone being next pressed downwards, the slight connection with the pterygoid process, through the medium of the palate bone, gives way, when the upper jaw-bone, including the whole of the antrum and disease originating in it, is easily dissected out.

The flap is brought down, and the wounds united with the twisted suture, aided with narrow strips of adhesive plaster. Mr. Liston prefers, as less irritating, strips of oiled silk, smeared with a solution of isinglass in brandy. These strips he does not usually remove till the wound is healed. The straight steel needles which he employs for the twisted suture, and the eye ends of which are tipped with red sealing-wax, and the points cut off with pliers directly after their introduction, are removed within the first forty-eight hours, leaving the many twisted silk to come away as soon as it loosens.

The following is Mr. Liston's description of the operation: — To expose the bone, the cheek is divided from the angle of the mouth to the origin of the masseter; and a second incision made from the inner canthus to the edge of the upper lip, near the mesial line, detaching the ala of the nose from the maxillary bone. The flap of the cheek, thus formed, is dissected up, and the nasal process of the maxillary bone, and the body of the os malæ are divided with a saw, or with strong cutting pliers. An incision having been made through the covering of the hard palate, near the mesial line, a small convex-edged saw is applied to the bone, and the alveolar process is cut through with the pliers, after extraction of the middle and lateral incisors. The bone is then pulled downwards and forwards, and its remaining adhesions separated by means of the knife or pliers. During the progress of the operation, the cut branches of the facial and temporal arteries are commanded by ligature or pressure, and the violence of the hæmorrhage is moderated by pressure on the carotids. After removal of the bone, the deep vessels, branches of the internal maxillary, are secured either by ligature, or by firm pressure with charpie, or dossils of lint. The facial flap is replaced, brought together over the charpie by which the cavity is filled, and united by interrupted or convoluted suture. (See *Liston's Elem.* part ii. p. 160.)

In the examples of this operation which I have seen, any preliminary ligature of the common carotid artery would have been totally unnecessary. In one instance the internal maxillary was cut, but secured with the greatest facility. In a case, operated upon by Mr. Liston in University College Hospital, not a single ligature was necessary.

It is an important object to prevent, as much as possible, the blood from flowing towards the throat, in the early part of the operation: hence the advantage of the sitting posture, and of Gensoul's plan of beginning with the division of the cheek-bone, or zygoma, before the nasal process of the upper jaw-bone itself is attacked.

[In making the external incisions, the surgeon should be guided:—1. By the size, form, and connections of the diseased structures to be removed. 2. By the position of the parotid duct, which should be carefully avoided in order to guard against the occurrence of a salivary fistula. 3. By the course of the principal branches of the facial nerve, so as to prevent, as far as possible, the deformity arising from the paralysis of the muscles of the face consequent upon the division of the nerves. The cases for which this operation was originally proposed by Mr. Lizars, M. Gensoul, and by Dupuytren, viz. for malignant disease of the antrum, are not in the present day considered suitable for it. The all but certainty with which a recurrence of these malignant growths takes place soon after their removal, has induced surgeons to restrict this formidable operation to tumors of a non-malignant character, such as those of the *fibrous*, *chondromatous*, or *myeloid* kind.

Cases occasionally occur in which the removal of a portion only of the superior maxilla will be required. This may be effected either with or without an external incision depending upon the size and situation of the piece to be removed. When the disease is confined to the alveolar process, it may be found convenient to cut out a triangular piece of bone, with its apex above, and its base corresponding to the alveolar process. When the disease extends much beyond the alveolar border, it may be necessary to make two vertical divisions of the bone on either side of the disease, and to connect these by a horizontal one above it.]

See *Jh. Gensoul*, Lettre Chir. sur quelques Maladies Graves du sinus Maxillaire et de l'Os Maxillaire Inférieur, 8vo. Paris, 1833. *Liston*, in Elements of Surgery, part ii. 8vo. 1831; also in Trans. of Royal Med. Chir. Soc. vol. xx. *G. J. Guthrie*, in Lond. Med. Gaz. 1835, 1836. *A. L. M. Velpeau*, Nouv. Elém. de Méd. Opératoire. *O. Regnoli*, Sull' Estirpazione della Quasi Totalita dell' Osso Mascellare Superiore Sinistro per Osteo Sarcoma Memoria, 8vo. Pisa, 1832. *Professor Regnoli* makes only one external incision, which reaches from the external canthus to the commissure of the lips. Also Sull' Estirpazione d'un Osteo Sarcoma, &c. Pisa, 1831; and Mem. Intorno L'Asportazione di Gran. Parte dell' Osso Mascellare Superiore destro. This operation was performed in 1828. *J. F. Nivison*, Malignant Tumor successfully removed from left Antrum, in Ed. Med. Surg. Jour. No. 83. *Irving's* Obs. on the same, No. 84. *James Syme*, in Ed. Med. Surg. Journ. No. 100, p. 218, and No. 101, p. 238. Mr. *Lizars'* cases, I believe, are recorded in the London Med. Gaz. *Chelius*, System of Surgery, translated by South. London 1845. *Nélaton*, Elem. de Pathol. Chir. t. i. Paris, 1844.

[EXCISION OF BOTH SUPERIOR MAXILLARY BONES.]

[In the year 1824 Rogers of New York, and soon after Liston and Dupuytren, performed to a greater or less extent partial resections of both jaw-bones. The first total removal of these bones must, however, be ascribed to J. F. Heyfelder, who accomplished it in the year 1844 and repeated it twice in the years 1850 and 1852. (*Dublin Quarterly Journal of Medical Science for February*, 1857, p. 108.) His first patient laboured under what he termed pseudo-plasma, affecting both upper jaws, but which he afterwards designated as a medullary carcinoma. The patient recovered, but was attacked some months afterwards with a similar disease, situated in the frontal region, of which he died in Oct. 1855, fifteen months after the operation. Heyfelder's second and third cases were performed for open cancer implicating both upper jaws. One of these also died from a return of the disease twenty-three months from the time of the operation. The other was reported well a year after. The operation in Heyfelder's first case is thus described by his son Dr. Oscar Heyfelder (op. cit).

"The patient was seated in an arm chair; his head supported against the breast of an assistant, and fixed in this situation. The operator made two incisions from the outer angles of the eyes to the corners of the mouth, and pared all the softer parts away from the tumor to the inner angles of the eyes and the nasal bones. The flap thus formed being drawn upwards over the forehead, and the orbital margin being cleared down to the inferior ridge, he separated on both sides the juncture between the jaw and cheek-bone by means of a chain-saw introduced through the inferior orbital fissure. In the same way, the separation of this bone with the nasal bone was effected. Then the vomer and the other junctions still existing were divided by a bone-forceps, and the soft palate separated from the hind edge of the hard palate. After that, pressure with a chisel upon the upper part of the tumor sufficed to dislocate the upper jaw-bones out of the principal junctions, and so to finish the operation. It lasted three quarters of an hour, as three times fainting of the patient had necessitated rather long interruptions."

Dieffenbach, in 1848, performed this operation, in consequence of a large tumor of the face. He incised the soft parts in the median line, and removed the greater part of both upper jaw-bones, together with the palatine bones and a part of the cheek-bone.

Maisonneuve, in 1849, totally removed both ossa maxillaria superiora, following the same method as Dieffenbach as regards the cutaneous incision. The operation was for a case of cancer; the man operated on died a few days after.

Maisonneuve, in 1850, performed the same operation upon a girl who had long been employed in a phosphorus match manufactory.

Similar operations have been performed by Dietz and Jüngken; the latter separated both bones in their median line with the bone-forceps of Liston. Both operations had good success.

Langenbeck, in 1853, in a case of a medullary carcinoma, removed both upper jaw-bones, excepting only the orbital plate of the left one. The bones were separated by means of a metacarpal saw, a bone-forceps and a chisel.

The following are the methods hitherto adopted to expose the diseased parts where removal of both upper jaws is to be accomplished. (*Oscar Heyfelder*, op. cit.)

The median incision, followed by Dieffenbach and Maisonneuve, commences from the root of the nose, and ends in the middle of the upper lip. If necessary, a second incision, from the beginning of the first to the inner corners of both eyes, must be added. In this way we obtain two lateral flaps, which are pared closely from the bones, and held on either side with blunt hooks. By this proceeding the fewest vessels, nerves and muscles are cut, and the cicatrix produces but little deformity, although it affords room enough to perform the operation.

The posterior lateral incision or *cheek incision*, employed by J. F. Heyfelder in his three cases, begins on each side from the outer corners of the eyes, and finishes at the angles of the mouth; or, to avoid the ductus Stenonianus in the upper lip, some lines within the corner. By this incision, a large flap is obtained with the base above. This gives more room than any other of the simple methods, but it has the disadvantage of exposing the facial nerves, the principal vessels of the cheek, the ductus Stenonianus, and a great number of muscles to the knife.

The anterior lateral method would consist in two incisions beginning at the inner corner of the eye, and descending near the wing of the nose, to the upper lip. Hitherto it has not been practised upon the living, except on one side. But from my experiments on the dead body, it would appear to be well adapted for both sides. This and the former methods may be usefully combined on the different sides.

In the rare case that these simple proceedings would not suffice to denude excessively enlarged bones, the complicated method must be employed on one or both sides; it was practised by Malgaigne, Syme, Jaeger, Lisfranc, Blandin, Fergusson and others, for the resection of one upper jaw-bone.

Instead of the crucial and flap incisions, which always expose the soft parts a great deal, and produce much deformity, J. F. Heyfelder proposes for those cases where the simple methods do not suffice, the following proceeding:—"One incision slits the under lip in the middle and proceeds to the chin; from thence a second and third incision extend themselves on both sides along the under edge of the mandibule and the hind edge of the ramus ascendens. By this method the nerves and Steno's duct are preserved, and the cicatrix falls where it may be easily concealed—in men by a beard, in women by a handkerchief.

"The soft parts being cut through, they are pared from the bones, preserving, if possible, the periosteum on that side, and the flaps thus formed are held back by an assistant."

The separation of the bones are to be effected by the aid of saws and bone-knippers, in the same way as where one upper jaw-bone is to be removed. The central attachment of the superior maxillary bones to the nasal and frontal bones may be executed by one act, as recommended by Maisonneuve.

"Of nine cases that were thus operated on, four died; in one case the final result is unknown; in four it was successful. One of the patients seems to have succumbed to the operation, that is to say the first operated on by Maisonneuve; one died from an apoplectic seizure—that was the man operated on by Dieffenbach; two (No. 1 and 2 of those operated on by Heyfelder) succumbed to a relapse of cancer, but one not until fifteen the other twenty-three months after the operation."

J. F. Heyfelder, Klinischer Bericht von, 1853-44, in Walthers und Von Ammon's Journal, B. iv. Heft 4, 1844. Idem. Ueber die Resektion beider Oberkiefs, Stuttgart, 1850. Idem. Klinischer Bericht von, 1851-52. Deutsche Klinik, 1852. Idem. Amputationem und Resectionen. Breslau, 1854. *Reid*, Die Resektionen der Knochen, 1847. *Dieffenback*, Operative Chirurgie, 1848. *Maisonneuve*, Gaz. des Hôp. 1850, Nos. 97, 100, and 510. *Oscar Heyfelder*, Klinischer Bericht von, 1849-50, in der Prag. Vierteljahrschrift, Bd. xxi. Idem. Artikel Resectionen in Prosch Handworterbuch. Leipsic, 1854. *Malgaigne*, Revue Medico-Chir. tome xiii. *Jüngken*, Deutsche Klinik, 1850, p. 48. *Langenbeck*, Deutsche Klinik, 1853, p. 204.]

EXCISION OF THE INFERIOR MAXILLARY BONE.

The practicability of this operation was long ago evident enough from cases in which the greater part of the bone had been torn away by gun-shot injuries, or where it had exfoliated from necrosis. Boyer relates an instance in which it was torn away by machinery, and Wepfer quotes a case where it was amputated in his time. Mr. Anthony White, Surgeon to the Westminster Hospital, removed, at Cambridge, a considerable portion of the bone for an osteo-sarcoma many years ago. Unfortunately, the case was not published; so that the revival and execution of the operation are generally referred to Dupuytren, who, in 1812, performed his earliest excision of the body of the lower jaw-bone. The parts removed weighed a pound and a half; the bone was affected with exostosis, caries, and necrosis, softened in several places, and combined with a hard fibrous fungus. The patient recovered, and was in perfect health twenty-one years after the operation. (*Dupuytren, Clinique Chir.* t. iv. p. 628.)

Subsequently to the year 1812, the operation has been frequently repeated by Dupuytren, Dr. Mott, Richerand, Lallemand, Delpech, Roux, Cusack, Martin, Gerdy, Magendie, Cloquet, Wardrop, Lisfranc, Warren, Gensoul, Græfe, Walther, Wagner, Randolph, Liston, Lawrence, Ph. Crampton, Velpeau, &c. By M'Clellan, Walter, and Græfe, nearly the whole of the bone has been taken away. By many other operators, disarticulation has been performed at one of the condyles. (See *Cusack*, in *Dublin Hospital Reports* vol. iv. p. 13; *Liston's Elem.* part ii. &c.)

[Mr. South has taken great pains to fix the dates at which the several operations for removal of portions of the lower jaw have been performed. "Deadrick, of Rogerville, Tennessee," he writes, "was the first who, in 1810, cut away the side of the lower jaw; in 1812 Dupuytren sawed off a large portion of the front of the jaw; in 1816, Anthony White removed half a necrosed jaw from the socket; in 1818, Sir Astley Cooper sawed off the projecting part of the chin; in 1821, Græfe removed the front of the jaw, and in the same year, one half of the lower jaw, which he exarticulated, and the patient lived. Mott's first operation, in which half the jaw was removed, by sawing through the chin and across the ascending branch was performed in March, 1822; the second, in which he exarticulated one half, in May, 1822, died on the evening of the fourth day. Cusack removed the left half of the jaw in 1825, first sawing through the horizontal and afterwards the ascending branch, and then exarticulating the condyle." He also gives interesting details of these early operations, especially of that of Mr. Anthony White, mentioned above by Mr. Cooper. Mr. White's case was one of necrosis, and not of osteo sarcoma, as supposed by Mr. Cooper. (See *Translation of Chelius, by South,* p. 986.)]

The method of performing the operation varies according to the extent of the disease. To expose the tumor, and allow the bone to be readily divided, there must necessarily be a free division of the soft parts. Previously, also, to fixing upon the plan of operation, the extent of the disease must be correctly ascertained. (See *Liston's Elem.* part ii. p. 224.) When only *the central portion of the body of the bone* was to be *removed*, the following was Dupuytren's plan:—the patient is seated, and his head held steady against the breast of an assistant, who is to stand behind him, and, if necessary, make pressure on the facial arteries. The surgeon standing in front of the patient and on his right side, is to take hold of the right portion of the lower lip with his left hand, while an assistant takes hold of the left portion. In this way, the lip is rendered tense, and separated from the other. With a common scalpel, an incision is then made completely through it, from above downwards to the base of the jaw. The next thing is to extend the wound through the skin and cellular tissue from this point down to the prominence of the os hyoides. Thus, two lateral flaps are produced each of which is to be dissected from the bone, as far as the extent of the disease requires, with the knife kept close to the bone, so that the facial arteries may not be wounded. The exact places having been ascertained to which the saw is to be applied, a tooth on each side must be extracted. The operator then taking a fine metacarpal saw, or one of Hey's, goes behind the patient, in which position the saw can be employed without any risk of its extremity being pushed against the palate. If requisite, the nose and upper lip may be protected with a piece of pasteboard. But, according to my observations, the best plan is only to make a groove, or partial division of the bone with the saw, and then to complete the section on each side with the cutting pliers, which expedites the business very considerably, and with no risk of injury to the contiguous parts. The bone having been cut through on each side, the surgeon takes hold of the portion about to be removed, with his left hand, and while it is inclined forwards, he introduces a straight bistoury from below upwards, close behind it, and detaches it from the soft parts to the right and left, keeping the edge of the knife close to the bone. An assistant takes care to keep the tongue out of the way with a spatula, or the handle of a director. The vessels are now secured, the ends of the bone approximated to one another, and the flaps of skin united with sutures; care being taken to leave a small portion of the wound open below for the insertion of a bit of charpie, or lint, and as an outlet for the discharge, in the event of matter being formed.

When a perpendicular cut will not suffice, on account of the extent of the disease, it may be converted into a crucial wound, by making an incision along the base of the jaw. If the portion of bone to be taken away were so extensive as to require the excision of a part of the integuments, Dupuytren made two incisions, one in each side of the lip, which were extended down, so as to meet at the os hyoides, and form together one in shape of a V.

One danger attending the operation is the retroversion of the tongue into the pharynx, as soon as the attachments of the mylo hyoidei, genio hyoidei, and genio hyoglossi muscles behind the symphysis have been cut. In this state, the tongue presses the epiglottis towards the glottis, and the patient is in imminent peril of suffocation. Indeed, in one case, M. Lallemand would have lost his patient had he not instantly performed tracheotomy. Hence, Delpech, before he divided the muscular connections of the tongue, behind the symphysis, used to seize the extremity with a double tenaculum, which was then entrusted to an assistant; and afterwards, in applying the sutures, he passed the thread of one of them through the frænum of the tongue and the skin together: if the interrupted suture were employed, or, supposing the twisted suture to be preferred, the ends of the thread, passed through the frænum, were twisted round the pins. In one case, Delpech introduced a piece of gold wire through the apex of the tongue, and fastened it to the contiguous teeth. The wire soon cut its way out, leaving a sufficient adhesion. In a few instances, the circumstances of the disease may be such as to make it necessary to remove only a portion of the depth of the bone.

As the retroversion of the tongue, though not constant, is always a possible event, I concur with Malgaigne (*Man. de Méd. Opér.* p. 255) in the prudence of attending to the advice delivered on this subject by Delpech, or else of taking care not to cut through muscles inserted into the back of the symphysis until the possible displacement of the tongue has been guarded against.

[On this point Chelius remarks: "At the moment when the soft parts on the inside of the bone are cut through, the tongue often retracts suddenly, and there is danger of choking. It is unnecessary to draw the tongue forward and fix it: its retraction depends on the contraction of the m. sterno hyoideus, after the separation of the m. mylo hyoideus and genio hyoideus, if the head be drawn back; and, therefore, if the head be bowed towards the chest, the tongue resumes its proper place, and the choking ceases, as I noticed in a case in which I removed the fore part of the jaw, in front of the *masseteres,* on both sides."]

In the *excision of the whole of the horizontal portion of the lower jaw-bone*, one plan consists in making an incision along its base, and extending it a line or two beyond its angles. A large flap is then dissected up, and turned over the face. The bone is sawn on each side beyond the limits of the disease, and then detached from the soft parts which are connected with it behind, with the precautions and according to the directions above particularised.

If the disease were to extend high up on the rami, an incision should be made along the posterior edge of each ramus, so as to meet the extremities of the first wound.

Another method, specified by M. Malgaigne is easier than the foregoing. After the horizontal incision has been made, a perpendicular one is made completely through the lower lip, and carried down in the middle line till it meets the horizontal wound. Both the lateral flaps are then dissected from the bone.

In the *excision of one half of the horizontal portion,* several methods are adopted. In one, preferred by several British surgeons, and also by J. Cloquet, a horizontal incision is begun at the commissure of the lips, and terminates at the distance of one or two lines beyond the ramus of the jaw. To this first incision are added two vertical ones; one descending from the border of the lip to the base of the bone; the other, taking a parallel course, descends behind the ramus to a point a few lines below the angle. The flap is dissected from above downwards; the soft parts are next detached from the inner surface of the jaw; and, lastly, the bone is sawn through.

Mr. Liston has likewise expressed himself, as follows, in favour of one method, in which the flap is made from above downwards: — "The cheek may be divided (says he) by passing through it a long narrow bistoury, close to the anterior edge of the masseter muscle, and carrying the instrument forwards, and through at the angle of the mouth. From each extremity of this incision, another is made downwards; the anterior one inclining forwards, the other backwards. By reflection of the flap thus formed, the bone is exposed more easily, rapidly, and perfectly, than by the former mode of incision, in which the flap is made by a semilunar incision along the base of the jaw." (See *Liston's Elem.* part ii. p. 225)

In the plan adopted by Dr. Mott of New York, *two flaps are formed.* A curved incision is made, with its convexity downwards, from a point in front of the ear, and on a level with the condyle to the vicinity of the chin, below the commissure of the lips. The upper flap is raised and reflected on the face. A second incision, descending from the upper end of the first to the angle of the jaw, enables the surgeon to form a lower flap. The bone is sawn through, first in front, and then behind, as high up as the circumstances of the case require. If above a certain point, Dr. Mott recommends the inferior maxillary nerve to be cut through, before the bone is drawn outwards, and the lingual branch of the fifth pair to be carefully avoided.

A *third method*, which has the names of Cusack, Lisfranc, Liston, Malgaigne, &c., in its favour, consists in making, first, a vertical incision through the lip down to a point below the chin, and then a horizontal cut, extending from the first along the base of the jaw to two lines beyond its angle. The flap is then dissected off the tumor, in the direction from below upwards, and reflected on the face. The bone is then sawn through in front and behind, and the flap united with sutures. I am of opinion with M. Malgaigne, that this plan is more simple than the others; no lodgment of pus is likely to follow it; and the scar will produce but slight disfigurement. I recommend, however, the front portion of the bone to be divided before the posterior part of it, as facilitating the safe detachment of the mylo hyoideus and other parts connected with its inner surface.

One method, described by Mr. Liston, is a modification of the foregoing:—"If the tumor is included between the lateral incisor tooth and last molar, on the same side, these teeth must be extracted to permit division at these points. A semilunar incision may then be made along the base of the jaw, the horns of the incision pointing upwards, and passing over the spaces which were occupied by the extracted teeth. The flap is dissected up, and the membrane of the cheek divided along the line of the incision. The bistoury is then carried along the inside of the bone, so as to divide the membrane of the mouth, and separate the attachments of the muscles. The tongue is pushed aside, and a copper spatula placed under the jaw at the part to be divided, in order that the soft parts may not be injured during the sawing. A small narrow saw, or one commonly known by the name of Hey's, is applied to the bone at the points where the teeth were extracted; and, by a few motions of this instrument, a notch is made of no great depth; a pair of strong cutting pliers are placed in the track, and by them division of the bone is accomplished with equal neatness and much more rapidly than if the use of the saw had been continued. The pliers should be strong in every point, and the handles long, to afford the advantage of a powerful lever." The chain saw, he says, is not to be depended upon, and is slow in its operation. (See *Liston's Elem.* part ii. p. 224.)

A *fourth plan*, described by M. Malgaigne, may be applicable where the disease extends more in the direction backwards than forwards. In such a case, perhaps, it may be sufficient to make a semilunar incision along the posterior border of the ramus and the base of the bone, from the ear to the chin. Thus only one flap would be formed, and no cicatrix would be seen on the face.

M. Malgaigne lays it down as a maxim, that, in making the flaps in any of these operations, the skin and cutaneous muscles alone should be divided, and that the masseter should be cut through, and removed at the same height as the bone itself.

The facial artery is readily secured. All those operators who have had recourse to the ligature of the carotid artery, as a preliminary measure, have subjected their patients to a very needless proceeding.

Even in the *excision of one half the lower jawbone at its articulation* with the temporal bone, the ligature of the carotid artery is quite uncalled for. One plan of performing this operation consists in making an incision along the base of the jaw; a second incision is then made perpendicularly through the lower lip down to the first; and a third begins at the zygoma, and extends behind the ramus. The flap is raised, and the fore part of the bone sawn through. The soft parts are then detached from its inner surface, and the tendinous attachment of the temporal muscle to the coronoid process cut through from within outwards. Lastly, the disarticulation of the condyle is effected: for this purpose, the external lateral ligament should first be divided, while the bone is depressed and twisted, in order to render the capsular ligament tense. The latter part may either be cut through with scissors, as recommended by M. Malgaigne, and then the probe-pointed bistoury used, or it may be divided at once, together with the external pterygoid muscle, by means of the probe-pointed bistoury kept close to the highest part of the inner side of the condyle, so as to leave the internal maxillary artery safe at the inner side of the neck of the bone.

A great deal of the safety of this operation will depend upon the edge of the knife being kept close to the inner surface of the bone, so that the lingual branch of the fifth nerve may be left uninjured, and upon attention being paid to the directions given for the disarticulation, which, after the insertion of the temporal muscle has been divided, is greatly facilitated by depressing the anterior part of the bone forcibly, and twisting the condyle itself. The hæmorrhage will be chiefly from the facial, dental, and branches of the temporal and internal maxillary arteries.

In the horrible operation of extirpating the whole of the lower jaw-bone, the incision should extend from a point, a few lines in front of the lobe of one ear, down the posterior edge of the ramus, along the whole base, from one angle to the other, and then up to a point, a few lines in front of the lobe of the other ear. Care having been taken to prevent retroversion of the tongue, and the front portion of the flap raised, the soft parts behind the symphysis should be cut, and the bone sawn in this situation. Then the rest of the vast flap is to be raised on each side, and each half of the bone to be removed according to the foregoing directions.

For other observations connected with the excision of bones, see Amputation; Caries; Joints, Excision of; Necrosis; and Stumps.

On the subject of this operation, consult *Dupuytren*, Leçons Orales de Clinique Chir. t. iv. art. xv. 8vo. Paris, 1834. *W. Cusack*, in Dub. Hospital Reports, vol. iv. p. 1. *Ph. Crampton*, vol. cit. p. 537. *Jh. Gensoul*, Sur quelques Maladies Graves du Sinus Maxillaire, &c. 8vo. Paris, 1833. *Robert Liston*, Elements of Surgery, part ii. p. 223, 8vo. Lond. 1831. *J. F. Malgaigne*, Man. de Méd. Opér. 12mo. Paris, 1834. *A. L. M. Velpeau*, Nouv. Elém. de Méd. Opér. t. i. p. 537, 8vo. Paris, 1832. *G. Regnoli*, Intorno l'Amputazione di Quasi la Meta della Mascella Inferiore Brevi Cenni. 8vo. Pisa, 1834. *Id.* Dell' Amputazione di una Porzione di Mascella Inferiore per Epulide Cancerosa ed Osteo-Sarcoma, 8vo. Pesaro, 1826. *Chelins*, System of Surg., translated by South. London, 1845. *Nélaton*, Elem. de Pathol. Chir. t. i. Paris, 1844.

BONES, PATHOLOGY OF. As a living texture, that of the bones is subject to many of the diseases which affect other parts endued with vitality, and in which the functions of circulation, innervation, absorption, and nutrition are continually going on. Thus it is liable to atrophy, hypertrophy, inflammation, suppuration, a change resembling ulceration, and another like mortification of other parts. The nerves, it is said, have never been demonstrated in the osseous texture; yet, if it be the seat of pain, our judgment must infer the existence of what may not be discernible by the eye. M. Sanson very aptly compares the organisation of bone to something between that of an organic and that of an inorganic body, its vitality being necessarily obscure, and correspondent to its constituent elements. The organic actions seem indeed to be carried on in it, with greater difficulty, the more the earthy matter in it predominates over the animal part. Thus, in children, irritation, inflammation, and every action in the osseous texture are quicker, than in old persons; because the bones in early life contain a greater proportion of animal matter than at a later period, when the phosphate of lime is more abundant. However, even in children, and still more conspicuously in adults and old persons, the diseases of the bones are generally marked by a slowness of character which has attracted the notice of all pathologists. Many weeks are required for the completion of a provisional callus, and nearly a twelvemonth for that of a definitive one; while a few days, and often a few hours, will suffice for the union of the wound of the soft parts. In consequence also of the inferior, or inconsiderable connection of the bones with the nervous system, they frequently appear to inflame and undergo disease, without involving the rest of the system in any sympathetic disturbance, till the irritation is propagated to the surrounding parts, or suppuration comes on. As M. Sanson observes, a necessary consequence of these facts is, that therapeutic means, even those of the most energetic kind, frequently have but little power over affections of the osseous tissue; and, if they prove effectual, it is not till after a long perseverance with them. (See *Sanson*, in *Dict. de Méd et de Chir. Prat.* t. xii. p. 308.) See Antrum, Cancer, Caries, Exostosis, Fragilitas, Joints, Mollities, Necrosis, Osteo-Sarcoma, Osteitis, Periostitis, Rickets, Spina, Bifida, Stumps, Trephine, Venereal Disease, and Vertebræ.

The following works, relative to the pathology of bones, deserve notice: — *F. C. Spoendli*, De Sensibilitate Ossium Morbosa, 4to. Gott. 1814. *A. Murray*, De Sensibilitate Ossium Morbosa: (Ludw. Script. Neur. 4.) *O. Murray*, Diss. Acad. de Sensibilitate Ossium Morbosa. *Frank.* Del. Op. 12. *A. Bonn*, Tab. Ossium Morbosorum præcipue Thesauri Hoviani, fol. Amst. 1785—1788. *C. F. Clossius*, Ueber die Krankheiten der Knochen, 12mo. Tubing. 1799. *R. Nesbitt*, Human Osteogeny; two Lectures on the Nature of Ossification, 8vo. Lond. 1736. *Sandifort*, Museum Anatomicum, 2 vol. fol. Lugd. 1793. *Weidmann*, De Necrosi Ossium, fol. Francof. 1793. *Brodie*, On Diseases of Joints, 8vo. last ed. *J. Howship*, in Med. Chir. Trans. *Cruveilhier*, Anat. Pathol. fol. Paris, 1829—1835. *Dr. Cumin*, in Edin. Med. and Surgical Journ. No. 82. *J. B. Paletta*, Exercit. Pathol. 4to. Mediol. 1820-26. *B. Bell*, On Dis. of the Bones, 12mo. Edinb. 1827. *Dr. Carswell's* Illustrations of the Elem. Forms of Disease, fol. *Herbert Mayo*, Outlines of Human Pathology, ch. i. 8vo. Lond. 1835. *J. L. Sanson*, Art. Os. et Osteitis in Dict. de Méd. et de Chir. Prat. t. xii. Paris, 1834. And various other publications specified at the end of the article Necrosis. *Chelius*, System of Surg. translated by South. London, 1845. *Nélaton*, Elem. de Pathol. Chir. t. i. Paris, 1844.

BOUGIE is a smooth and generally a flexible instrument, which is introduced into the urethra for the cure of diseases of that passage (see Urethra); and so named from its bearing some resemblance to a wax taper, in French, bougie. However, the kinds of bougies are various, and some of them, employed in modern surgery, so far from having any similitude to a wax taper, are formed altogether of metal or catgut. They admit of being divided into those which are solid, and others, which are hollow, and more commonly named catheters. (See Catheter.)

The exact period when bougies were first used is a doubtful point. By Andrew Lacuna, a Spanish physician, the invention is ascribed to a Portuguese empiric: and, in 1551, the same author published what had been communicated to him upon this subject. In the year 1554, Amatus Lusitanus published a work, in which he refers to several witnesses to prove, that the empirical practitioner above alluded to had learned from him the use of bougies; while, on the other hand, he candidly owns that he himself was indebted to Aldereto, of Salamanca, for a knowledge of these instruments. In 1553, however, Alph. Ferri, of Naples, endeavoured to show that his acquaintance with the utility of bougies reached as far back as 1548, and of course that he had anticipated Lacuna, and perhaps even Aldereto. But, instead of representing himself as the original inventor of bougies, he mentions that they were known to Alexander of Tralles, which, if true, carries back the invention to the sixth century. A. Ferri, also, before describing bougies and escharotic ointments, mentions various means for examining the state of the urethra, and, amongst other things, cylinders made of flexible lead, and of different sizes. Escharotic ointments for what were termed *carnosities* of the urethra, and bougies, were also described by Petronius in 1565, and afterwards by A. Paré. The oldest bougies, which were wicks of cotton, or thread, covered with wax, and escharotic plasters, were in time succeeded by those composed of linen smeared with wax. This change was made with the view of letting them have a hollow construction; an improvement first noticed by Fabricius ab Aquapendente. (*Op. Chir.* 1617.)

In the middle of the 17th century, the manner of making and using bougies was well known to Scultetus, as appears from his *Armamentarium Chirurg. tab.* 13, *fig.* 9, 10.

Daran, and some of the older writers, attributed the efficacy of their bougies to the composition used in forming them. On the contrary, Mr. Sharp apprehended that it was chiefly owing to the pressure, which was made on the affected part; and Mr. Aikin adds, that, as bougies of very different compositions succeed equally well in curing the same diseases in the urethra, it is plain that with the exception of caustic bougies, they do not act from any peculiar qualities in their composition; but by means of some common property, probably their mechanical form.

Plenck recommended bougies of catgut, which may be easily introduced into an urethra, even when it is greatly contracted, their size being small, their substance firm, and dilatable by moisture. It is objected to catgut, however, that it sometimes expands beyond the stricture, and gives great pain on being withdrawn.

The invention of elastic gum bougies and catheters originated with Bernard, a silversmith at Paris, who, in the year 1779, presented some instruments of this kind to the Academy of Surgery, which period was prior to the date of the claim made by Professor Pickel of Wurzburg to the discovery. (See *Journ. de Méd. an.* 1785.)

[Bougies are made, according to Dr. Pickel as follows:—Take three parts of boiled linseed oil, one part of amber, and one part of oil of turpentine, melt and mix well together these ingredients, and apply them by layers thrice successively, on a cord or ribbon of silk; put the articles thus coated into an oven at a temperature of 149° Fahr., allow them to remain for twelve hours, giving them successively fifteen or sixteen additional coats, until they have acquired the requisite size. Polish them first with pumice, and give the finish with tripoli and olive oil. This procedure is that in use at Paris, with the exception of some slight modifications, the principal of which consists in dissolving in the oil about a twentieth part of its weight of caoutchouc, in order to impart solidity. For this purpose, the caoutchouc must be cut into small thin fragments, and gradually added to the hot oil; the silken tissue ought to be fine and loose, in order that the composition may penetrate readily. After the application of each layer, the substance must be dried in an oven, or, preferably, in the open air, before another is laid on. This procedure requires for completion at least two months, so as to furnish the highly elastic bougies.

The editor is informed by Messrs. Whicker and Blaise of St. James's Street that the best gum elastic bougies and catheters are now made in the following manner. A cylindrical tube is first woven with cotton or silk in a circular braid machine. This is coated carefully with a composition of gum copal and linseed oil, and is then dried in a heated closet. A second web is then made over the original one, and is coated with the same composition until of the required size and stiffness. Any inequalities of the surface are removed by friction with pumice stone, and it is polished with sweet oil until it attains a proper gloss. The very small bougies and catheters, and also those which possess greater flexibility, are made with a single tube only. Both bougies and catheters, therefore, are tubular, and are similarly constructed, the only difference being that in the bougie the canal is closed, while in the catheter it is left open at one end, and has an aperture cut near the other, to permit fluids to flow through it.

Gutta percha has also been employed in the manufacture of bougies and catheters; but several examples having been recorded in which they have broken, and portions have been left in the urethra or bladder, its use has been very properly abandoned.

To make the wax bougies, a piece of tape or narrow strip of linen is coated with wax, and is then rolled into a circular form.]

Elastic gum bougies sometimes cannot be introduced, when a wax bougie can; and from the trials which I have made of them, I conceive that it arises from their elasticity and continual tendency to become straight, when they reach the perineum, so that the point presses on the lower surface of the urethra. Hence, when the obstruction is on that side, it must be difficult to get the end of the bougie over it.

Mr. Smyth discovered a metallic composition, of which he formed bougies. These bougies are flexible, have a highly polished surface, of a silver hue, and possess a sufficient degree of firmness for any force necessary for the cure of strictures of the urethra. The advocates for the metallic bougies assert, that such instruments excel any other bougies which have yet been invented, and are capable of succeeding in all cases, in which the use of a bougie is proper. The greatest objection which has been urged against them is, that they are attended with a risk of breaking. I have heard of an eminent surgeon being called upon to cut into the bladder, in consequence of a metallic bougie having broken, and a piece of it passing into that organ, where it became a cause of the severe symptoms which are commonly the effect of a stone in the bladder. For the particulars of an interesting case, in which a metallic bougie broke in the urethra, the reader may consult *London Med. Repository*, vol. ix. No. 51. The manufacture of metallic bougies, however, is now brought to such perfection, that we rarely hear of their breaking; but it is most prudent not to be too bold with those of small diameter. [They are composed of a mixture of lead and tin. By using these metals in the proportion of five parts of the former to three of the latter, a moderate degree of flexibility is produced.]

The bougie with its application, said Mr. Hunter, is perhaps one of the greatest improvements in surgery which these last thirty or forty years have produced. "When I compare the practice of the present day, with what it was in the year 1750, I can scarcely be persuaded that I am treating the same disease. I remember, when, about that time, I was attending the first hospitals in the city, the common bougies were either a piece of lead, or a small wax candle; and, although the present bougie was known then, the due preference was not given to it, nor its particular merit understood, as we may see from the publications of that time."

Of armed bougies, as well as of some other kinds, and of the manner of using bougies in general, I shall speak in the article URETHRA, STRICTURES OF.

See *J. Hunter*, on the Venereal Disease, p. 116. *Sharp*'s Critical Inquiry, chap. iv. *Aikin* on the External Use of Lead. *Daran*, Obs. Chir. sur les Maladies de l'Urètre, 12mo. Paris, 1748 and 1768. *Olivier*, Lettre dans laquelle on Démontre les Avantages que l'on peut retirer de l'Usage des Bougies Creuses, &c. 8vo. Paris, 1750. *Desault*, Journ. de Chir. t. ii. p. 375, and t. iii. p. 123, 1792. *Smyth's* Brief Essay on Flexible Metallic Bougies, 8vo. Lond. 1804. Dict. des Sciences Médicales, t. iii. p. 265, &c. 8vo. Paris, 1812.

BRAIN. (For concussion, compression of, &c. see HEAD, INJURIES OF. For hernia of, see HERNIA CEREBRI.)

BREAST. (See CANCER; MAMMARY ABSCESS; MAMMA, DISEASES AND REMOVAL OF; and NIPPLE.)

BRONCHOCELE (from βρόγχος, the windpipe, and κήλη, a tumor). An enlargement of the thyroid gland forming a tumor in front of the neck. (See THYROID GLAND.)

BRONCHOTOMY (from βρόγχος, the windpipe, and τέμνω, to cut). An operation by which an opening is made into the trachea or larynx, either for the purpose of making a passage for the air into and out of the lungs, when any disease prevents the patient from breathing through the mouth and nostrils, or of extracting foreign bodies, which have accidentally fallen into the trachea: or, lastly, in order to be able to inflate the lungs in cases of suspended animation. If the incision is made in the trachea, the operation is termed *tracheotomy;* if in the larynx, *laryngotomy.* (See LARYNGOTOMY and TRACHEOTOMY.)

BUBO (βουβὼν, the groin). A swelling of the lymphatic glands, particularly of those in the groin, from acute or chronic inflammation, with or without suppuration. The term is also occasionally applied to a similar swelling of the absorbent glands in other parts, especially the axilla.

The disease may arise from the mere irritation of a local disorder, from the absorption of some poisonous matter, such as the venereal virus, or from constitutional causes.

Of the first kind of bubo, that which is named the *sympathetic* is an instance. Of the second, the venereal bubo is a remarkable specimen. (See VENEREAL DISEASE.)

The *pestilential bubo*, which is a symptom of the plague, and *scrofulous* swellings of the inguinal and axillary glands, may be regarded as examples of buboes from constitutional causes. (See SCROFULA.)

The inguinal glands often become affected with simple phlegmonous inflammation, in consequence of irritation in parts, from which the absorbent vessels, passing to such glands, proceed. These swellings ought to be carefully discriminated from others which arise from the absorption of venereal matter. The first cases are simple inflammations, and only demand the application of leeches, cold evaporating lotions, and the exhibition of a few saline purges; but the latter render the administration of mercury, or other remedies for syphilis, advisable.

Sympathetic is the epithet usually given to inflammation of glands from mere irritation; and we shall adopt it without entering into the question of its propriety. The sympathetic bubo is not unfrequently occasioned by the irritation of a virulent gonorrhœa. [In such cases the tumor less frequently suppurates, and is altogether a less severe affection than a bubo arising from the absorption of a specific poison like the venereal. Sympathetic buboes are also less tedious than those resulting from constitutional causes, such as scrofula. (See SCROFULA.)]

BUBONOCELE (from βουβὼν, the groin, and κήλη, a tumor). A species of oblique inguinal hernia, in which the protruded bowel is situated in the inguinal canal, entering the canal by the internal abdominal ring, but not descending sufficiently far to escape from the canal by its external aperture, the external abdominal ring. (See HERNIA.)

BUNYON. An inflammation of the bursa mucosa, at the inside of the ball of the great toe. (See *Brodie's Pathological and Surgical Obs. on the Joints*, p. 320, ed. 3.) The adjacent parts become thickened and indurated; the bones of the joint enlarge, and in process of time suffer a sort of subluxation; the bursa being thus projected more and more against the shoe, is kept in a state of continual excitement. Dropsical effusion, thickening of the membrane, and suppuration, with obstinate sinuses, may ensue. (See *Syme's Princ. of Surgery*, p. 347.) It is therefore proper to employ, in the early stage of the inflammation, leeches, poultices, and fomentations, or cold applications, and in particular to remove pressure from the swollen part, the foot being kept perfectly quiet, and not in a depending position. I suspect that the subluxation, or projection of the bones inwards at the joint above spoken of, is frequently antecedent to the bunyon, and a principal cause of the disease. I had a patient in the North London Hospital with an enormous bunyon, and in whom the original conformation of the toe of each foot corresponded to this statement. In fact, he suffered from bunyons in both feet, in consequence of the pressure acting with great effect on the angular projection at the inner side of each of the great toes. I have no doubt, however, that the inflammation and its effects may lead to disease and further displacement of the joint; and perhaps this had happened in the case to which I am referring.

[The angular projection alluded to by Mr. Cooper as the cause of bunyons is situated at the junction of the metatarsal bone with the first phalanx of the great toe. The deformity appears to be occasioned by the gradual yielding of the theca belonging to the tendon of the extensor longus pollicis, which ought to bind it to the central line of the bones. The yielding of the theca takes place principally opposite the junction of the metatarsal bone and the first phalanx of the great toe, consequently the tendon is permitted to pass in a straight line to the extreme phalanx. The result is that the extremities of the bones entering into the formation of the metatarso-phalangeal joint are made to form a considerable projection inwards. Pressure and friction on this prominence is sooner or later followed by the formation of a bursa, which is subjected to continual attacks of inflammation from increased exertion, and becomes the source of extreme suffering and annoyance to the patient. In addition to the ordinary treatment, I have found advantage derived from having the inner edge of the sole of the shoe made thicker than the outer, by which contrivance the weight of the body is thrown more on the outer edge of the foot. When the bunyon has frequently suppurated I have succeeded in obliterating the diseased bursa composing it by making a free crucial incision into it and dressing it in with lint. The inner surface of the bursa is thus made to granulate, and a cure of the bunyon is effected. The angular prominence remaining, however, in the course of time another bursa will be formed, will inflame and constitute another bunyon. The displacement of the tendon of the extensor longus pollicis being the cause of the projection at the metatarso-phalangeal joint, upon which the bunyon is subsequently formed, renders it possible and even probable that the division of this tendon might be attended with advantage.]

BURNS. [In considering the injurious effects of heat upon the human body, it is quite unnecessary to make any distinction between BURNS and SCALDS. There is no difference in the effect produced upon any part of the body if anything heated to 212° Fah., for instance, be applied in a solid or a fluid form. The only difference is in the nature of the heated matter applied, the degree to which it has been heated, the duration of its application, and the sensibility of the burnt parts. Of course, a solid or ignited body is capable of retaining a much higher degree of heat than a fluid, so that a BURN with a red-hot iron is more likely to produce extensive injury than a SCALD with hot water or oil. But the effects which follow the application of heat in any form are not regulated by the medium through which it is conveyed. It will be well, therefore, in the present article, to set aside the distinction between BURNS and SCALDS, and to include under the general term BURNS all injuries which are the effect of heat, however applied, from simple redness of the skin to the most complete destruction of the solid tissues of the body.]

Moderate, but long-continued, radiating heat thickens the cuticle, hardens the skin, blunts its sensibility, and renders it more or less brown. These effects are exemplified in persons habitually exposed to the burning rays of the sun, or whose usual occupations are before vast fires. Thus, as Dupuytren observes, smiths are able to grasp with their rough horny hands pieces of iron of a very high temperature, and even to touch them for a few seconds with impunity.

A higher degree of radiating heat produces marbled discolorations in the skin, and cracks in the cuticle, frequently leading to troublesome ulcerations. Such effects are common on the skins of old persons, who are constantly sitting close to the fire. In a still greater intensity, radiating heat will blister the surface of the body, or cause the formation of vesicles. In hot climates, exposure to the solar rays during sleep is alleged sometimes to have excited inflammation, followed by gangrene, and death on the fourth or fifth day. (See *Dupuytren*, *Clin. Chir.* t. i. p. 419.) Cæteris paribus, a burn is less deep when it takes place on parts habitually exposed to the air, than when it occurs on parts always covered with clothes, and whose cuticle is very thin. (Ib. p. 420—422.)

[Burns have been classified by various authors into several kinds or degrees. The following is the classification of Dupuytren] : — 1. Erythema, or superficial phlogosis of the skin, without vesicles. 2. Inflammation of the skin, with detachment of the cuticle, and the formation of vesicles filled with serosity. 3. Destruction of a part of the corpus papillare, and rete mucosum. 4. Disorganisation of the cutis completely down to the subcutaneous cellular tissue. 5. Conversion of all the superficial textures and the muscles into eschars to within a variable distance from the bones. 6. Carbonisation of the whole thickness of the burnt part.

[The most convenient and practical arrangement of BURNS, however, is to divide them into three classes: — 1. Those which produce mere redness or inflammation of the skin. 2. Those which produce vesication. And 3. Those which completely disorganise and destroy more or less of the integument and more deeply seated structures.

It must be borne in mind that very different effects are produced upon the human body by the same degree of heat and by the same apparent amount of injury under varying circumstances of general health and bodily vigour. A strong country servant girl may be extensively burned, and suffer comparatively little to her delicate mistress just recovering from a confinement, but whose burn has been much less extensive or severe. The one may escape with a few scattered vesications, while the integuments of the other may be completely destroyed. This can only be explained by referring to the phenomenon observed when any part of the body is deprived of its supply of nervous power by operation or injury. Thus, in a case where Mr. Earle removed a large portion of the ulnar nerve in a young woman, for the cure of neuralgia, the parts supplied by that nerve — the little finger and one side of the ring finger — for a long time after the operation were incapable of resisting changes of temperature which did not in the least degree affect the rest of the hand. "Thus, moderately hot water produced frequent vesications, and exposure to cold air induced sloughing of the extremity of the finger, and loss of the nail. In another instance, where the axillary plexus of nerves was crushed by a comminuted fracture of the clavicle, leaving the whole arm in a comminuted state, the same phenomena presented themselves. The patient, on one occasion, immersed his arm in warm grains for some time, and, on removing it, the whole hand and forearm were covered with vesications." (*Med. Chir. Transactions*, vol. vii. p. 173.) So a burn which would produce only temporary inconvenience in a strong adult, may easily lead to death in old people or young children.

Besides the age and general condition of a patient, the extent and situation of the burn must be considered. A superficial burn, if very extensive, is more dangerous than a deep one of limited extent. A hand or foot may be completely burnt off with less constitutional disturbance than follows extensive erythema or vesication over a great part of the body.

The effects of a local burn upon the general system will be better understood after an account of the appearances found on examining the bodies of those who have been killed either by the primary or secondary effects of a burn.]

According to Dupuytren, there are then four different periods or stages, in which the patient's life may be successively endangered in cases of severe burns: —

1. The stage of irritation, or, as I should say, the period of the first shock on the system.
2. The stage of inflammation.
3. The stage of suppuration.
4. The stage of exhaustion, or hectic. (See *Clin. Chir.* t. i. p. 438, 439.)

The *post mortem* examinations of burnt patients, instituted by Dupuytren, tend to prove that, when the sufferer perishes in the flames, or a few instants after having been extricated from them, traces of excessive congestion are observable in the digestive tube, although there has not been sufficient time for inflammation to commence. Not only does the mucous membrane exhibit bright red patches of greater or less size, not only is it gorged with blood, but the cavity of the intestines contains a certain quantity of this fluid, which has passed into it by exhalation. The brain is largely injected with blood, and the serosity in its ventricles of a reddish tint, which is likewise frequently noticed in the serous fluid of the pericardium, pleura, and peritoneum. The mucous secretion of the bronchi is also bloody, and their investing membrane, at various points, of a bright red colour, and streaked with highly injected capillary vessels. It seems, in such cases, as if the blood, suddenly driven from the skin, made an effort to escape through all the pores of internal surfaces. (*Clin. Chir.* t. i. p. 440.) A boy, about fifteen years old, died in the North London Hospital in the winter of 1835-36, a few hours after the receipt of an extensive and deep burn. I took the opportunity of having the body carefully examined, in the expectation of finding the congestions of the mucous surfaces, and the bloody serosity in the ventricles of the brain, the chest, &c. specified by Dupuytren; but these effects were much less conspicuous than the observations of this distinguished surgeon led me and others to anticipate.

According to Dupuytren, when patients die between the third and eighth days after the accident, or in the second stage, in consequence of the violence of the inflammatory action, all the signs of gastro-enteritis will be found strongly marked, and ordinarily accompanied by inflammatory affections of the brain and lungs.

Lastly, if the patient has not sunk till a later period, or the stage of suppuration and exhaustion, the viscera, especially the intestines, are found much altered by the previous long-existing inflammation; the mucous coat is studded with patches of redness and ulceration, and the mesenteric glands are generally enlarged. (Also *Andral*, *Anat. Pathol.* t. ii. p. 223.)

In a child, three years old, who died in November, 1836, under my care in the North London Hospital, about a month after her admission with several extensive burns of the fourth and fifth degrees, the *post mortem* examination revealed inflammation of the mucous membrane of the bowels in various places, and deposits of pus in the lungs.

[More recently Mr. Curling has shown how frequently ulceration of the duodenum follows severe burns in young persons, and terminates fatally by perforating the gut, and thus producing peritonitis.

Knowing all this, it is easy to comprehend and explain the severe constitutional symptoms which follow extensive burns. The system receives a great shock, and the powers of the vascular and nervous systems are depressed. There are four periods of danger:—1, that of collapse; 2, that of reaction; 3, that of sympathetic fever and congestion; 4, that of exhaustive fever and suppuration.

1. In the period of collapse the pulse is feeble, the extremities cold, and there is frequent shivering. But little pain may be felt at first, and if there be *no* pain, there can hardly be a worse sign. Want of pain after any severe injury is always an ill omen. The patient is seen in a sort of apathetic stupor. He wants simply to be left undisturbed. His nervous susceptibility is sunk so low that pain cannot be perceived. If this insensibility be accompanied by shivering, failing pulse, and duskiness of the lips, the great probability is that the patient dies comatose without even rallying.

2. In a case rather less severe than the above, the first shock is followed by a sort of irregular reaction. There remains the state of general prostration; but it is accompanied by a certain amount of excitement, quickened breathing, a jerking pulse, and delirium.

3. In a more favourable case, or one in which the state of collapse and reaction have been passed over safely, there is a period of sympathetic fever during which the patient is in peril from the congestive affections of the great cavities just described.

4. If all this be overcome there is the period of suppuration to dread, during which the patient may die of pyæmia, or from the exhausting effects of the profuse discharge.

With these general ideas of what is to be expected in cases of burns, no detailed account of the constitutional symptoms observed in the different varieties of burns can be needed by any one acquainted with the ordinary constitutional effects of local injuries.

THE LOCAL AND CONSTITUTIONAL TREATMENT OF BURNS

should be considered as applicable to each of the three classes of these injuries.

Local Treatment.

I. In a burn of the first class. There is simple redness of the skin. It is hotter than natural. There is very considerable pain, and more or less swelling, but no vesication. The practical question so long debated in such a case as this is, should we try to diminish and keep down the inflammation by the application of cold, or should we use stimulating applications? The representatives of the two systems, the antiphlogistic, and the stimulating, have indulged in much warm controversy. In this, as in most other controversies, there is some truth on both sides. One plan need not be adopted to the entire exclusion of the other. Some cases are best treated in one way; others in the opposite; and it may appear that a middle course, avoiding each extreme, is safer than either.

The use of *cold* has one great advantage: it may generally be adopted without delay. The bane and the antidote are close at hand. Many a cook, who has scalded her arms or legs with hot water, has at once found relief in a stream of cold water from the pump; and the popular remedies of cold scraped potatoe, cold soapsuds, brown paper steeped in cold vinegar and water, or cold spirit and water, are daily used with excellent effect. So are the more orthodox cold applications of the surgeon, lead lotion, linseed oil and lime water, iced water, or a lotion of spirit, acetic acid and water. But the use of any of these cold applications must be restricted to cases, first, where the skin is not broken; and second, to those where the chest or trunk are not affected. In the latter case there would be danger of setting up pleuritis or peritonitis. The cases where it may be adopted are those of burns on the extremities when the skin is unbroken, and very little if any vesication has taken place. In these cases some matters of detail must be attended to. Any clothes over the injured part must be removed with great care, if they are removed at all. Carelessness may lead to tearing away of large portions of cuticle, and exposure of the cutis. If a limb be covered by a stocking or sleeve, it is often advisable to immerse it, still covered, in cold water, and afterwards keep the heat down by careful sponging. If the part does not happen to be covered, it should be covered with old linen or lint, and this kept constantly wet with cold water, iced in summer time, if ice can be procured. Care must be used not to remove the rags from the burnt surface. The application of cold must be continued steadily as long as heat and pain return. Very probably any inflammation set up terminates in resolution under this treatment, or vesication may take place.

In cases of vesication of superficial burns of the chest or trunk, when the application of cold is contra-indicated, two principles are to be borne in mind; first, that reaction appears to be controlled by *gradually* bringing down a burnt part to its normal temperature; and secondly, that air must be excluded from the inflamed skin.

II. When vesication has taken place — simple vesication without abrasion of the cuticle — the same principle of excluding the air must be acted on. It is not a matter of great importance whether the skin be covered with cotton wool; or dredged with flour, or chalk, or any harmless powder; or covered with rags steeped in the oil so famed for its good effects at the Carron ironworks,—a mixture of linseed oil and lime water. The principle is the same. The air is excluded which would otherwise stimulate the inflamed surface and induce inordinate reaction. A solution of gum arabic applied on rags forms a very soft and pliant dressing for this purpose. More recently, a varnish made by mixing one part of castor oil with two parts of neutral collodion has been used as a sort of artificial cuticle, and with very good effect. It would be hard to say which of these applications is the most useful in all cases; but it is quite certain that in any individual case that is the most useful and the one that should be used which is nearest at hand. The surgeon, therefore, should know the best way of applying them all. If both are at hand the cotton is more cleanly and comfortable than flour, which is apt to become hard and crack when moistened by pus or serum. If cotton be used it should be spread smoothly and evenly over all the burnt surface, and secured by a loose bandage. One great advantage of this dressing is the avoidance of the pain which attends other dressings requiring frequent renewal, for this may be left unchanged for many days. Dr. Anderson, of Glasgow, who has used it on a large scale says (*Glasgow Med. Journ.* vol. i.) that there] appears to be a twofold effect from this kind of treatment. The primary effect arises from the exclusion of the air, and the slowly conducting power of cotton, by which the heat of the part is retained, whilst a soft and uniformly elastic protection from pressure is afforded. The secondary effect, he says, depends entirely on the sheath, or case, formed by the cotton, absorbing the effused serum, or pus, and giving the best possible substitute for the lost cuticle. "But, in order that the full benefit may be derived from this substitute, and to ensure an equable and continued support to the tender parts, until the new skin is formed, it is absolutely necessary that the cotton should not be removed, except under particular circumstances, until the real cuticle is sufficiently formed to bear exposure" (p. 217). If much constitutional irritation be evinced after the cotton has been for some time applied, Dr. Anderson confesses that it may be necessary to let out the discharge, or even remove the cotton altogether.

[If flour be used instead of cotton, or starch, arrowroot, chalk, or any innocent powder that may be at hand, it must be dusted evenly over the whole burnt surface until a soft uniform covering has been formed completely excluding the air. This is then to be secured by a bandage. If any of the moist applications above referred to be used on rags, it is necessary to be very careful that the rags are not allowed to become dry and adhere to the cuticle, or the whole of the separated cuticle may be raised with the linen, and a simple vesication is thus converted into a painful ulcer. The raised cuticle is the best protection from the air, and the softest possible covering for the cutis.]

Some surgeons are in favour of opening vesicles as soon as they have formed; while others assert that they should not be meddled with. Mr. B. Bell disapproved of opening them till the pain arising from the burn had entirely ceased. Then he thought that they should always be punctured; because when the serum remained a long while upon the subjacent skin, he found it likely to bring on ulceration. He was certainly right in expressing a preference to small punctures; a practice which has the sanction of Dupuytren, who observes, that only a single prick of the vesicle with a needle, or the point of a lancet, should be made in its most depending part.

On the subject of opening vesicles in burns, Dr. Thomson believes that the diversity of opinion arises from the different effects resulting from the particular manner in which the opening is made. "If a portion of the cuticle be removed, so as to permit the air to come into contact with the inflamed surface of the cutis, pain, and a considerable degree of general irritation, will necessarily be induced; but if the vesications be opened cautiously with the point of a needle, so as to allow the serum to drain off slowly, without, at the same time, allowing the air to enter between the cuticle and cutis, the early opening of the vesications will not only not occasion pain, but will give considerable relief, by diminishing the state of tension with which the vesications are almost always, in a greater or less degree, accompanied. When opened in this manner, the vesications frequently fill again with serum; but the punctures may be repeated as often as is necessary, without any hazard of aggravating the inflammation. Great care should be taken, in every instance, to preserve the raised portion of cuticle as entire as possible," &c. (See *Lecture on Inflammation*, p. 595.)

[III. In more severe burns we may have to treat merely an inflamed and exposed cutis; or the skin may have been destroyed, and we have a sloughing sore—a mass of disorganised tissue covering the surface of the burnt part. In the one case the treatment described under the second head is to be generally adopted; in the other the application of stimulants is necessary, and of all stimulants turpentine appears to be the most useful.]

Dr. Kentish, who wrote towards the close of the last century on burns, relied chiefly on alcohol, liquor ammoniæ subcarbonatis, æther (so applied as to avoid the cooling process of evaporation), and spirit of turpentine.

In applying these, we are directed to proceed as follows:—The injured parts are to be bathed, two or three times over, with spirits of wine, spirits of wine with camphor, or spirit of turpentine, heated by standing in hot water. After this a liniment, composed of the ceratum resinæ softened with spirit of turpentine, is to be spread on soft cloth, and applied. This liniment is to be renewed only once in twenty-four hours, and at the second dressing the parts are to be washed with proof spirit, or laudanum, made warm. When the secretion of pus takes place, milder applications must be made till the cure is effected.

The yellow ointment stops the pores of the cloth, impedes evaporation, and thus confines the effect of the alcohol to the burnt surface. The first dressings are to remain on four and twenty hours. Dr. Kentish thinks it of importance that the injured surface should be left uncovered as little as possible. It is therefore recommended to let the new plasters be quite ready, before the old ones are removed, and then only to take off one piece at a time.

It will seldom be necessary to repeat the application of alcohol, or that of oleum terebinthinæ.

[Dr. Kentish's plan has been extensively followed, and has met both with praise and abuse. When properly applied it has done much good; and when misapplied a great deal of harm. In deciding whether to adopt or reject it in any case the following rules should be borne in mind:—It should never be employed in the extensive superficial burns of children, as it produces the most intense agony, and a very dangerous amount of constitutional irritation may be set up. In other cases it is very useful as a stimulant before reaction is set up; and in cases of sloughing sores after burns it is invaluable. Whenever the burnt parts are quite disorganised the best treatment is to bathe those parts with warm spirits of turpentine, as advised by Kentish, and then to cover them completely with his cerate spread thickly on soft lint. This, so far from being an irritating application, is very soothing even to young children, offering a marked contrast to its effects in superficial burns. But it is not advisable to follow Dr. Kentish's plans further than this. He advises us on the second or third day, or as soon as pain ceases, to remove the first dressing and employ simple oil, or calamine cerate. This is a great practical error. The patient is easy. The air is excluded. No possible good can be done by disturbing the first dressings until suppuration is fairly established. The patient is saved unnecessary fatigue and pain, and the surgeon much trouble, by non-interference. After some days, when suppuration has been established, the dressing may be removed, and then very probably the sloughs may separate if a stream of warm water be squeezed over them from a sponge. If the slough still adhere, warm water dressing, or a poultice, may be applied until separation takes place; when the remaining sores must be treated on the ordinary principles regulating the local treatment of granulating surfaces. They must be kept covered by some clean soft dressing. Any dry or offensive pus must be removed, but the soft creamy coating of pus, which is nature's best protection to a granulating surface, must not be washed away. The blueish film around the margin of the healing ulcer must be carefully preserved from injury, taking care to prevent the dressings from adhering to it. When any such sore is in a situation where the contraction which follows granulation would be likely to lead to deformity or impaired function of any part, special precautions must be taken to obviate any such ill effect.] Dupuytren enters into some very interesting reflections on the surgical plans which are to be adopted, in order to make the cicatrix correspond as accurately as possible to the destroyed textures. The first is, *position of the limb or part*. Here the general maxim is to let the position of the part be diametrically the reverse of what would promote the cure, by bringing the edges of the ulcer towards one another. The desideratum is to obtain a cicatrix, whose extent should be equal to that of the destroyed skin, and even somewhat greater, on account of the contractile property of the new texture. Thus, if the burn is on the front of the elbow, the arm is to be kept forcibly extended, until the substance of the cicatrix has been formed. The same plan is applicable to burns of the anterior part of the fingers, hand, and wrist, groin, sole of the foot, ham, &c, Supposing the burn to be on the back of the neck, the chin is to be kept approximated to the chest; but, on the contrary; if the burn is on the forepart or side of the trunk, the opposite position is to be maintained. If the burn is on the front of the knee, or back of the elbow, the leg, or fore-arm, should be kept half bent, or, what is still better, in a state of complete and forced flexion. When the armpit is burnt, the arm should be kept in the position of abduction; but in that of adduction when the top of the shoulder is the seat of the burn. (See *Clin. Chir.* t. ii. p. 27.)

Dupuytren notices some circumstances, however, under which it is difficult, or impossible, for the foregoing principle to be acted upon in practice. Such is the case where the skin all round the member has been destroyed to some extent: by adopting one position the advantages of another would be lost. Here Dupuytren advises a position to be selected which will leave a cicatrix that will interfere least with the free movements of the part. Thus, if the burn occupies the whole surface of the radio-carpal articulation, it is better to keep the wrist extended than bent, because the cicatrix, which would confine the joint in the first posture, would be less inconvenient than one which would fix it in the second. In some of these perplexing cases, Dupuytren considers it advantageous to adopt different positions alternately, and to hasten cicatrisation on one side and retard it on the other. (See *Clin. Chir.* t. ii. p. 29.)

Mr. Earle is of opinion that, by due attention to certain principles, the deformities from burns may generally be avoided. "I am quite ready to admit (he observes) that it is not in our power to arrest the law of nature, by which a cicatrised surface becomes smaller, and occupies less space, than the original wound; but it is in our power, in most cases, to direct and modify that which we cannot wholly prevent; and thus, at all events, to counteract its injurious effect. We cannot prevent the process of absorption (of the granulations), but we can prevent its taking place in a direction which may interfere with the healthy functions of the part. To take the upper extremity as an example. I will suppose a case where the whole integuments on the inner and front part of the arm and fore-arm have been destroyed. If such extremity be kept carefully extended on a splint, not only during the whole progress of healing, but long subsequent to the perfect cicatrisation, you will find that the cicatrised surface will diminish in a circular direction, drawing the healthy integument together from side to side; but, that no contraction will take place in the long axis, in which alone it can impede the due motions of the limb. This permanent extension should be persevered in during the day and night, until all changes have ceased, and the cicatrix has contracted to its smallest dimensions. Care, however, should be taken, during this time, to give passive motion to the different joints, by which the proper secretion of synovia will be kept up, and the eventual free use of the limb will be insured. This plan of maintaining the limb in a state of permanent extension should be commenced as soon as the wound has begun to granulate." (See *Earle's Lect. on Burns*, p. 43.)

Cases are noticed by Dupuytren, in which the plans calculated to produce a good cicatrix cannot be persevered in without danger; as, where the patient is likely to be exhausted by the long and profuse discharge. Here, instead of retarding the formation of the cicatrix, and compelling nature to fill up the chasm with a new texture, it is necessary to expedite it by favouring the approximation of the edges of the ulcer to one another, promoting the development of the tissues of union, or exciting inflammation when it is languid, and repressing it when it is too violent. But, in such cases, it is prudent to follow Dupuytren's advice in apprising the patient, or his friends, of the necessity for this plan, and of the deformity which will unavoidably follow it.

There are also certain regions of the body, specified by Dupuytren, where no advantage can be derived from position, and where it is exceedingly difficult to prevent deformity. Such, in particular, is the face. Thus, if a burn of the fourth degree were to destroy a portion of the lower eyelid and cheek, it would be impossible to hinder the edges of the ulcer from getting nearer together, and the eyelid would be drawn down until it almost formed a junction with the upper lip. If a similar burn were to occur on the forehead, temples, upper eyelid, or scalp, an analogous deformity would be result. Feeble as the means are which are within the surgeon's reach, when position is unavailing, they should never be neglected. Here, as Dupuytren explains, it is proper, 1. To retard, as much as possible, the detachment of the eschar, which, so long as it remains, has the effect of keeping the edges of the ulcer apart. The healing processes commence under it, and the margins of the chasm, becoming more fixed to the subjacent textures by inflammation, are less disposed to be drawn towards one another when the separation of the eschar does take place. 2. As soon as the latter event has occurred, cicatrisation is to be quickened, by frequently touching the ulcer with the nitrate of silver. Care is also to be taken to prevent any cicatrising points in the centre, or at the circumference of the ulcer, from being destroyed, by the pus being suffered to continue too long in contact with them. Hence Dupuytren was an advocate for frequently washing the part and renewing the dressings.

In burns, attended with a more or less considerable destruction of textures, the cicatrices which follow are frequently deformed, and sometimes interfere seriously with the free motion of the parts on which they are situated, or even totally prevent the execution of some function. The plan recommended by Dupuytren for the hindrance of these ill consequences, is to take care that the cicatrix may be of nearly the same extent as the destroyed skin, and that it may not heal by the approximation of its margins to one another. The end may almost always be fulfilled by carefully applying the nitrate of silver to the granulations which are too high; by placing the limb in a proper position, and employing suitable dressings and splints. Thus, if the burn be situated over the flexor muscles, the limb should be kept extended; if over the extensor muscles, bent. Tents, tubes, or pieces of sponge, are to be kept in natural openings, which the healing process may tend to contract or close. Parts, like the fingers, which are disposed to grow together, are to be kept apart with lint or plaster. In the face, where the parts are so moveable and extensible, more or less deformity cannot always be prevented; but the best way of counteracting the tendency to it seemed to Dupuytren to consist in drawing the margins of the ulcer away from one another with straps of adhesive plaster, and other means which circumstances will admit of. But whenever the attempts to obtain a good cicatrix cause a dangerous degree of suffering they should be abandoned. (See *Clin. Chir.* t. i. p. 489.)

Position, by means of which a good cicatrix has been obtained, is recommended by Dupuytren to be continued a month, six weeks, or even longer, after the cure.

It is not only necessary to place the parts in the desirable position, but also to maintain it by means of a bandage, or apparatus. Thus, when the burn is situated on the anterior, posterior, or lateral part of the neck, the head is to be kept inclined in one direction or another, with straps or bands, fastened to a bandage on the body. When the burn is on some part of the wrist, Dupuytren used to put along the fore-arm on the side furthest from the injury, a pad of a certain thickness which descended to the joint without going beyond it. Over this he laid a splint of sufficient length to reach to the ends of the fingers, and then, availing himself of the vacancy between the hand and the splint, he kept the former inclined towards the latter with a few additional turns of the roller employed to fix the pad.

When the burn involved the palm of the hand, or passed between the fingers, Dupuytren used to place the pad along the back of the fore-arm, carpus, and metacarpus, and then a splint terminating below in a hand board, and long enough to cover the whole hand, even when the fingers were extended, and widely separated from one another. The hand board, at the points corresponding to the extremities of the fingers, had ten slits in it, intended for the reception of the ends of five pieces of tape, which formed so many nooses for the confinement of the fingers. Or the hand board, instead of having fissures, was adapted to the shape of the hand, and furnished with prolongations for the fingers.

In burns of the second and third degrees, Dupuytren found that adhesion of contiguous parts might be prevented by keeping them apart by the interposition of some extraneous body, moving them about, and passing a probe between them at every time of dressing them ; but that when the burn was of the fourth degree these means were not effectual. Thus he found it not enough to maintain the fingers separated and extended, but that it was essential to make more or less pressure directly on the point where the cicatrix began. This pressure was made by means of a long narrow compress, the middle of which was applied precisely to the angle of the commissure of the fingers, while the two ends were carried over the front and back of the fore-arm, and there fastened. The same principle is applicable to other similar cases.

When a burn of the fourth degree implicated the circumference of natural orifices, as those of the nostrils, vagina, mouth, &c., Dupuytren used to prevent the obliteration of such apertures with dossils of lint, tents, cannulæ, prepared sponge, ivory tubes, &c. Attention to this indication seemed to him here as proper as in burns with vesication, or those of the third degree ; but, with these differences, 1. That they are even more rigorously indispensable. 2. That the diameter of the foreign bodies must always exceed that of the orifice into which they are introduced. 3. That their use must be continued long after the cure, in order to resist the contractile tendency of the cicatrix.

Amongst the means for fulfilling the indication under consideration, are straps of adhesive plaster. But Dupuytren correctly observes that though they are very efficient, when they are applied across an ulcer, in keeping its edges approximated, their action is but feeble when employed for maintaining them apart. Yet he admits that circumstances occur in which they are of service. Such are burns of the face, forehead, temples, scalp, &c.; where the parts cannot be operated upon by position and other means.

In burns of the fifth and sixth degrees, implicating the muscles and tendons, a chief object is to keep the limb or part in such a position as will leave after the cure the least inconvenience. In general, as Dupuytren remarks, the disorganisation is so considerable, that the preservation of the patient's life, by promoting cicatrisation by every possible means, engages all the surgeon's attention, who has now no opportunity of thinking about the prevention of deformity, or the losses of functions resulting from it. (See *Clin. Chir.* t. ii. p. 33—39.)

[The means of remedying those deformities or losses of function produced by the contraction of cicatrices, will be fully treated under the head CICATRIX.

THE CONSTITUTIONAL TREATMENT OF BURNS necessarily depends upon the circumstances of each case, such as the age and strength of the patient, the extent of the burn, the period after the injury, &c. In the worst cases, where the surface is cold and the pulse low — the whole system depressed by the shock — the endeavour to excite reaction must be made ; keeping the body warm by flannel coverings, and giving some warm wine and water or brandy and water. Stimulants must be persevered with until the pulse rises and the surface of the body regains and maintains its natural temperature. But all cordials or stimulants must be used with caution. As soon as reaction takes place they must be discontinued, or the danger is incurred of increasing the inflammation in the great cavities, which is so apt to follow severe burns. *Opium* is a most useful agent when the patient suffers much, and may be used as soon as there is sufficient reaction to give him the capacity of suffering. A full dose may be administered at first to tranquillise the nervous system and procure sleep ; smaller doses being continued afterwards, combined with some diaphoretic, to allay the irritative fever.

In cases where there is much irritative fever, with a dry hot skin, furred tongue, thirst, quick pulse, and inflammatory redness around the burnt part, it is possible that in a strong plethoric person it might be advisable to have recourse to blood-letting; but this should not be practised unless it be found impossible to control the symptoms by other means. In almost every case undue reaction may be controlled by a combination of opium and tartarised antimony, a mild purgative, if necessary, restricting the diet to light farinaceous food, giving diluents freely, and applying some soothing fomentation to the burnt part. Fever of an asthenic type is far more frequently met with than inflammatory fever. This low fever is best treated by wine and opiates, mild nutritious diet, and the free use of demulcent drinks. Diarrhœa frequently sets in during the course of the fever of either type; and if the evacuations are copious, they are generally followed by great relief. But this should not lead us to imitate Dr. Kentish and others, who, observing the good effects of spontaneous diarrhœa, have advocated the free use of purgatives in the treatment of the sympathetic fever after burns. The artificial purgation is something very different from the spontaneous diarrhœa. The latter must not be checked, but encouraged by the free use of diluents, so long as it is followed by relief; but when it is at all exhaustive, when the evacuations are scanty, contain mucus, and are attended by pain or tenesmus, all this must be regarded as symptomatic of that form of inflammation of the mucous membrane of the bowels so often found after death in the bodies of those who die from burns. In such cases it is not judicious to attempt to control the diarrhœa by astringents; but sinapisms, warm fomentations, and flannel bandages should be applied to the abdomen, and morphia suppositories, or enemata of starch and opium, administered by the rectum.

As a case goes on, the appearance of the granulations upon the surface of the sore will be found a very good guide both to local and constitutional treatment. If they are small, conical, red, firm, and regular, it is certain that the constitution is in a favourable state. If they are large, soft, flabby, and purplish, both general support and local stimulants will be required. If they are extremely sensitive, the local use of nitrate of silver and the general employment of opium are called for. If they are irregular in size, gorged with blood, of a deep florid hue, and surrounded by an inflammatory blush, soothing local applications and general antiphlogistic treatment are indicated. When the suppurative discharge is very copious and exhausts the patient's strength, he must be well supported by nutritious animal diet and the use of wine. Sleep should be procured by opium, and the mineral acids, with or without quinine, may prove useful.

The question of *amputation*, when a limb has been destroyed by a burn, has been decided on the following principles] : —

When the whole thickness of a limb is destroyed, amputation is proper, as substituting a simple wound, the cure of which will be easy, for an eschar, or disorganised mass, the separation of which would be tedious, and followed by an irregular solution of continuity, and a projection of the bone, and other deep textures to which the action of the concentrated heat had least extended. Besides, as Dupuytren justly observes, the operation preserves the patient from the secondary inflammation which would otherwise take place, and not be free from peril. At the same time, before making a decision, the surgeon is to consider the age, constitution, and strength of the patient, and whether he is in a state to bear the process by which the dead parts are to be thrown off. If he were in a condition of stupor, or inflammation had already come on, with fever, &c., the subsidence of these effects, and the establishment of suppuration, must be awaited; after which, a decision for or against amputation should be made, according to the general state of the patient, or that of the ulcerated surface. (See *Dupuytren, Clin. Chir.* t. i. p. 490.)

[More recent experience has modified these conclusions, inasmuch as there seems to be danger of pyæmia from cutting near parts injured either by extreme heat or extreme cold — and the practical rule seems to be established that both in cases of burns and frostbite, if the period for primary amputation have passed over, it is advisable only to remove such portions of projecting bone as can be done without division of soft parts, and leave the separation of the latter to the processes of sloughing, granulation, and cicatrisation, while the constitutional and local treatment is being carried out on the principles above inculcated.]

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BURSÆ MUCOSÆ. Small sacs of synovial membrane, interposed either between the periosteum and the skin; or between the periosteum and muscles; or between the periosteum and tendons; or between tendon and tendon. The slippery fluid, which they secrete, serves to lubricate the surface over which it passes. The subcutaneous bursæ are either natural, like those upon the patella, or the olecranon, or are developed in the common cellular tissue by pressure. (See *Mayo's Outlines of Human Pathology*, p. 110.) It is an observation made by Meckel, that it is not uncommon to find in some individuals cellular tissue substituted for certain portions of serous tissue. Thus, in situations where a synovial bursa is met with in one person, simple cellular tissue, containing a larger quantity of lubricating fluid than usual, is found in another. On the other hand, at more than one point, where commonly only cellular tissue exists, a bursal cavity, more or less developed, is discovered. When the integuments are subjected to protracted and repeated friction, the subcutaneous cellular tissue is transformed at the part into a synovial sac. In persons with club feet, Béclard found similar bursæ placed at the point where the skin suffers friction against the projecting bones of the tarsus. When a stump is examined, long after amputation, a bursal cavity is frequently found beneath the skin, at the extremity of it. Sir Benjamin Brodie met with an instance of a bursa formed between the projecting part of a curved spine and the integuments, which at this point were continually gliding over the bony prominence. In examples of unreduced dislocations, the bones, in their new relation to one another, frequently require and receive a synovial sac in the interspace between them, which sac, according to Andral, is formed at the expense of the cellular tissue; and the same thing happens in cases of fracture where the bones continue united. (See *Andral, Précis Anat. Pathol.* t. i. p. 243.)

Together with synovial bursæ, Sir Benjamin Brodie arranges the sheaths of tendons, as they have the same structure and perform a similar office. In the healthy state, the lubricating fluid formed by the synovial bursæ is so small in quantity, that it cannot be seen without opening the membrane containing it; but, occasionally, such an accumulation takes place that very considerable swellings are the consequence. Tumors of this sort are often produced by bruises and sprains, and now and then by rheumatic affections. Sometimes they are not attended with much pain, though in other cases, when pressure is made with the fingers, it is rather acute. The tumors yield, in a certain degree, to pressure; but they rise again with an elasticity not remarked in other sorts of swellings. Generally they appear to be circumscribed, and confined to a small extent; but sometimes the fluid forming them is so abundant that they extend over a considerable surface. The skin when not inflamed retains its usual colour.

In this morbid state of the bursæ mucosæ, they contain different kinds of fluids, according to the cause of the disease. When the tumor depends on a rheumatic affection, the contents are mostly thin; but they are usually glairy, transparent, and of the consistence of the white of egg. When the disease is the consequence of a bruise or sprain, the effused fluid often contains hard concretions, and, as it were, cartilaginous ones, which are sometimes quite loose, and more or less numerous. I have had some cases, in which they corresponded to Sir Benjamin Brodie's description, in bearing some resemblance, in shape and size, to small melon seeds. This is not unusual when the tumor is of long standing. Such substances may occasionally be felt with the fingers; but, in general, when the swelling is old, the cyst is thick, and prevents them from being perceptible.

In the greater number of instances, inflammation of the bursæ mucosæ produces an increased secretion of synovia. In other cases, the bursa is distended with a somewhat turbid serum, containing floating portions of coagulable lymph. The inflammation sometimes leads to the formation of matter, and occasionally the membrane of the bursa becomes thickened, and converted into a gristly substance. Sir Benjamin Brodie has seen it at least half an inch in thickness, with a small cavity in the centre containing synovia. In University College Hospital, I lately saw a diseased bursa, equal in size to an orange, the membrane of which was fully half an inch thick. The fluid within it contained numerous small bodies, of the size of melon seeds. In other instances, however, though the inflammation has lasted a considerable time, the membrane of the bursa retains nearly its original structure. (*Pathological and Surgical Obs. on the Joints*, p. 317, ed. 3.)

According to the same authority, the disease may be the consequence of pressure or other local injury; sometimes of rheumatism, gout, or other constitutional affection; and, in such cases, the complaint is frequently joined with inflammation of the synovial membrane of the joints. (See JOINTS.) Sometimes it has the form of an acute, but, more commonly, that of a chronic inflammation.

In the beginning, Sir Benjamin Brodie recommends the use of leeches and cold lotions, and afterwards that of blisters or stimulating liniments. In particular cases, he says, these means should be combined with such constitutional remedies as circumstances indicate. When the disease is of long standing, the preternatural secretion of fluid will often continue after the inflammation has entirely subsided. If blisters now fail in procuring its absorption, Sir Benjamin Brodie recommends friction; and, if this be unavailing, he considers it advisable to discharge the fluid by a puncture. The presence of loose substances in the bursa, he thinks, may of itself keep up a collection of fluid.

Dr. Monro met with cases in which the ill consequences of a puncture were such as to render amputation necessary. These he imputed to the air having access to the interior of the bursa. Hence it has been recommended to pass a seton through the swelling, and to remove the silk after it has remained just long enough to excite inflammation of the cyst, when an attempt is to be made to unite the opposite sides of the cavity by pressure.

This practice is sometimes approved of by Sir Benjamin Brodie on other grounds; he has noticed that after the whole cavity of the bursa has been converted into an abscess, and this has been cured, no fluid generally collects again. Hence, he has sometimes been induced to pass into the puncture a seton, or tent, or (what he deems better) the blunt end of a probe, for the irritation of the inner surface of the bursa. This practice I tried very successfully on a young woman who was under my care. I punctured the bursa below the patella, and discharged about an ounce of fluid resembling white of egg. The disease had existed several months, and the bursa was much thickened. I kept the puncture open about ten days, during which time there was a discharge from it of the same kind of fluid, without any tendency to suppuration. I therefore introduced a tent into the opening, by which means the necessary degree of inflammation was excited, the bursa suppurated, and the disease was soon permanently cured, without any severe symptoms. [The injection of the tincture of iodine has been recommended by Velpeau, Chassaignac, and other French surgeons, as a preferable mode of exciting the necessary inflammation for the obliteration of enlarged bursæ.] Inflammation and suppuration of a large bursa, Sir Benjamin Brodie observes, sometimes disturb the the constitution so much, that it may be prudent merely to make a puncture, and keep the patient afterwards perfectly quiet. He mentions a diseased bursa mucosa, which he had seen between the lower angle of the scapula and the latissimus dorsi, and which was not much less than a man's head. In this case, death followed the constitutional disturbance excited by a puncture and a seton. In another example seen by this judicious surgeon, where the patient was in bad health, and the due observance of quietude was neglected, the puncture of a diseased bursa was followed by death. (Op. cit. p. 360.) In some instances, the making of an incision into a bursa mucosa has been followed by a fatal attack of phlegmonous erysipelas.

Mr. Mayo believes, that there is never occasion to lay an enlarged bursa extensively open, or to pass a seton through it, or to apply caustic. "If the fluid will not disperse by common means, it is only necessary to puncture the sac several times, when it will either cease to secrete an undue quantity of fluid, or suppurate, and thus get well." (See *Mayo's Outlines of Human Pathology*, p. 111.)

In University College Hospital, I have had under my care numerous cases of diseased bursæ. If inflamed, I find cold applications, leeches, and quietude the best means of relief. Afterwards a blister, or friction with ointment of hydriodate of potash, or camphorated mercurial ointment. When the swelling suppurates, or resists these plans, I usually make an opening. A large bursa, which was under the care of Mr. Liston, and the sides of which were nearly three quarters of an inch thick, was successfully removed by means of the knife. It lay between the patella and the skin, and was easily taken out, after a crucial division of the integuments.

When the coats of a bursa are much thickened, and cannot be restored to their natural condition, if superficially situated, it may be removed with as much facility as an encysted tumor. This practice Sir Benjamin Brodie has only as yet applied to the bursa between the patella and the skin, though he entertains no doubt of there being other superficial bursæ which would also safely admit of removal.

[I have frequently succeeded in curing small bursal swellings with thin walls, especially those situated about the wrist, by subcutaneous incision — a method of treatment not mentioned by Mr. Cooper, but adopted with advantage by many surgeons. A tenotomy knife should be introduced under the skin, half an inch from the position of the bursa; it should then be carried on by the side of, and even beyond, the swelling, and plunged into it, so as to incise its walls freely; the object should be to convert it into an open sac. The glairy fluid it contains should now be made to pass by pressure into the surrounding cellular tissue, or out at the external wound. A compress of lint fixed on the site of the former swelling will generally complete the cure. The advantage of the subcutaneous incision is that it is rarely followed by inflammation.

The surgeon should be aware that a bursal swelling situated over the carpal bones may communicate with the intercarpal synovial membranes. This affection is probably caused by a sort of hernial protrusion of the synovial sac between the fibres of the intercarpal ligaments. The puncture of such swellings should be carefully avoided, as they might be followed by destructive inflammation of the carpal joints. They may be distinguished by the circumstance that they may be made to disappear, to some extent, by pressure, although they will reappear on its removal; whereas the ordinary closed bursal enlargement will simply be displaced by pressure, but never partially emptied. It should be borne in mind that in other situations also a bursa may communicate with a neighbouring joint, as the subdeltoid bursa with the shoulder, and the subpsoal with the hip-joints. In these latter instances, the bursæ are placed between the capsule of the joint and the adjacent tissues; and the communication with the joint, which is not congenital, appears to be effected by the gradual thinning and ultimate destruction of the capsule and bursal wall by friction or usure. Puncture or incision here would also compromise the neighbouring joint, and should be carefully avoided. I have seen a fatal result follow the puncture of an enlarged bursa in each of the above named situations. The morbid specimen of a shoulder-joint thus destroyed is preserved in the museum of St. Mary's Hospital. The bursa of the crureus muscle may also be mentioned as occasionally communicating with the knee, and that of the subscapular muscle with the shoulder-joint.

I have met with cases not alluded to by Mr. Cooper, where thickened bursæ of the patella have either suppurated, or have been incised, and where the openings into the diseased bursæ have remained fistulous. In these cases, the skin adhered to the thickened and collapsed bursæ, and presented ill-conditioned ulcers which no remedies, general or local, have disposed to heal. The proper treatment, in these cases, is to make a crucial incision through the diseased and adherent integument, to dissect back the flaps, and expose the thickened and diseased bursa, and to completely remove it.

The bursal sheaths of the flexor tendons of the fingers, where they pass under the annular ligament of the wrist joint, are occasionally extensively distended with synovia, giving rise to a double swelling, one in the palm of the hand, and one in front of the wrist, which, on manipulation, are found to communicate with each other. It is in fact but one swelling constricted by the annular ligament, which, by pressure, can be made to project entirely in the palm, or entirely above the wrist. Sometimes they contain the so-called melon seed bodies. These swellings produce great deformity, but are not generally attended with pain; and when they do not seriously impede the movements of the hand and fingers, should not be interfered with by operative procedure. In extreme cases, however, where the hand becomes completely crippled by the disease, it has been recommended that they should be opened freely above and below the constriction formed by the annular ligament. A seton also has been passed lengthways through the swelling under the ligament, and this latter has even been divided, by Dupuytren, Velpeau, and others, for the cure of this affection. Mr. Syme has published a successful case treated by the division of the annular ligament. (See *Edinburgh Monthly Journal for October*, 1844.) The intention of these operations is to produce suppuration of the enlarged bursal sheaths and their subsequent obliteration. This cannot, however, be done without causing considerable constitutional disturbance, and risking the limb, or even life, of the patient. The surgeon should not, therefore, lightly undertake to operate in such cases, and without fully explaining to his patient the danger and risk attending the operation. For a more detailed account of this affection, the reader is referred to a paper published by Mr. Coulson in the *Monthly Journal of Medicine for October*, 1851, p. 881.] (See GANGLION.)

Consult *Monro's* Description of all the Bursæ Mucosæ, &c., with remarks on their accidents and diseases, &c. fol. Edin. 1788. *C. M. Koch*, De Morbis Bursarum, tendinum mucosarum. Sir *B. C. Brodie's* Pathological and Surgical Obs. on the Joints, chap. x. ed. 3. 8vo. Lond. 1831. *Nélaton*, Elém. de Pathol. Chir. t. i. 1844. *Herbert Mayo's* Outlines of Human Pathology, p. 110. 8vo. Lond. 1835.

CÆSAREAN OPERATION. Called also *Hysterotomia*, from ὑστέρα, *uterus*, and τομὴ, *sectio*. Pliny, book vii. chap. 9 of his Natural History, gives us the etymology of it as follows: "*Auspicatiùs* (says he) *enectâ parente gignuntur, sicut Scipio Africanus prior natus, primusque Cæsar à cæso matris utero dictus; quâ de causâ cæsones appellati. Simili modo natus est Manlius qui Carthaginem cum exercitu intravit.*" Whether this explanation be correct or not, it is now difficult to settle. According to Bayle, Aurelia, Cæsar's mother, was living at the period when that warrior invaded Britain, so that, if he were taken out of the womb by this proceeding, the life of the mother was also saved. Although the etymology and first practice of the Cæsarean operation are points involved in obscurity, its great antiquity is generally admitted; and this notwithstanding no description of it is to be found in the works of Hippocrates, Celsus, Paulus Ægineta, or Albucasis. The earliest account of it in any medical work, is that in the Chirurgia Guidonis de Cauliaco, published about the middle of the fourteenth century. Here, however, the practice is only spoken of as proper after the death of the mother. (See *Cap. de Extractione Fœtûs.*) Vigo, who was born towards the close of the fifteenth century, takes no notice of the Cæsarean operation; and Paré, who greatly improved the practice of midwifery, thinks this measure only allowable on women who die undelivered. (*De Hominis Generatione*, cap. 31.) Rousset, who was contemporary with Paré, collected the histories of several cases, in which the operation was successfully performed; and, after their publication, the subject excited more general interest.

[Sir F. Ould, 1742, is the first British author, according to Dr. Churchill, who notices the operation, which, he says, may be performed "either while the mother is living, or after her death, according to the nature of the circumstances."

Smellie, 1751, takes, as usual, a sound common sense view of this matter: — "When a woman," he observes, "cannot be delivered by any of the methods hitherto prescribed and recommended in laborious and preternatural labours, on account of the narrowness or distortion of the pelvis, into which it is sometimes impossible to introduce the hand; or from large excrescences or glandular swellings that fill up the vagina, and cannot be removed; or from large cicatrices in that part and at the os uteri, which cannot be separated; in such emergencies, if the woman is strong and of a good habit of body, the Cæsarean operation is certainly advisable, and ought to be performed; because the mother and child have no other chance to be saved, and it is better to have recourse to an operation which has sometimes succeeded, than leave them both to inevitable death." (See *Churchill's Theory and Practice of Midwifery*, p. 378, 379, ed. 3.)]

By the *Cæsarean Operation* is commonly understood that in which the fœtus is taken out of the uterus, by an incision made through the parietes of the abdomen and womb. The term, however, in its most comprehensive sense, is applied to three different proceedings. It is sometimes employed to denote the incision which is occasionally practised on the cervix uteri in order to facilitate delivery; but this particular method is named the *Vaginal Cæsarean Operation*, for the purpose of distinguishing it from the former, which is frequently called, by way of contrast, the *Abdominal Cæsarean Operation*. With these cases, we have also to class the incision which is made in the parietes of the abdomen for the extraction of the fœtus, when, instead of being situated in the uterus, it lies in the cavity of the peritoneum, in consequence of the rupture of the womb, or in the ovary, or Fallopian tube, in consequence of an extra-uterine conception.

Vaginal Cæsarean Operation.

Disease, malformation, or a preternatural position of the cervix uteri, may render this practice indispensable. A fibro-cartilaginous hardness of the neck of the uterus is the most frequent cause. When the induration is such, that the cervix cannot be dilated, and the patient is exhausting herself with unavailing efforts, the parts should be divided in several directions. This has been successfully done under various circumstances. Cases have been met with in which the cervix uteri presented no opening at all, and yet the preceding operation proved quite effectual. Such was the example which Dr. Simpson inserted in the third vol. of the Edinb. Essays. A woman, forty years of age, became pregnant, after recovering from a difficult labour, in which the child had remained several days in the passage. She had been in labour sixty hours; but the neck of the womb had no tendency to dilate. Dr. Simpson, perceiving that its edges were adherent, and left no opening betwixt them, determined to practise an incision, with the aid of a speculum uteri. The bistoury penetrated to the depth of half an inch before it got quite through the substance which it had to divide, and which seemed as hard as cartilage. As the opening did not dilate in the efforts which the woman made, it became necessary to introduce a narrow bistoury on the finger, in order to cut this kind of ring in various directions. There was no hæmorrhage; and the only additional suffering which the patient encountered, arose from the distension of the vagina. As the child was dead, Dr. Simpson perforated the head, in order to render delivery more easy.

Strong convulsions at the moment of parturition may create a necessity for the vaginal Cæsarean operation. These sometimes subside, as soon as the membranes are ruptured, and the waters discharged, so as to lessen the distension of the womb. However, if the convulsions were to continue, and the cervix uteri were sufficiently dilated, the child should be extracted with the forceps, or by the feet, according to the kind of presentation. On this subject, Baudelocque has recorded a fact which was communicated to the Academy of Surgery by Dubocq, professor of surgery at Toulouse. A woman, forty years of age, had been in convulsions two days. She was alarmingly pale; her pulse feeble, and almost extinct; and her extremities cold, and covered with a clammy perspiration. The edges of the opening, which was about as large as a crown piece, felt, as it were, callous; and hardly had this aperture been dilated, when delivery took place spontaneously. The child was dead. The symptoms were appeased, and the woman experienced a perfect recovery. Another case, in which the indurated cervix uteri was successfully divided, is recorded by Lambron, a surgeon at Orleans. (See *Dict. des Sciences Méd.* t. xxiii. p. 297.)

A considerable obliquity of the neck of the womb, combined with a pelvis of small dimensions, may also be a reason for the performance of the vaginal Cæsarean operation. Not that such obliquity always occasions that of the rest of the uterus; nor is the neck of this viscus invariably directed towards that side of the pelvis which is opposite to its fundus, although this is sometimes the case. In the latter circumstance, as the contractions of the uterus do not produce a dilatation of its cervix, which rests upon the bones of the pelvis, the adjacent part of that organ is dilated and pushed from above downwards, so as to present itself in the form of a round smooth tumor without any appearance of an aperture. Such a case may have fatal consequences. Baudelocque furnishes us with an instance. A woman, in her first pregnancy, not being able to have the attendance of the accoucheur whom she wished, put herself under the care of a midwife, who let her continue in labour pains during three days. When the accoucheur came, on being sent for again, the child's head presented itself in the vagina, covered with the womb. The portion of the uterus which included the fœtus was in a state of inflammation. The os tincæ was situated backward toward the sacrum, hardly dilated to the breadth of a penny piece, and the waters had been discharged a long time. The patient was bled, and emollient clysters and fomentations were employed. She was laid upon her back, with her pelvis considerably raised. The accoucheur had much difficulty in supporting the head of the child, and keeping it from protruding at the vulva, enveloped, as it was, in the uterus. Notwithstanding such assistance the patient died.

So fatal an event, says Sabatier, might have been prevented, by making the woman lie upon the side, opposite the deviation of the uterus, and employing pressure from above. If these proceedings had failed in bringing the os tincæ toward the centre of the pelvis, this opening might have been brought into such position, by means of the finger, in the interval of the pains, and kept so, until it were sufficiently dilated for the membranes to protrude. This is what was done by Baudelocque in one case where the womb inclined forward and to the right.

When the obliquity of the uterus is such, that the os tincæ cannot be found, and the mother and fœtus are both in danger of perishing, it is the duty of the practitioner to open the portion of the womb that projects towards the vulva. Lauverjat met with a case of this description. A woman, pregnant with her first child, suffered such extreme pain in her labour, that Lauverjat was solicitous to ascertain the real state of things. He was surprised to find the vulva completely occupied by a body, which even protruded externally, and yielded to the pressure of the fingers, except during the labour-pains. In examining this tumor, he could only find at its circumference a *cul-de-sac,* half an inch deep, without any aperture through which the child could pass. Other practitioners, who were consulted about this extraordinary case, were also anxious to learn what had happened. They found in the tumor a laceration, which only affected a part of the thickness of its parietes. This laceration was deemed the proper place for making an incision. The operation having been done, the finger was passed into the cavity in which the child was contained. A large quantity of turbid fluid was discharged. The child presented, and passed through the opening, with a trivial laceration on the right side. Lauverjat, having passed his hand into the uterus, was unable to find either the os tincæ, or the cervix. No particular indisposition ensued, and the lochia were discharged through the wound, which gradually closed. In the course of two months, the os tincæ and neck of the uterus were in their natural position again. (*Lauverjat, Nouvelle Méthode de pratiquer l'Opération Césarienne.* Paris, 1788.)

When the case is a fibro-cartilaginous induration of the cervix uteri, or a laceration of the parietes of this viscus, at the place where it projects into the vagina, the vaginal Cæsarean operation is attended with no difficulty. It is performed with a probe-pointed bistoury, the blade of which is wrapped round with lint, to within an inch of the point. The instrument is introduced, under the guidance of the index finger, into the opening presented by the uterus, and the aperture is enlarged, from within outwards, in various directions. But when the hardness of the cervix presents no opening at all, or when the part of the uterus projecting in the vagina is entire, the incision should be made from without inwards, with the same kind of knife. Too much caution cannot be used in introducing the instrument, in order that no injury may be done to the child. No general direction can here be offered, except that of proceeding slowly, and of keeping the index finger extended along the back of the knife, so that it may be immediately known when the substance of the womb is cut through, into the cavity of which the finger ought to pass as soon as the knife. If it should be necessary to extend, or multiply the incisions, the cutting instrument should be regulated in a similar manner, with the same finger. The cervix uteri having been divided, the expulsion of the child is either to be left to nature, or promoted by ordinary means. The wounds require no dressings. If the bleeding should prove troublesome, we are recommended to apply to the incision a dossil of lint dipped in spirit of wine. (See *Sabatier, Méd. Opératoire,* t. i.) The chief object would here be to prevent adhesions, between the cervix of the uterus and the upper part of the vagina. (*Dict. des Sciences Méd.* t. xxiii. p. 298.)

Abdominal Cæsarean Operation.

This is a far more serious operation than that which has just now been treated of, and is the proceeding, to which the term Cæsarean operation is more particularly applied. There are three cases, in which it may be necessary:—1. When the fœtus is alive, and the mother dead, either in labour, or the last two months of pregnancy. 2. When the fœtus is dead, but cannot be delivered in the usual way, on account of the deformity of the mother, or the disproportionate size of the child. 3. When both the mother and child are living, but delivery cannot take place from the same causes, as in the second example.

In many instances, both mother and child have lived after the Cæsarean operation, and the mother even borne children afterwards. (See *Heister's Institutes of Surgery,* chap. cxiii. *Mém. de l'Acad. de Chirurgie,* t. i. p. 623; t. ii. p. 308, in 4to. *Edin. Med. Essays,* vol. v. art. 37, 38. *Edin. Med. and Surgical Journal,* vol. iv. p. 179.

Med. Chir. Trans. vol. ix. and xi. &c.) Dr. Müller, of Lowenburg, in Silesia, performed the Cæsarean section, and saved both the mother and the child. (*Magazin für die gesammte Heilkunde*, 1828; b. 28, p. 146.) An instance of similar success is reported by C. H. Graefe. (*Journal für Chirurgie, &c.* b. 9, s. i.) Two cases occurred in which both women and children were saved, at the hospital of Maestricht, by M. Bosch. (*Bibl. Med.* 1823.) And in a valuable periodical work one example is reported from Hufeland's Journal, where the mother and twins were all saved by the operation. (See *Quarterly Journ. of Foreign Medicine, &c.* vol. iv. p. 625.)

The most extraordinary case of Cæsarean operation on record, is one performed by a negro-girl on herself, who recovered. (See *New York Med. and Physical Journ.* March, 1823.) Dr. Mosely mentions the case of a negro-woman at Jamaica, who opened her side with a butcher's knife, and extracted a child, which died of locked jaw. The woman recovered. (See *Ryan's Manual of Midwifery*, p. 280.)

In England, the operation has been attended with remarkably ill success; no doubt the reason of this was correctly explained by Dr. Hull: — "In France," he says, "and some other nations upon the European continent, the Cæsarean operation has been, and continues to be, performed, where British practitioners do not think it indicated; it is also had recourse to early, before the strength of the mother has been exhausted by the long continuance and frequent repetition of tormenting, though unavailing, pains, and before her life is endangered by the accession of inflammation of the abdominal cavity. From this view of the matter we may reasonably expect that recoveries will be more frequent in France than in England and Scotland, where the reverse practice obtains. And it is from such cases as these, in which it is employed in France, that the value of the operation ought to be appreciated. Who would be sanguine in his expectation of a recovery under such circumstances as it has generally been resorted to in this country, namely, where the female has laboured for years under *malacosteon* (*mollities ossium*), a disease hitherto in itself incurable; where she has been brought into imminent danger by previous inflammation of the intestines, or other contents of the abdominal cavity; or been exhausted by a labour of a week's continuance, or even longer?" Dr. Hull thus refutes the opinion of Mr. W. Simmons that our ill success was owing to climate or some peculiarity in the constitution of the females of this island. (See *Hull's Defence of the Cæsarean Operation*, p. 10.)

The general readiness of Continental practitioners to have recourse to the Cæsarean section, has been sometimes censured, because they have even operated in cases, in which the patients had previously borne children in the natural way. According to Dr. Ryan, however, there are but four such cases on record: —"One by Nagele, in his *Erfahrungen und Abhandl. aus dem Gebiete des Krankheiten des Weibliehen Geschlechts*; another by Henderson, in the *Edin. Med. and Surg. Journ.* No. 66; a third by Meier, in *Siebold's Journ.*; and a fourth in the same Journal by Bergen." (See *Ryan's Manual of Midwifery*, p. 279.) Certainly, if a woman had already borne children in the natural way, the fact should be received as a strong argument against the necessity of the operation, but perhaps not as an absolute prohibition, since everything must depend on the actual dimensions of the lower aperture of the pelvis in relation to the size of the existing fœtus.

[Dr. Fleetwood Churchill has collected the statistics of this formidable operation with extreme care, and has tabulated the successful and unsuccessful cases occurring in England and America up to the date of the third edition of his Theory and Practice of Midwifery, published in 1855.

The result of these tables shows that out of 63 cases 18 mothers were saved and 45 lost, or nearly three fourths. Out of 60 cases where the result to the child is noted, 34 were saved and 26 lost, or 1 in 2$\frac{1}{3}$.

Dr. Churchill also collected from foreign authorities 371 cases, out of which 217 mothers recovered and 154 died, or about 1 in 2$\frac{1}{3}$. Out of 189 of these, where the result to the child is given, 139 were saved and 50 lost, or nearly one fourth. In a note he refers to eleven additional cases out of which six mothers were saved and five lost—eight children saved and three lost. Figueira records 720 cases of Cæsarean operation, of these the recoveries amounted to 366, the deaths to 424. Kayser gives the result of 339 cases; 129 were saved and 210 lost. Dr. West collected 409 cases, of which 158 recovered and 251 died. The result to the child is stated in 347 of Dr. West's cases, to be deaths 110, recoveries 237. Dr. Merriman records 26 cases, 2 mothers were saved, 24 lost; 11 children recovered, 15 were lost. The mortality in each of these collections of cases differs considerably, but a tolerable close approximation to the proportion of deaths to recoveries both as regards the mother and child will be obtained from the annexed tabular view of the whole.

Authorities.	No. of Cases.	Results to Mother.		Results to Child.	
		Reco.	Died.	Saved.	Lost.
Dr. Churchill	63	18	45	34	26
Ditto . .	371	217	154	139	50
Ditto . .	11	6	5	8	3
Dr. Figueira	790	366	424		
Dr. Kayser .	339	129	210	252	86
Dr. West .	409	158	251	237	110
Dr. Merriman	26	2	24	15	11
	2009	896	1113	685	286

The number of operations reported in these tables is doubtless greater than actually occurred: the same cases being repeated in more than one of the collections. If each author, however, has impartially reported the cases which came under his notice, the result will not be much vitiated by the repetition. As regards the mothers they give a mortality of 55·4 per cent. As regards the children, of 29·45.

Kayser gives the mortality to mothers in hospital practice as 79 per cent. Dr. West estimates the mortality to the mothers as high as 83 per cent.

It is a remarkable fact that some women have undergone this operation several times. Dr. Churchill has given the following table of twenty-eight such cases.

No.	Date.	Operator or Authority.	Patient or Place.	No. of Operations.	No. of Children saved.	Result to Mothers.
1	—	Guillet - -	- -	6	6	saved.
2	—	Le Noir and Lebrun -	- -	3	3	recovered.
3	—	M. Jobert - -	- -	2	1	ditto.
4	—	M. Peyronnie -	- -	2	-	ditto.
5	—	M. Sommius - -	his own wife	7	-	ditto.
6	—	A surgeon at Paris -	his own wife	5	-	ditto.
7	—	- - - - -	- -	3	-	ditto.
8	—	- - - -	at Auçois -	6	-	ditto.
9	—	Count Nessan -	- -	7	-	ditto.
10	1775–9	M. Lambron - -	- -	2	-	ditto.
11	1797	Mangold & Burckhardt	L. Mautz -	3	-	recovered twice, died after third.
12	1801					
13	1805					
14	—	M. Bacqua - -	Gabery -	2	-	recovered.
15	1796	Rhode and Sommer -	- -	2	-	ditto.
16	1810					
17	1802	Lorinzer - -	Groger -	2	-	ditto.
18	1805					
19	1805–7–11	M. le Maistre d'Aix -	Fauve -	3	-	ditto.
20	1817–19	M. Locher - -	- -	2	-	recovered once, died second time.
21	1821–26	M. Merrem - -	Viandes -	2	-	recovered.
22	1823	M. Bosch - -	- -	2	-	ditto.
23	1823–25	M. Schenck - -	- -	2	-	ditto.
24	—	M. Dariste - -	Martinique	2	-	ditto.
25	1828 -30-32 -39	M. Michaelis - -	Adawetz -	4	-	ditto.
26	—	M. Gardey - -	- -	2	-	ditto.
27	1825–26	Dr. Schmidt - -	- -	2	-	recovered once, died second time.
28	1824–26	Dr. Engeltrum -	Amsterdam	2	2	ditto. ditto.

When the fœtus is contained in the womb, and cannot be expelled, by reason of the invincible obstacles to which I have already referred, and embryotomy, or the practice of sacrificing the fœtus and extracting it piecemeal by the vagina, be deemed improper, the Cæsarean operation should be practised before the mother and fœtus both perish from the violence of the pains, hæmorrhage, convulsions, &c.

For this purpose, it is necessary to make an extensive incision in the integuments of the abdomen and in the uterus. All the opponents of the Cæsarean Operation fear the hæmorrhage, which, they say, must follow. Indeed, if the uterus were not to contract sufficiently, when the fœtus and afterbirth had come away, the bleeding would really be perilous. But when the fœtus is extracted, together with the placenta and membranes, the uterus contracts, just as it does after a natural labour. Besides, even when the mother is alive, the operation is not commonly done till the uterus evinces a propensity to deliver itself, and begins to contract. The womb being delivered of its contents, the incision becomes closed, the vessels obliterated, and there is no fear of hæmorrhage. The wound must also make so irritable an organ more disposed to contract; but whatever arguments may be adduced, it is enough to say in this case: *Artem experientia fecit, exemplo monstrante viam.* Rousset, in 1851, published a work, in French, entitled, *Hystérotomie, ou l'Accouchement Césarien.* This book, in 1601, was translated into Latin, and enlarged with an appendix by the celebrated Bauhin. Even then, the practice of the Cæsarean operation on the living mother had its defenders. Bauhin relates that, in the year 1500, a sow-gelder performed the Cæsarean operation on his wife, *tam feliciter, ut ea posteà gemellos et quatuor ad huc infantes enixa fuerit.*

The possibility of operating successfully on the living mother, was proved with great perspicuity and accuracy by Simon. (See *Mémoires de l'Acad. de Chirurgie*, t. i. 4to.) But, if the life of the mother should not invariably be preserved, the Cæsarean operation ought not to be rejected on this account; it ought always to be done when relief cannot be obtained by other means; just as amputation and lithotomy are practised, though they are not constantly followed by success. Would any thing be more cruel than to abandon a mother and her child, and leave them to perish, while there is any hope of saving them both? It is true that when a pregnant woman dies of any inward disorder, and not from the pains and efforts of labour, the fœtus is sometimes still alive in the uterus; but, in cases of death after difficult labours, and the great efforts made by the uterus to overcome the obstacles to parturition, the fœtus is generally dead; and the operation therefore is less likely to be availing. (See *Bertrandi, Traité des Opérations de Chirurgie*, chap. v.)

It is the opinion of the best writers upon this subject that whenever a woman dies far advanced in pregnancy, the performance of the Cæsarean operation is highly proper. The propriety of this practice, in such circumstances, was known to the ancient Romans; for, by a decree of Numa Pompilius, no woman who died pregnant was suffered to be buried ere her body had been opened, with the view of preserving the infant for the use of the state. (*Sprengel*, *Geschichte der Chir.* th. i. p. 371.) Experience has proved that when the fœtus has not attained the period at which parturition commonly happens, it will sometimes survive the operation a considerable time, and that when it is full grown its life may be most happily preserved. Although instances are cited in which the fœtus in utero has been found alive upwards of four-and-twenty hours after the death of the mother, little stress should be laid on such prodigies. The operation ought to be done without any delay. Even then, we are not certain of saving the infant's life. In the greater number of instances, the fœtus perishes at the same time with the mother, and from the same causes. The cases, which are recorded of the fœtus being extracted alive, after the death of the mother, are numerous: I shall here only refer to three, two of which rest on the unimpeachable authority of Flajani, who was himself the operator. (*Osservazioni, &c. di Chirurgia,* t. iii. p. 144—146.) In one of these instances, the operation was done on a woman, killed by violence, in the ninth month of pregnancy; the child lived six hours: in the other, a fœtus was extracted from a woman who had died of typhus fever, in the seventh month, and though the operation was not done till she had been dead about an hour, the child was taken out alive, and continued to live full ten minutes. A living child was also taken out of its mother by Vesling, after her death from typhus. (*Welsch. Obs. Med. Episagm.* No. 74, p. 47; *Sprengel, Geschichte der Chir.* th. i. p. 374.) On the 15th of April, 1820, Mr. Green, of St. Thomas's Hospital, extracted by the Cæsarean operation, from a woman suddenly killed in the ninth month of pregnancy by the passage of a stage coach over her, a fœtus that lived thirty-four hours after its removal from the uterus. (See *Med. Chir. Trans.* vol. xii. p. 46.) With respect to the statements of Cangiamila, a Sicilian practitioner, I join Sprengel in considering them as incredible exaggerations: five instances are given in which the fœtus was taken out of the mother from fifteen to twenty-four hours after her death, and yet it continued to live. Cangiamila says that, at Syracuse, in the course of eighteen years, the operation had been practised twenty times under the same circumstances; that at Girgenti, thirteen children were saved out of twenty-two women, who had died pregnant; and that, in twenty-four years, at Montereali, twenty-one children were preserved in the same manner. (*Embryologia Sacra. Venet.* 1763, fol.) As Sprengel remarks, one might almost suppose, from this account, that in Sicily pregnancy was generally fatal.

If the mother should happen to die in labour, and the neck of the uterus were sufficiently dilated, or disposed to be so, an attempt should be made to accomplish delivery in the ordinary way; for examples have occurred, in which women supposed to be dead in this circumstance, were in reality alive. Hence, we find that the Senate of Venice, in 1608, enacted a law, by which practitioners were liable to punishment in case they neglected to operate with as much caution on a pregnant woman supposed to be dead as on the living subject; and rules to be observed were again issued by the same government in 1720. (*Sev. Melli, La Commare levatrice,* p. 108. 4to. *Venez.* 1721; *Personè, Diss. sopra l'Operaz. Cesar.* p. 15. 8vo. *Venez.* 1778.) A law to the same effect was likewise made in 1749, by the king of Sicily, who decreed the punishment of death to those medical men who omitted to perform the Cæsarean operation on such women as died in the advanced stages of pregnancy. The following case, confirming the propriety of such caution, was recorded by Rigaudeaux, surgeon to the Military Hospital at Douay. This practitioner having been sent for to a woman, to whose residence he was unable to proceed till two hours after her apparent death, he had the sheet, with which she was covered, removed, and perceiving that the body retained its suppleness and warmth, he tried whether the fœtus could not be extracted in the ordinary way, which was easily effected as soon as the feet were got hold of. The first endeavours to save the child were very unpromising; but, after a few hours, they had the desired effect. As the woman continued in the same state five hours afterwards, Rigaudeaux recommended that she might not be buried before her limbs were quite cold and stiff. He afterwards had the satisfaction to learn that she was also restored to life. This remarkable case happened on the 8th of June, 1745, and both the mother and child were living at the period when Rigaudeaux published. (See *Journ. de Savans, An.* 1749.)

Almost all the insurmountable obstacles to delivery originate from the bad conformation of the pelvis, depending upon rachitis; though they are not an invariable consequence of it, since there are women, extremely deformed, in whom no imperfection of the pelvis exists, while it prevails in others whose shape is but trivially disfigured. An examination of the dimensions of the pelvis is the right mode of ascertaining whether there is really such an impediment to parturition. [It becomes important therefore to determine what degree of distortion and consequent narrowing of the dimensions of the pelvis would warrant the performance of this operation. Authorities differ considerably on this point. M. Velpeau gives the diameters of the pelvis in 62 cases. In 30 of these the antero posterior diameter was from two to two inches and three quarters, in the remaining 32 from one inch to two inches. Dr. Simpson remarks that in the 30 cases in which the diameter was from two inches to two inches and three quarters the operation would not have been performed in this country. Amongst the latest authorities in Germany and France (see *Manual of Obstetrics by Dr. Tyler Smith,* p. 608) we find Bash and Moser stating that the Cæsarean section is the only practical mode of delivery when the diameter of the pelvis is two inches and a quarter or less, and the Cæsarean section is indicated when the child is alive if the diameter is from two and a quarter to three inches. Jacquemier is of opinion that when the child is dead and the pelvis is below two inches in diameter hysterotomy is the only justifiable operation, or when, in the case of a live child, it varies from two inches to two inches and a half. Dr. Meigs states that he considers the Cæsarean section inevitable in diameters of an inch to an inch and a half, but that he should not hesitate when a patient was in imminent danger to operate when the pelvis was from two to two inches and a half in diameter. He relates a case where the diameter was not beyond two inches, in which he delivered by embryotomy on two occasions, but in which the Cæsarean section was afterwards performed twice successfully, and once under his own sanction. Dr. Churchill observes, we may safely conclude that when from any cause, the antero posterior diameter of the upper outlet or the transverse diameter of the lower is not more than one inch and a half there is no possibility of delivery "per vias naturales," but that we must have recourse to the Cæsarean section. Dr. Ramsbotham considers the Cæsarean section the only alternative in labour at the full term, when the antero posterior diameter is one inch and three eighths, and three inches and a half at the brim laterally, or with an antero posterior diameter of an inch and a half by three inches. According to Dr. Tyler Smith the limits of the performance of the Cæsarean section only ranges between a two inch diameter of pelvis from deformity, and its entire occlusion from exostosis, or if cases can ever occur in which the operation is necessary above two inches, they are cases in which death is threatened or certain before the lengthened operation of embryotomy could be completed.]

But how are we to form a judgment respecting the dimensions of the pelvis? And how can we know, whether that diameter, which extends from the prominence of the sacrum to the os pubis, is long enough to allow the passage of the child?

In order to acquire more correct opinions, double compasses have been employed. The branches of the first being applied to the top of the sacrum, and middle of the mons veneris, three inches are to be deducted from the dimensions indicated by the instrument; viz. two inches and a half for the thickness of the upper part of the sacrum (which is said to be constant in subjects of every size), and half an inch for that of the os pubis. In women who are exceedingly fat, some lines must also be deducted on this account. Hence, when the total thickness of the pelvis, measured in this direction, is five inches, there will remain two for the distance from the upper part of the sacrum to the os pubis, or for the extent of the lesser diameter of the upper aperture of the pelvis.

For taking the measurement internally, a kind of sector was invented by Coutouly. It bears a considerable resemblance to the instruments employed by shoemakers for measuring the feet. It is passed into the vagina, with its two branches approximated, until one arrives opposite the anterior and upper part of the sacrum, when the other is to be drawn outward, so as to be applied to the pubes. The distance between the branches is judged of by the graduations on the instrument. This was named by its inventor a pelvimeter. According to Sabatier, it is not always easy to place it with accuracy; its employment is attended with some pain; and there are particular cases in which it cannot be used.

Instead of this contrivance, Baudelocque reommended a means which is safe and simple. The index finger of one hand is introduced into the agina to the upper part of the projection of the acrum. The finger, having the radial edge turned orwards, is then to be inclined anteriorly till it ouches the arch of the pubes. The point of conact being then marked with the opposite hand, the ength from the point in question to the end of the finger is to be measured. This length, which indicates the distance between the sacrum and the bottom of the symphysis pubis, usually exceeds that of the lesser diameter of the pelvis by about six lines. Baudelocque acknowledges that this measurement is not exactly accurate; but he believes it to be sufficiently so, because, unless the narrowness of the pelvis be extreme, two or three lines hardly make any difference in the facility of parturition.

The following is the description of the pelvis of the woman, twice operated upon by Dr. Locher: the ossa pubis, which should be on the same level with the promontory of the sacrum, were found perpendicularly under it; so that the child necessarily extended the abdominal integuments, by its own weight, into a pendulous bag overhanging the thighs. For the same reason, nothing could be felt of the child by examination per vaginam. The sacrum, instead of closing the pelvis behind, by a semicircular curve, which forms a kind of conductor for the child in parturition, stretched nearly horizontally backwards. A representation of this pelvis, with a few other particulars, may be seen in the *Med. Chir. Trans.* vol. xi. p. 199.

The pelvis may be everywhere well formed, and yet present an insurmountable obstacle to delivery. This may happen when an exostosis exists on one of the bones which compose this part of the skeleton. Pineau met with a case of this description in a woman who died undelivered. The tumor originated from one of the ossa pubis. A steatomatous swelling, situated with the head of the child in the upper aperture of the pelvis, might produce the same effect, unless it were detected, and could be pushed out of the way, so as to make room for the fœtus to pass. Baudelocque mentions a swelling of this kind. It was six or seven inches long, and an inch and a half in width. The extremity of it, which was as large as half a hen's egg, had a bony feel, and contained nine well-formed teeth, the rest of the mass being steatomatous. It had descended into the lesser pelvis below the projection of the sacrum, and a little to one side. It might have been taken for an exostosis of this last bone. The labour-pains continued sixty hours, and the propriety of performing the Cæsarean operation was under consideration. Baudelocque was averse to this proceeding. He recommended turning the child, and extracting it by the feet, because he thought that the pelvis was sufficiently capacious to admit of delivery. The event proved that it was three inches nine lines from before backward, and four inches nine lines transversely. The fœtus was soon extracted with the assistance of forceps. The child was still-born. The mother, exhausted with numerous unavailing efforts, only survived between fifty and sixty hours.

Among the insurmountable obstacles to delivery may be reckoned such a displacement of the uterus, that it protrudes from the abdomen, and forms a hernia. The records of surgery contain some examples of this extraordinary occurrence. Twice has the Cæsarean operation been performed under such circumstances, and, in one of the cases, the woman survived so long, that hopes were entertained of her recovery. Indeed, as Sabatier observes, why should not the operation succeed in such a case, where the uterus is only covered by the integuments, and there is no occasion to cut into the abdomen, just as well as in other instances, in which it is indispensable to divide the muscles and open the cavity of the belly? In the other case on record, delivery was effected in the ordinary way, either by raising the abdomen, and keeping it in this position with towels skilfully placed, or by making pressure on the uterus, which had the beneficial effect of making this organ resume its proper situation.

Having shown the absolute necessity for the Cæsarean operation, under certain circumstances, it remains to consider the proper time for performing it, the requisite preparatory means, and the method of operating.

With regard to the time of operating, practitioners do not agree upon this point; some advising the operation to be done before the membranes have burst, and the waters have been discharged; others, not till afterwards. The arguments in favour of the first plan, are, the facility with which the uterus may be opened without any risk of injuring the fœtus, and the hope that the organ will contract with sufficient force to prevent hæmorrhage. The advocates for the second mode, assert that, in operating after the discharge of the waters, there is less danger of the uterus falling into a state of relaxation, in consequence of becoming suddenly empty after being fully distended, that the risk of the liquor amnii escaping into the peritoneal cavity is avoided, and that this method does not demand so extensive an incision. Hence they recommend, as a preliminary step, the membranes to be opened. Whatever conduct be adopted, it is essential that the labour should be urgent and unequivocal, that the cervix uteri should be effaced, and that the os tincæ should be sufficiently dilated to allow the lochia to be discharged; but, at the same time, says Sabatier, if the operation is not to be done till after the escape of the waters, there ought not to be too much delay, lest the patient's strength should be exhausted, and the violent efforts of labour should bring on an inflammatory state of the parietes of the uterus. [Kayser's tables show that the mortality to the mother is increased by any delay beyond seventy-two hours from the commencement of labour, and that the greatest amount of success has attended those cases which were operated on before or within six hours of the rupture of the membranes. Delay has proved still more destructive to the child, the mortality increasing in proportion to the duration of the labour after the first twenty-four hours. Indeed it may be stated that the operation is so much the more unfavourable both to mother and child, as a greater time has elapsed after the rupture of the membranes.]

The propriety of emptying the rectum and bladder is so evident, that it is unnecessary to insist upon it. This precaution is more particularly requisite in regard to the latter of these viscera, which has been known to rise so much over the uterus as to conceal the greater part of it. Baudelocque had occasion to remark this circumstance in a woman upon whom he was operating. The bladder ascended above the navel, and presented itself through the whole extent of the opening made in the parietes of the abdomen.

The instruments, dressings, &c. which may be wanted, are two bistouries, one with a convex edge, the other with a probe-point; sponges, basins of cold water; long strips of adhesive plaster; needles and ligatures; lint; long and square compresses; a bandage to be applied round the body, with a scapulary, &c.

For the purpose of undergoing the operation, the patient should be placed at the edge of her bed, well supported; her chest and head should be moderately raised; her knees should be somewhat bent, and held by assistants, one of whom ought to be expressly appointed to fix the uterus by making pressure laterally, and from above downward, so as to circumscribe, in some degree, the swelling of the uterus, and prevent the protrusion of the bowels. These things being attended to, the integuments are to be divided with the convex-edged bistoury to the extent of at least six inches. The place and direction of this incision differ with different operators.

In the most ancient method, it was customary to make the incision between the outer edge of the rectus muscle, and a line drawn from the anterior superior spinous process of the ilium to the junction of the bone of the first rib with its cartilage. This cut was begun a little below the umbilicus, and was continued downward to an inch above the pubes. After the integuments had been divided, the muscles, aponeuroses, and peritoneum were cut, and the uterus cautiously opened. The left index finger was then introduced into this viscus, the wound of which was dilated by means of a probe-pointed bistoury.

This manner of operating is subject to great inconveniences both on account of the direction of the muscular fibres and from the close proximity of blood-vessels. The fibres of the uterus also are cut transversely, so that the edges of the incision gape, instead of being in contact. This last circumstance may the more readily permit the lochia to escape into the abdomen, inasmuch as the uterus is cut nearly through its whole length, and there is no cavity, in which they can accumulate, in order to be discharged through the cervix of that organ.

The linea alba has been frequently considered the most eligible place for making the incision. It was the method adopted by Soleyrès and Deleurye, and it had the recommendation of Baudelocque, because there are fewer parts to be cut, and when the uterus is exposed, an incision, parallel to its principal fibres, may be made in its middle part. The method was known to Mauriceau, as we may be convinced of by the following passage, extracted from the chapter in which he treats of the Cæsarean operation: "*La plupart veulent qu'on incise au côté gauche du ventre; mais l'ouverture sera mieux au milieu entre les muscles droits, car il n'y a en ce lieu que les tégumens et les muscles à couper.*" Lauverjat, who has made this remark, and cited the Latin edition of Mauriceau, page 247, also observes that the incision in the linea alba was practised by a contemporary of La Motte, a circumstance which Sabatier was not able to ascertain. (*Méd. Opér.* t. i.) The following is the proper manner of operating in the linea alba. The bladder is to be previously emptied. The operator should first divide the integuments perpendicularly, so as to expose the linea alba, making the wound six or seven inches long. An opening should then be carefully made through the aponeurosis, fascia transversalis, and peritoneum, into the abdomen, either at the upper or lower part of the linea alba in view. A curved bistoury is then to be introduced into the opening, and the peritoneum, fascia transversalis, and linea alba cut from within outward, as far as the extent of the wound in the integuments. The latter cut should be cautiously made with the crooked bistoury, guided by the forefinger of the left hand, lest any of the intestines be accidentally injured. The uterus must next be carefully opened, and an incision made in it, of the same length as the preceding wound. The fœtus is to be taken out through the wound, and then the placenta and membranes. In this way, M. Artiste lately operated, so as to save both mother and child. (See *Edin. Med. and Surg. Journ.* vol. iv. 178.)

In this country (where, indeed, the Cæsarean operation has proved most unsuccessful) the linea alba is preferred, I believe, by the majority of practitioners. That the method is not always attended with the formidable objections urged against it by Sabatier, is quite certain; the case published by Dr. Chisholm is a decisive proof of this assertion. (See *Edin. Med. and Surg. Journ.* vol. iv. p. 178, 179.)

A third method of performing the abdominal Cæsarean operation, consists in making a transverse incision, five inches in length, through the parietes of the abdomen, between the rectus muscle and the spine, and in a situation more or less high, according to the more or less elevated position of the uterus. This plan was recommended by Lauverjat. (See *Nouvelle Méthode de pratiquer l'Opération Césarienne.* Paris, 8vo. 1788.) Lauverjat acknowledges, that the method had been successfully practised by different persons before himself, and especially in one instance, which was particularly remarkable, as, in consequence of the first incision having been made too high up, it became necessary to make a second one, which extended obliquely from the other.

The side on which the operation is to be done, is in itself a matter of indifference. But, if the liver or spleen were to project, one ought to avoid it. Also, if the uterus were to incline more towards one side than the other, it would be proper to operate on the side where this viscus could be most conveniently exposed. The patient being put in a proper position, and her abdomen kept steady by an attendant, who must apply the palms of his hands to the sides of the uterus, the integuments, muscles, and peritoneum are to be divided with the usual precautions. The uterus is then to be opened, and the wound in it enlarged in the requisite degree, by means of a probe-pointed bistoury. Should the placenta present itself, care must be taken not to injure it; but it should be separated, in order to facilitate breaking the membranes at its circumference. The child is next to be extracted. This part of the operation is subject to no general rule.

Delivery being accomplished, we are recommended to introduce through the vagina anodyne injections, in order to lessen spasm, and wash out the coagula. This method is preferable to that of clearing out the uterus with the hand. Sabatier condemns the plan, formerly advised by Rousset and Ruleau, of passing a catheter up the neck of this viscus for the purpose of washing out the lochia, as well as the absurd proposal of employing a seton to promote their escape. Should the lochia not pass readily outward, we are recommended to introduce the finger occasionally into the cervix uteri, so as to free it from coagula.

The only dressings advised by Sabatier are a large pledget, compresses, and a moderately tight bandage round the body. These are to be changed when soiled with the matter or discharge. In this country, practitioners would not neglect to bring the edges of the wound together, by means of sutures and strips of adhesive plaster, in order to promote the healing of the wound by the first intention.

Mr. Wood, of Manchester, performed the Cæsarean operation, in a case where parturition was prevented by deformity of the pelvis. The incision was made nearly in a transverse direction, on the left side of the abdomen, about five inches in length, beginning at the umbilicus. This part was fixed upon, because the nates of the child could be felt there, and it was evident that no intestine was interposed betwixt the abdominal parietes and the uterus. There was scarcely any effusion of blood, either from the external wound or from that of the uterus, though the latter was made directly upon the placenta. Instead of dividing the placenta, Mr. Wood introduced his hand betwixt it and the uterus, and, laying hold of one of the knees, extracted the fœtus with ease. His hand readily passed betwixt the placenta and uterus; this produced hæmorrhage; but the whole quantity of blood lost did not exceed seven or eight ounces. After the uterus had been emptied, the intestines and omentum protruded at the wound. These having been reduced, the integuments were brought into contact with sutures and adhesive plaster. This operation, however, did not save the woman's life; she died on the fourth day after its performance. (See *Med. and Physical Journal.*)

[It may be here mentioned that Dr. Aitken suggested that the operation should be performed under tepid water, in order to exclude the air from the peritoneal cavity and to preserve the temperature of the body.]

OF OPERATING WHEN THE FŒTUS IS EXTRA-UTERINE.

Delivery cannot possibly happen in the ordinary way when the fœtus is situated in the ovaries, or Fallopian tube, or in the cavity of the peritoneum. However, there are many instances recorded of ventral pregnancies, which the mothers survived, the dead fœtus having been discharged by fragments out of an abscess in the parietes of the abdomen. About the year 1820 I had an opportunity of seeing a case, under Mr. Gunning, in St. George's Hospital, in which the child was discharged piecemeal from an abscess of the abdomen; and I saw another case, under Dr. Blicke of Walthamstow, in which portions of bone and a great deal of matter had been voided through the vagina, though the swelling was altogether on the right side.

Practitioners are occasionally called upon to do a very similar operation to the Cæsarean, when the child has passed into the cavity of the peritoneum, in consequence of the rupture of the uterus. Unfortunately such an accident is not uncommon, and though the causes of it may not be obvious, nothing is more certain than that the fœtus itself is entirely passive, and has no share in producing the misfortune. The symptoms by which the event may be known are not always clear. When, however, the pains have been violent; when the last, after being excessively severe, has been followed by a kind of calm; when the countenance loses its colour, the pulse grows weak, and the extremities become cold and covered with a cold sweat; when the abdomen is generally flat and only partially affected with the swelling occasioned by the fœtus, which either continues to move, or is dead and motionless; when the patient complains of a moderate degree of heat about the belly; and, lastly, when the child shrinks from the touch of the accoucheur; it is manifest that the uterus is lacerated. If the child has passed completely into the abdomen, its extraction by incision is the only resource; and whether this should be attempted or not, must depend upon circumstances. If a part of the child, however, were yet in the uterus, it might be extracted, with the aid of the forceps, if the head presented, or by the feet, provided only the upper part of the body were in the abdomen.

Baudelocque quotes three instances of gastrotomy, performed on account of rupture of the uterus. The first is that inserted by Thibaud Dubois, in the *Journal de Médecine*, for May, 1760. Every preparation was made for a natural labour, when, after excessively violent pains about the upper and left parts of the uterus, the child disappeared. Thibaud opened the abdomen, though not till some hours after the accident. The infant was dead; but the mother experienced no ill effects after the operation, except such as are usual after ordinary labours.

The second and third cases were communicated to the French Academy of Surgery, in 1775, by Lambron. He practised the operation twice, on the same woman, with success. In the first instance, he operated eighteen hours after the rupture of the uterus. The child was dead. An ill conditioned abscess formed near the wound; but the patient got quite well in the course of six weeks. She was pregnant again the following year, and the uterus was once more ruptured. Lambron now had recourse to the operation without delay. The child betrayed some signs of life, but soon died. The mother not only survived, but afterwards became pregnant again, and had a favourable delivery.

Dr. Locher, of Zurich, saved both the mother and child by the Cæsarean operation, performed in the linea alba. After her recovery, a small point of the wound, not exceeding two or three lines in length and breadth, required a long time to be quite healed, though no particular inconvenience was experienced from it. Some time afterwards the cicatrix gave way again, and a portion of omentum protruded, which was reduced, when a piece of bowel came out, and was also returned. The edges of the wound were then brought together; but a small superficial ulcer continued open in spite of every effort to close it. In 1818, the year following that in which the Cæsarean operation had been performed upon her, she became pregnant again, and the chief particularity, which happened during gestation, was an increase in the size of the preceding ulcer, which became three inches in width. The sore, however, was covered with charpie, and the integuments well supported with adhesive plaster. On the 23rd of May, she was seized with labour-pains; and, about seven in the evening, she complained all at once of a very acute pain, and at the same moment voided a considerable quantity of blood from the vagina. On examining by this passage nothing was discovered; but when the hand was applied below the navel, in the line of the old wound, and under the ulcer, a circumscribed firm swelling was felt, caused by the child's head, of which the sutures were plainly discernible. Dr. Locher naturally concluded that the uterus had burst, so as to allow the child to escape, and the hæmorrhage was thus easily explained. A repetition of the Cæsarean operation was deemed indispensable. The place of the incision was determined by the round swelling, caused by the child's head. An incision six inches in length, was made into the abdomen, where a quantity of coagulated blood was found. When this had been removed, the membranes presented themselves, exhibiting a bluish hue, and, after they had been opened the head of the child immediately appeared. The navel-string passed round the neck, and was also compressed in the opening of the uterus. The child evinced no signs of life. The placenta came away during the attemps to reanimate the child. The uterus contracted, and there was little bleeding. This patient, after a good deal of indisposition, and occasional approaches to a perfect recovery, was at length attacked with inflammation of the stomach and bowels, and died on the 9th of July, nearly two months after the operation. The uterus was found contracted to a small size, with an opening, of about the size of an almond, on its anterior surface, with a rounded callous edge. This aperture Dr. Locher thinks had remained ever since the first operation, and had allowed the escape of the child in the second labour; a circumstance which may be doubted, as the hæmorrhage indicated the period when the uterus had been lacerated, as this gentleman indeed has in one place particularly noticed himself. (See *Med. Chir. Trans.* vol. xi. p. 182, &c.) An almost incredible case is related of what may be called a Cæsarean birth, effected solely by the powers of nature, and, as would appear, by a sudden rupture of the uterus and parietes of the abdomen, after the patient had been in labour three days. (See *Essays and Obs. Physical and Literary.* vol. ii.)

A laceration in the uterus, or the wound made in this viscus in the Cæsarean operation, may give rise to dangerous and even fatal symptoms of strangulation, if any of the intestines insinuate themselves into the preternatural opening. When such an occurrence happens in the performance of the preceding operation, the intestine must be directly withdrawn and replaced. If the accident were to happen when the child is extracted in the natural way, the bowel is to be pushed back into the abdomen from the uterus. Were the occurrence to take place several days after the operation, Sabatier inquires, what ought to be done? A surgeon is said to have pushed back the intestine from the uterus as late as the third day. Sabatier thinks, that later it could not be done. In this circumstance, Baudelocque advises the operation suggested by Pigrai, namely, that of opening the abdomen and withdrawing the bowel from the place in which it is incarcerated.

Gastrotomy has not only been recommended for cases where the child had passed into the abdomen through a rupture of the uterus; it has likewise been advised for instances in which the fœtus has grown in the Fallopian tube, ovary, or cavity of the abdomen. Here, indeed, the operation deserves to be called Cæsarean; for, in addition to the incision in the skin and muscles of the abdomen, it is necessary to open the pouch in which the child is contained. The instances of conceptions in the Fallopian tube are not uncommon. Those in the ovary, and cavity of peritoneum, are more rare. Sabatier conjectures, that most of the cases reported to be of the latter kind, if attentively examined, would have been found to be in reality conceptions in the Fallopian tube.

Extra-uterine conceptions hardly ever arrive at maturity. However, the fœtus formed in the Fallopian tube has sometimes been known to attain the term of nine months and then die either from the impossibility of its expulsion or from the insufficiency of the nourishment afforded it. The pouch in which it is contained and the neighbouring parts have then inflamed, and, after becoming connected together by numerous adhesions, have suppurated. The abscess has burst, partly at some point of the circumference of the belly, and partly into the rectum, vagina, or bladder; and the dead fœtus has been discharged piecemeal with the matter.

In other examples, the fœtus, instead of giving rise to abscesses, has become ossified with the enveloping membranes, and continued in this state many years, without any other inconvenience to the patient than what depended on the size and weight of the tumor within the abdomen.

Most frequently, however, the pouch containing the fœtus bursts, about the middle of the ordinary period of gestation, and the child passes into the cavity of the peritoneum. At the same moment, the blood-vessels, ramifying on the parietes of the containing parts, usually pour forth into the abdomen so much blood that the patients generally die in the space of a few hours. (*See a case by Dr. Clarke in Trans. of a Society for the Improvement of Medical and Chirurgical knowledge. Also another, adverted to by Sir C. Bell, in Med. Chir. Trans.* vol. iv. p. 340.)

Two facts of this kind fell under Sabatier's observation. The women were in the end of the fourth month of pregnancy. Excepting a swelling, which affected only one side of the abdomen, and frequent dragging pains in this cavity, there was no indication of anything extraordinary. In other respects, the patients were well. They were both, all on a sudden, attacked with extremely acute pains, which lasted two or three hours. A more violent suffering than the rest was followed by entire ease. The abdomen subsided, and became flat. An equal moderate warmth diffused itself over this part of the body. The skin lost its colour. Almost continual syncopes occurred. The pulse became feeble and concentrated. Cold perspirations ensued, and the women died. The rapid course of these symptoms rendered it impossible for Sabatier to be of any service. The patients were actually dying when he was called to them. The examination of their bodies evinced that the abdomen contained a large quantity of blood; that the fœtuses lay on the intestines, connected with the lacerated Fallopian tube by means of the umbilicial cord; and that the tube itself, which was strongly contracted, presented no other tumor except that which depended on the after-birth.

There is nothing that announces an extra-uterine pregnancy with sufficient certainty to justify any positive conclusion respecting the nature of the case, before the ordinary time of parturition. In many women, the gravid uterus inclines to one side, and numerous pregnant females have dragging pains which may depend upon other causes. Things, however, are different when the fœtus has lived to the ordinary period of parturition, and the woman is attacked with labour-pains; because, besides the unequivocal signs of the presence of a child in the abdomen, the womb is empty, and is little changed from its common state. Should we now, asks Sabatier, have recourse to the Cæsarean operation, just as if the fœtus were in the womb? Can we be sure that the pouch which contains the child will contract like the uterus, and that the incision which is in contemplation will not give rise to a fatal hæmorrhage? Would it be easy to separate and remove the whole of the placenta? How could the discharge, analogous to the lochia, find an outlet, and would not its extravasation in the abdomen be likely to prove fatal? Sabatier thinks, that the risk which is to be encountered is much less when things are left to nature. The child, indeed, must inevitably perish. It will either give rise to abscesses, with which it will be discharged in fragments, or it will remain for a length of time in the abdomen, without any urgent symptoms. Sabatier also calls our attention to the great precariousness of an infant's life, and expresses his opinion that there can be no difficulty in deciding what conduct ought to be adopted. Happily, practitioners are not often placed in circumstances so delicate, and extra-uterine conceptions mostly perish, before the end of the common period of gestation. We have then only to second the efforts of nature; either by promoting suppuration, if it should seem likely to occur; by making a suitable opening, or enlarging one that may have formed spontaneously; by extracting such fragments of the fœtus as present themselves; by breaking the bones, when their large size confines them in the abscess, as Littré did in an instance where the abscess burst into the rectum; and, lastly, by employing suitable injections.

An extremely uncommon case of extra-uterine conception was related a few years ago by Josephi; the fœtus having at length passed into the bladder by ulceration, and caused such affliction as rendered cystotomia indispensable, with the view of extracting the parts of the fœtus lodged in that organ. The operation was done above the pubes; but the internal mischief already existing was so great, that the patient did not recover. (*Ueber die Schwangerschaft ausserhalb der Gebärmutter*; Rostock, 1803, 8vo.)

Govei, p. 401, relates a case of ventral conception, in which instance the Cæsarean operation was done and the child preserved. A lady, aged twenty-one, had a tumor in the groin, which was at first supposed to be an epiplocele, but an arterial pulsation was perceptible in it. In about ten weeks the swelling had become as large as a pound of bread. Govei, solicited by the lady, opened the tumor. He first discovered a sort of membranous sac, whence issued a gallon of limpid fluid. The sac was dilated, and a male fœtus found, about half a foot long, and large in proportion. It was perfectly alive, and was baptized. After tying the umbilical cord, the placenta was found to be attached to the parts just behind, and near, the abdominal ring; but it was easily separated. Govei does not mention whether the mother survived. Bertrandi was unacquainted with any example of the Cæsarean operation being done, in cases of extra uterine fœtuses, so as to save both the mother and infant. This eminent man condemned operating in ventral cases, on the ground that the placenta could not be separated from the viscera, to which it might adhere, or, if left behind, the subsequent inflammation and suppuration would be mortal. (See *Traité des Opér. de Chir.* chap. v.)

Ruth, a surgeon in Upper Silesia, performed the Cæsarean operation successfully in a case of extra-uterine pregnancy of some years standing, during which period the woman became pregnant in the usual way, and was safely delivered. (See *Graefe und Walther's Journ.* part 3, vol. vi.) The particulars, which are well deserving of the attention of obstetric practitioners, may also be found in one of our own periodicals. (See *Edinb. Med. and Surg. Journ.* vol. xxiii. p. 429.)

Whenever the Cæsarean operation, or gastrotomy, has been performed, the practitioner is not merely to endeavour to prevent inflammation, heal the wound, and appease any untoward symptoms which may arise ; he should also prevail upon the mother to suckle the child, in order that the lochia may not be too copious ; and, after the wound has been healed, she should wear a bandage, for the purpose of hindering the formation of a ventral hernia.

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CALCULUS. Calculi form in the kidneys, bladder, prostate gland, urethra, gall-bladder, &c. ; also in the ducts of the salivary glands ; and in the lachrymal sac. (See *Graefe's Journ. für die Chir.* No. i. Berlin, 1820.) For an account of stones in the bladder, refer to Urinary Calculi.

CALCULUS IN THE INTERIOR OF THE EYE. (See Eye, &c.)

CALLUS, *New-bone,* or the osseous substance which serves to unite the ends of a fracture. The process by which it is formed, and the differences between the *provisional* and the *definitive* calli, will be explained in the article Fracture.

CALOMEL. (Hydrargyri chloridum, P. L. 1836 and 1851. Hydrargyri submurias, P. L. 1824.) Its extensive utility in surgical diseases will be conspicuous in a large proportion of the articles in this work. When prescribed as an alterative, the common dose is a grain once or twice a day ; when ordered as a purgative, from three to eight grains may be given ; and when directed with the view of exciting salivation from two to four grains, conjoined with opium, are usually administered night and morning, and in urgent cases, like iritis, sometimes oftener, till a full impression is made on the salivary glands, and system at large. (See Mercury.) [Calomel is also an excellent local application to condylomata (mucous tubercles) about the anus or vulva. The dry powder should be sprinkled freely on the surface of the affected parts.]

CAMPHOR. Is used externally, as a stimulant, and as a means of exciting the action of the absorbents, and thus dispersing many kinds of swellings, extravasations, indurations, &c. Hence it is a common ingredient in liniments. It has also the property of rousing the action of the nerves and quickening the circulation in parts on which it is rubbed. For this reason, in paralytic affections, it is sometimes employed. It is thought to accelerate the absorbent action of mercury ; few applications have greater power in exciting the absorption of any tumor or hardness than camphorated mercurial ointment.

Camphor has also been recommended for the relief of strangury, even that depending on the operation of cantharides. The experience of its effects, however, has been somewhat contradictory ;

for although it appears to have sometimes succeeded when given with this view, it not only does not always do so, but it has been known to cause an opposite effect, sometimes producing great scalding in voiding the urine, and pains like those of labour. (*Med. Trans.* vol. i. p. 470.) In chordee, its utility is generally acknowledged. Persons who cannot procure rest unless they take very large doses of opium, sometimes find smaller ones answer if combined with two or three grains of camphor. (See *Brande's Manual of Pharmacy*, p. 46.)

CANCER. (Derived from the Latin *cancer*, a crab, to which a breast affected with this disease, and surrounded by varicose veins, was anciently fancied to have a resemblance.) Also *Carcinoma*, from the Greek χαρχίνος. Although the terms *cancer* and *carcinoma*, considered with reference to their etymology, seem decidedly to possess little recommendation, the moderns employ them with a far more precise and settled meaning than the ancients, unenlightened as they were by pathological anatomy. Still our knowledge of cancer is not even now sufficiently advanced to enable us to answer, conclusively, various questions respecting it. (See *Bégin*, in *Dict. et Méd. et de Chir. Pratiques*, t. iv. p. 425.)

Formerly, a vast number of morbid alterations of structure, entirely different from one another, were confounded together under the name of cancer. The French ascribe to Laennec the merit of having first demonstrated the elementary texture of true cancer, and thus freed the subject from a great deal of confusion. I believe, however, that Home, Baillie, Hay, and Abernethy, had all promulgated their observations on cancer when Laennec published. According to the latter distinguished pathologist, the human body is liable to two classes of accidental productions, or new formations: to the first belong certain abnormal textures, to which some of the natural tissues are more or less analogous: to the second appertain other abnormal textures, which have nothing analogous to them in any of the primitive tissues of the body. Amongst the productions of the latter kind, Laennec arranged *tubercles*, *scirrhus*, the *encephaloid*, *cerebriform*, or (as we more frequently call it) the *medullary tumor*, and *melanosis*. Notwithstanding all or several of these abnormal elementary modifications of disease may exist in tumors vaguely called cancerous, yet, as M. Bégin well observes, and M. Laennec admits it himself, it is particularly to *scirrhus* and *cerebriform*, or *medullary* formations, that the term cancer is applied. In this article, I shall exclude from consideration *tubercles*, which British pathologists never regard as cancerous, but generally as a form of scrofulous disease. Neither shall I enter, at present, into the subject of *melanosis*, which, though sometimes regarded as a species of cancer; as, for instance, by M. Alibert, who terms it *cancer mélane* (see *Nosologie Nat.* t. i. 1817, 4to.), will admit very advantageously of separate consideration. (See MELANOSIS.) According to Professor Carswell, carcinoma does not admit of a precise definition, but it may be said to consist in the formation or deposition of a peculiar substance which presents a great variety of consistence, form, and colour; frequently assumes a definite arrangement, and possesses a vascular organisation of its own; gives rise to the gradual destruction or transformation of the tissues in which it is situated; affects simultaneously or successively a greater or lesser number of organs; and has a remarkable reproductive tendency. Both *scirrhous* and *medullary* cancer, have long been looked upon as *malignant diseases*, though not with that discrimination and precision of meaning, which the valuable remarks of Mr. Travers are likely to establish. This gentleman considers carcinoma as a genus of the order "malignant diseases;" and agrees with Laennec, Carswell, and other eminent modern pathologists, in enumerating two species of it; the *schirrous* and *medullary*. It is to incurableness from causes not local, and consequently the disposition to appear in more than one part at the same time, or to reappear when the first affected part has been freely removed, that Mr. Travers applies the term malignity. But if, from any local cause, a sore will not heal, or becomes gangrenous; if, by the extension of the ulcerative process, blood-vessels are opened, and fatal hemorrhage ensues; if, by the profuseness of a secretion, the patient dies exhausted: if, by the incessant irritation of the nervous system, or the morbid actions set up in vital organs under a protracted symptomatic fever, life is extinguished; the circumstances of the disease, viewed with reference to the above definition of malignity, would not imply that its nature was malignant. (See *Med. Chir. Trans.* vol. xv. p. 198.)

[Rokitansky enumerates the following characters of malignancy: (1) *Hetero-plastic structure*, the constituent elements being unlike those of the naturally existing tissues; (2) *Infiltrating property*, the morbid mass spreading to and involving all, even the most various tissues; (3) A remarkable tendency *to break up and decay* by *saniation*, not suppuration. To these Mr. Paget adds the following; (4) *Extension of ulceration* by continual increase, and succeeding decay of the growth; (5) *Dissemination*, the original growth reproducing itself in many different parts and tissues; (6) Indiscriminate invasion of all tissues. Now with regard to all these, it is to be remarked that none singly are pathognomonic of cancer, "each of them may be absent in tumors having all the other features of malignancy, and certain of them may be observed occasionally in tumors that in other respects appear non-malignant." Taking, however, all these together, there is no question that where all or most of them concur, there the stamp of malignancy is unequivocally manifest. The term is, indeed, not a scientific one, not capable of exact definition, and the features above indicated must be regarded as belonging to the most typical and marked state. In proportion as one or more of them are dimmed or effaced, so does the malignant character become diminished. It must, therefore, be clear that the question as to whether a given tumor is malignant or innocent, cancerous or non-cancerous, is not by any means always to be answered by a yes or a no. If a typically malignant instance be represented by 10, then x may be malignant as 6, 5, or 3.

Considering cancerous formations as constituting a *genus*, we may enumerate the following *species*. (1) *Scirrhus*, (2) *Encephaloid*, (3) *Colloid*, (4) *Epithelial*. These seem to possess sufficiently strong differential characters to warrant their separation from each other, and this the more especially as it seems tolerably well established that no transformation of one species into another occurs. Of two striking peculiarities of cancerous growths it may be said positively that they are accidental, and involve no special modification of structure or quality. These are the melanoid and hematoid conditions, which will be hereafter noticed as *varieties*. *Villous* cancer is ranked by Rokitansky as a variety of encephaloid, but Mr. Paget states that either scirrhus, encephaloid, or epithelial may observe this mode of growth. *Osteoid* cancer seems to be essentially an ossification of a medullary or fibrous cancer, the change taking place to a greater or less extent, or an osteophyte production shooting from a normal bone into a medullary growth attached to its surface.

These are the principal varieties of cancer which the student may expect to find, and, with regard to a great number of trivial names which have been invented to describe the appearance of certain tumors, there is no advantage in burdening the memory with them. One of these, the term *apinoid*, is, however, of some use, as expressing a real difference in the condition of the cancer; it corresponds to Muller's variety of carcin. reticulare. The *C. fasciculatum* of Rokitansky in its structure appears to have much resemblance to a fibrous tumor, and so far may be considered with the recurring fibroid tumor of Mr. Paget, as belonging to groups of somewhat indeterminate character, standing in a debatable ground between common innocent fibrous tumor and scirrhus with predominance of fibrous tissue. *Cystic* cancer implies the development of cysts in a cancerous mass, usually encephaloid or colloid.

Cancer possesses in an eminent degree the power of *independent growth*. This is remarkably displayed in some cases of encephaloid, where the new formation continues to grow luxuriantly and attain a prodigious size, while all the other tissues are shrinking and wasting. The morbid mass, by its superior assimilative power, drains the vital fluid well nigh to its last drop, and so destroys life by exhaustion. One can hardly wonder that some who were impressed with this remarkable quality of cancer should have imagined that it was a parasitic animal, an hydatid. The power of *reproduction after extirpation* is another most remarkable feature of cancer, and to this is due, in great measure, its deadly character. This shows that the cause of cancer, whatever it be, must be deep rooted in the vital endowment of the system.

From these general observations we now proceed to a particular account of the species and varieties of cancer.]

SCIRRHUS.

[A tumor of this kind, appearing in the female breast, is of extreme hardness, heavy, and rigid. Hence it has been called stone cancer. Its size is not often great, in most cases not equalling the part of the gland which it involves. Its shape depends, according to Mr. Paget, chiefly on that of the part which it affects: it is sometimes irregular, with projecting processes. The margin is generally well defined; but it has no investing capsule, it is not encysted. The surrounding tissues are contracted, and drawn in towards it: in an advanced case the skin or nipple is retracted, and the superficial fibres of the pectoralis major elevated to the mass. Radiating white lines are sometimes seen extending outwards from the cancer; these seem to be more often merely bands of condensed fibrous tissue than continuations of the morbid growth. Its cut surface is nearly uniform, of a pale greyish or bluish grey colour, with a certain glossiness and appearance of translucency. This ground, as it may be called, of the proper cancer substance, is often streaked or spotted by yellowish or dead white marks, which are either the remains of involved gland ducts or the results of fatty degeneration. Microscopic examination of such a cancer shows an abundant cell-growth traversed by fibres. The latter, according to Rokitansky, are of new formation, like the cells, and constitute a kind of skeleton, somewhat like that of a sponge, in which the cells are lodged. To the aggregate of these fibres the term *stroma* is commonly applied. Mr. Paget, on the other hand, thinks this view incorrect, and believes "that in the large majority of cancers of the breast, the only stroma, the only substance that would remain after removing all that is cancerous, would be the structure of the breast itself." He states, among other arguments which determine him to this view, that when scirrhus occurs in organs possessing little or no fibrous tissue it is itself as destitute. Our own experience does not confirm this statement, but rather supports the common opinion. In fact, we think Rokitansky is not far from the truth when he says, speaking of the cells and stroma of cancer generally, "the relative proportional amounts of these two constituents vary extraordinarily; preponderance of stroma with fibrous trabeculæ constitutes the so-called fibrous cancer; preponderance of cancer (cell) mass, according to its quality, makes the growth a medullary or a colloid. The following case, which I recently observed in the practice of my friend Mr. Winchester, seems conclusive:—Mrs. W., æt. 51, of robust make, and having generally had excellent health, died with copious effusion into the right pleura. She first noticed a tumor in her right breast about two years before her death. It grew at first slowly; but after sixteen months, when the catamenia ceased, it enlarged rapidly. When I saw it, the breast was much enlarged, with brawny thickening of the skin in and around it, extending to the axilla, and to the arm, and some way down the side. The arm was much swollen. Some time before death, a tumor was observed at the outer part of the left mamma. At the post mortem examination there was found extensive cancerous deposit on the right pleura, and some also in the right lung; the pleural formation exhibited well marked cancer nuclei, multiform cells, also with endogenous development, all imbedded in a fibroid stroma. The tumor in the right mamma was a large, very ill defined, mass, whity-grey, semi-translucent, and exceedingly firm. Its deeper part was more dense than the superficial, and adhered closely to the pectoralis major, which formed a thin pale layer, closely attached to the ribs. In structure it consisted of a solid homogeneo-granular blastema, passing more or less completely into fibroid stuff. Not a corpuscle was to be seen in it characteristic of cancer; but acetic acid brought into view a great number of ordinary looking nuclei, elongated for the most part, and often appearing to be developing fibres, like nucleus fibres of Henle, which included mesh-like spaces. The tumor in the left breast was perfectly circumscribed, at one part, at least; its structure was essentially the same as that in the right. It seems to me impossible to have a more perfect instance of fibrous cancer than this.

Dr. Walshe describes the stroma of scirrhus as having a special tendency to a rectilinear arrangement, and believes that this peculiarity serves to distinguish it from fibrous tumor, where the tendency is to curvilinear. The fibrous tissue constituting the stroma does not always consist of perfectly developed fibres ; it may be in great part a striated solidified blastema tending to fibrillate. Elongated nuclei may be seen in it, and the fibre-developing cells which occur among the others probably belong to it. It does not contain yellow elastic tissue.

The cell-growth of scirrhus consists fundamentally of nuclei, with which are mingled celloid forms, of the greatest variety of shape, and in very different stages of completeness. In viewing a thin, translucent section with a linear power of 3 to 400, one readily observes that the nucleoli are the prominent objects, and those which have most appearance of being constructed on a uniform and definite plan. They are large, often very large, present a well marked, sharp contour, and a nearly clear cavity, containing one or two nucleoli, often bright and refracting. The nucleoli are sometimes seen within an elongated nucleus, separated from each other by a notable interval ; a condition which probably indicates that transverse division of the nucleus is about to take place. In the case in which I observed this, the number of nuclei was very great ; in some parts they existed almost alone: the growth of the tumor had lately been very rapid. Mr. Paget states that the cells are usually of smaller dimensions in quick-growing cancers than in others of slower progress. This may be very probably true ; but I should rather say that an abundance of free nuclei is a characteristic of rapidly growing scirrhus. These nuclei, to which especial attention has been directed by Lebert, Bennett, and others, are considered by some to be characteristic of cancer ; and in this opinion Mr. Paget seems pretty nearly to agree. While I join with them in their opinion as to the import of these peculiar large nuclei, *when present*, I wish to lay stress, at the same time, on the point, that their absence is no proof of the non-existence of cancer. Mingled with them, when they are best marked, are numerous corpuscles, not to be distinguished from ordinary nuclei, and to which it seems to me quite impossible to refuse the cancerous character. In many abdominal growths there are few, if any, of the large nuclei, the bulk of the mass is made up of ordinary looking ones and celloid particles developed upon them. It is not uncommon to observe a strange modification of the nucleus, or its becoming converted into a large pellucid vesicle, contained in a still larger cell, within whose granulous contents it lies imbedded, sometimes alone, sometimes with one or two other nuclei of larger or smaller size, and variously modified. Several nuclei seem occasionally, while in the course of cell development, to have amalgamated their several cell-masses together, so that there results a large compound cell, enclosing three to five nuclei. When complete cells are formed, their shape is exceedingly various ; oval, or round, or angular, or with out-stretching processes tending as it were towards fibre-formation, or of pyriform, fusiform, reniform, or lanceolate shapes. But this variety of outer configuration is not the most important feature in the structure of these cells, but rather the circumstance that they show so many variations from the normal plan of cell development. The liver cells differ exceedingly in shape, but are all formed on the same plan. Not so the cancer cells ; they almost foil description in some cases, so manifold are their interior arrangements. This has been termed by Bruch the multiformity of cancer ; and a most important feature it is ; one of the most diagnostic with which I am acquainted. Mr. Paget states : "I know no innocent tumors, except the cartilaginous, in which it is imitated." Amid the cancerous cell mass corpuscles are very commonly found which correspond in all respects to the so-called *glomeruli*, and are evidently the result of fatty degeneration. Others, instead of enlarging, as the latter mostly appear to do, shrink up, and look stunted and withered, as they are figured by Mr. Paget. Rokitansky thus describes the fatty metamorphosis of cancer, which has just been noticed in the individual cells : "The cancer mass changes to a yellow, yellowish white, greasy, fatty substance, which occupies the meshes of the stroma, and constitutes the so-called *reticulum* of cancer, traversing them. Sometimes cretification takes place in its residue, and then the cancer mass becomes thickened into a fatty, calcareous mixture, and at last changed into mortar-like plugs, filling up the stromal interspaces." The condition of the cancer here described may appear in one of two forms : either it exists as separate spots, compared sometimes to seeds, which contrast by their colour and opacity with the greyish, translucent ground ; or as fine interlacing lines, which alone truly deserve the name of *reticulum*, or net-work. To the former the term "apinoid" is appropriate (*απιον*, a pear), there being considerable resemblance between the cut surface of a pear and of a cancer in this state. Mr. Paget believes that the apinoid appearance does simply indicate fatty degeneration of the cancer mass itself ; but the reticulated, he thinks, is peculiar to glandular organs, and, in the breast is "to be ascribed to the minuter lactiferous ducts, which, involved in the cancerous infiltration, are now, with their contents, compressed, degenerate, and wasting." It is a remarkable thing, how much of decay there may be in a scirrhus which at the same time is growing actively. In a scirrhous tumor of the ribs, from a male æt. 64, the cut surface showed a scanty greyish ground, almost quite occupied with dead-white spots or short streaks. The grey parts consisted of fibroid tissue imbedding corpuscles ; the white were masses in a state of fatty degeneration. It is easy to conceive that, by a continuation of the same process, the whole morbid growth might have become inert and dead. Rokitansky distinguishes another kind of degeneration, in which portions of cancer change into a yellow brittle tubercle-like substance, often surrounded by a red injected area. The cells wrinkle up, become deformed and more or less destroyed, and finally fused into a puriform or sanious flocculent fluid, containing molecular fatty matter. Rokitansky terms this change a necrosis, and says that it commonly occasions inflammation in the contiguous tissues. The following may have been an instance of this kind. Among several enlarged axillary glands removed at the same time as a large mammary scirrhus, there was one which was of a peculiar yellow tint in the greater part of its extent, with a dead-whity marginal layer. The other glands were of the same colour and consistence as the growth in the breast, and had the same minute structure. In the yellow gland, the cells and nuclei, instead of the plump and large form they presented in the others, were withering and degenerating; the larger compound cells showed little trace of nuclei, and appeared rather as dim masses of granulous matter. The yellow colour depended on the presence of large granules or small masses of orange pigment, scattered through the mass, with which were mingled plates of cholesterine, and oily matter. The outer dead-white border of the degenerated gland consisted entirely in small masses of molecular fat—no doubt the remains of degenerated corpuscles. The most instructive part of the above history, to me, is the degeneration of one gland lying in close contiguity with others whose morbid mass was in luxuriant growth. This seems to point out the vital power of the cancer-substance as that condition which maintains its growth and activity, not the presence of some peculiar material in the blood.

The form of scirrhus is notably modified by the locality in which it occurs. Rokitansky says:—"In and on membranous structures it departs from the nodular form. In the stomach, for example, it forms a diseased layer following the submucous areolar tissue, and here and there growing up into knot-like masses; in the intestine it very commonly appears as a ring-shaped degeneration of the same submucous tunic; in the mesentery it constitutes an extended degeneration of the areolar tissue between its serous layers; on serous membranes, the pleura, for instance, it appears as a granulated uneven mass of different thickness, looking as if it had been effused while fluid, and had coagulated." Rokitansky describes, what I have also observed, the extension of the scirrhous growth from its primitive seat in the submucous tissue of the stomach to the muscular. The morbid layer sends off whity septal bands, which are very visible on a section traversing the thickened muscular coat. As the former increase in size, the latter wastes, and is at last converted into a cicatricial mass, which is fused on the one side with the mucous membrane, on the other with the serous. Small separate patches of cancer are sometimes found in the substance of the mucous membrane at a little distance from the margin of the main growth. The cell-growth of gastric scirrhus has always appeared to me to present much less of marked cancerous character than that of mammary. The great majority of the cells and nuclei are often just like those of some normal gland. Ulceration, says Dr. Walshe, is rather slow to occur in gastric scirrhus; but when once set in, it effects most extensive ravages both in superficies and depth. The cavity of the peritoneum may thus be opened, or a communication formed with the transverse colon; or, as in one case I witnessed, both with the transverse colon and a cavity in the abdominal parietes.

Mr. Paget describes scirrhus of the intestines as occurring most frequently in the upper part of the rectum, the sigmoid flexure of the colon, and sometimes, in a very striking form, in the ileo-cœcal valve. It is usually of annular form, and occupies the whole circumference of the intestine, situated in the submucous tissue, for an extent of half an inch to one inch. The cancer may, at the same time, or in other instances, occur externally to the muscular coat, and then forms separate tubercles which project with flattened, and sometimes centrally depressed, round or oval surfaces into the cavity of the intestine. Its effects are commonly to cause great constriction of the canal of the bowel, with prodigious distension of the part above, whose muscular coat becomes hypertrophied, while the mucous is often thinned, and inflamed, and ulcerated, and affected with black discoloration. The involved part of the intestine often becomes united firmly to some adjacent structure; thus the cancerous part of the rectum may be fixed to the promontory or surface of the sacrum quite immovably. Scirrhus of the intestine is, like that of the stomach, almost always primary, and exists a long while without multiplication, though often associated with exceeding, and seemingly disproportionate, cachexia. (*Paget.*)

In the *brain*, according to Dr. Walshe, true scirrhus is excessively rare, encephaloid being far the most frequent. The following seems to have been a genuine instance of cerebral scirrhus; it occurred under the care of Mr. Ballard, to whom I was indebted for the opportunity of seeing it. Mrs. V., æt. 50, one child, her parents dead, but no constitutional taint known, perceived, about the middle of February, 1855, a tumor in the left breast, which, three months later, was of evident scirrhous character; at the same time cerebral symptoms set in, and she died June 6th. At the post mortem examination there was found, in the left hemisphere, about its outer, upper, and anterior part, a tumor of the size of a nut. This was hard, perfectly circumscribed, of yellowish-grey tint, imbedded in the cineritious matter and the subjacent medullary, which were softened in some measure. It consisted of a fibroid stroma imbedding great numbers of cells. These were generally rather large, as large as an hepatic cell, and contained several nuclei of normal size and aspect, with some granular matter. The cells showed also a tendency to endogenous formation, one or more vesicles existing in their interior, in or around which the nuclei lay. Besides the larger cells there were also a good many fibre forming nuclei In the superior vermif. process of the cerebellum there was a larger cancerous mass, around which the tissue was much broken up. It consisted of roundish, largish, granulous cells, mingled with a good many glomeruli. The tumor in the left mamma was also an evident cancer.

Mr. Paget describes scirrhus in the *bones* as almost invariably a secondary affection. The growth may be either circumscribed, or infiltrated. As it grows, it often causes absorption of the bone around it, so that the whole diameter of the bone, increased or not in thickness, may be formed by the morbid mass. "The cancer cells," he says, "form, without fibrous tissue, a hard or very firm, elastic greyish substance, shining, and sometimes translucent, sometimes with an obscure fibrous appearance. The likeness to the common hard cancer of the breast is complete in both general and microscopic characters, and not less complete the contrasts to the usual forms of medullary cancer."

"In the liver," Dr. Walshe says, "the scirrho-encephaloid combination is of the most frequent occurrence; next follows the solanoid variety (potato-like). Fibriform stroma abounds in the scirrhous nodule." Dr. Bennett (*Obs.* xvi.) says with reference to the so-called white tubercle of the liver, described by Baillie and Farre:—Such cases are by no means uncommon, and I have invariably found cancerous masses to consist of a firm coagulated blastema, in which cancer cells, in every stage of development, could be discovered. One of my own observations is as follows. Hepatic cancer from an old man, æt. 80, who never had any symptoms referable to the liver; it appears as largish nodules varying in size from that of a pea to that of a small apple, somewhat nodulated, well defined, not encysted, depressed in the centre, where they reach the surface, and showing, on section, numerous dead-white spots crowded close together on a greyish translucent ground. They are very firm. The white spots consist of molecular masses of fatty matter heaped up together; the greyish consists of a fibroid stratum containing more or less perfect fibres, fibre-forming nuclei, free nuclei, staff-shaped corpuscles, and granulous globules. In another case, a liver presented numerous nodules and masses of hard white cancerous looking substance; in these I could find no appearance of cancer cells at all, only abundance of fibre-forming solid blastema, imbedding remains of hepatic cells, and orange pigment masses. Lebert relates, p. 381, a case of hepatic scirrhus, in which he describes the scirrhous fibres as thin, close, fasciculated, plexiform, and containing cells in their meshes. These instances seem sufficient, I think, to prove the existence of a fibrous stroma in scirrhus of the liver; an organ, whose structure, consisting mainly of cells with fibrous septa only between the lobules, affords a favourable opportunity for distinguishing certainly the presence of new-formed fibre.

Mr. Paget, after refusing the name carcinoma fibrosum (adopted by Rokitansky as a synonyme of scirrhus) to the ordinary instances of hard cancer, says, yet there are cancers which contain not only abundant, but peculiar, fibrous tissue; and these may well be called "fibrous cancers," and may be considered as a distinct form or species, unless it should appear that they are always associated as secondary diseases with scirrhous cancers of the more ordinary structure; so that we may suppose the same blastema is in one organ developed into fibrous tissue, in others, at the same time, into cancer cells. Fibrous cancer of the *ovary*, affecting one or both, coexists, according to Mr. Paget, with common hard cancer of the breast or stomach. The ovary is replaced "by a nodulated mass of uniformly hard, heavy, white, and fibrous tissue." The mass is very tough, and its component fibres, though too slender to be measured, are peculiarly hard, compact, closely and irregularly woven; they are not mingled with elastic fibres. But few and imperfect cancer cells are present, and more numerous nuclei elongated and slender. The unossified parts of osteoid cancer seem to belong to the same class. The distinction which Mr. Paget attempts to sustain between fibrous stroma of cancer developed from its specific blastema, and that which is derived from the original fibrous tissue of the affected organ, whether in its natural state, or increased, condensed, or otherwise morbidly changed, does not seem to be well established. Who can doubt that morbidly changed fibrous tissue in cancer is modified in such wise that it has become itself cancerous!

With respect to the vessels of a scirrhous tumor, all that needs to be said is that they are scanty. Dr. Carswell's account of a proper circulation must be considered rather mythical, although it is quite possible that blood and vessels may be formed *in* the morbid growth without being thrown out as loops from those naturally existing. An unusual development of such would give the hæmatoid character. No lymphatics, or nerves, of new formation have been found in scirrhus.

Very little information of any value has yet been obtained respecting the chemical constitution of scirrhus. It does not appear to contain any gelatine, or animal extractive, and a less proportion of albumen and fatty matter than encephaloid, but, on the other hand, nearly twice the amount of inorganic saline compounds in the latter. Müller considers casein to be very uniformly present in mammary scirrhus, although not derived from the lactiferous ducts.]

Description of various conditions of cancer. — A truly scirrhous tumor of the breast, capable of changing into open cancerous ulceration, and of a certain size, is described by Sir Everard Home as hard, heavy, and closely connected with the mammary gland, and when moved the whole gland moves along with it. When, indeed, all the following characters are present, no doubt can exist about the nature of the disease: an early puckering of the integuments; a dull brown, or leaden coloured appearance of them; a knotted uneven feel of the swelling; occasional darting pains in it: an early fixed attachment of it to the skin above, and pectoral muscle underneath; and a retraction of the nipple. According to Sir Charles Bell, it is the ligamentous bands which produce the retraction of the nipple, by extending between its ducts; and destroying its spongy texture. (See *Med. Chir. Trans.* vol. xii. p. 233.)

Mr. Travers's description of the external characters of scirrhus is one of the best which I am acquainted with. "Hardness (says he), with increase of weight, inelasticity or toughness in some cases, knotty or craggy induration in others. Circumscription and mobility beneath the skin in its earliest stage, but not to such a degree in the subjacent bed as to allow of the fingers passing beneath the tumor and turning its edge upwards. Next, *i. e.* in the second stage, close adhesion to the tegument, and such incorporation with the glandular organ, in which it is seated, as to have no mobility but that of the gland itself upon the parts beneath. The adhesion of the skin either stretches, or partially retracts and puckers it, according to the smooth or unequal surface of the tumor, or to the close or loose attachment and particular conformation of the integument at the spot, as, for example, next the nipple, and at a distance from it; or beneath the mucous membrane of the pylorus, or rectum, and the common integument of the body. Third stage: contraction and diminution by pressure of volume in the gland as the tumor increases. Abrupt projection of one large coloured tubercle; sometimes of several smaller tubercles, or nodules. Irreducibleness of volume and hardness by topics or medicine. Transient pains, which have been hitherto obscure and occasional, now more distinct and frequent, like the pricking of a sharp instrument, with a sense of heat, or burning. Dusky or livid-red colour of the skin, with resplendent tension. Excoriation or cracking of the skin at the summit or base of the tubercles, and fungous elevations, with ichorous and sanious oozing. Neither of these signs is individually diagnostic." (See *Med. Chir. Trans.* vol. xv. 205.) To continue the same gentleman's description, the ulcerative process at length opens the tumor, where the cracked and livid integument, previously exuding a sanious ichor, is most prominent, and the external opening is sometimes enlarged by a partial sloughing of the integument. Suppuration now takes place in the surrounding cellular membrane, and, as granulations spring up luxuriantly from the sides, the centre of the tumor gapes, and becomes a cavity more or less considerable. The granulations have a spongy or fungoid character, and are so elevated and broadly everted, as to give the appearance of additional depth and breadth to the sore. "As the sloughing process enlarges and deepens the centre, the disease becomes exceedingly offensive; and although granulations continue sprouting circumferentially at the same time, they have not the power of maintaining their vitality. It is in vain that we attempt to preserve the ulcer from foulness and fetor, by detergent applications; we can render it clean, but, in a day or two, the newly cleansed surface ulcerates afresh, instead of advancing towards cicatrisation." (*Travers*, in *Med. Chir. Trans.* vol. xv. p. 211.) He adds, that in scirrhus it is not suppuration which, as in scrofulous and other tumors, brings the disease to the surface; nor does the skin ulcerate until after the scirrhus. "Encompassed by a dense wall, the centre breaks up by ulceration, constituting the state of occult cancer. Indeed, the scirrhus is seldom removed so early as to be found with its nucleus unbroken" (p. 213). This observation agrees with that of Laennec respecting the softening process, who only erred in representing it as invariably taking place.

Mr. Abernethy describes the diseased skin, covering a scirrhous tumor of the breast, as generally ulcerating before the swelling has attained any great magnitude: a large chasm is then produced in its substance, partly by a sloughing, and partly by an ulcerative process. Sometimes, when cells contained in the tumor are by this means laid open, their contents, which are pulpy matter of different degrees of consistence and various colours, fall out, and an excoriating ichor ensues from their sides. This discharge takes place with a celerity which would almost lead to the belief that it can hardly result from the process of secretion. Afterwards an attempt at reparation is made. New flesh is formed, constituting a fungus of peculiar hardness. This even occasionally cicatrises. But though the actions of the disease are thus mitigated—though they may be, for some time, indolent and stationary — they never cease, nor does the part ever become healthy.

In the meanwhile, the disease extends through the medium of the absorbent vessels. Their glands become affected, at a considerable distance from the original tumor. The progress of carcinoma in an absorbent gland is the same as that which has been already described. The disease is communicated from one gland to another, so that after all the axillary glands are affected, those which lie under the collar-bone, at the lower part of the neck, and upper part of the chest, become disordered. Occasionally, a gland or two become diseased higher up in the neck, and apparently out of the course which the absorbed fluids would take. As the disease continues, the absorbent glands, in the course of the internal mammary vessels, become affected. In the advanced stage, small tumors, similar in structure to the original disease, form at some distance, so as to make a kind of irregular circle round it.

The strongest constitutions now sink under the pain and irritation which the disease creates, aggravated by the obstruction, which it occasions to the function of absorption in those parts, to which the vessels leading to the diseased glands belong. Towards the conclusion of the disease, the patient is generally affected with difficulty of breathing and a cough. (See *Abernethy's Surgical Works*, vol. ii. p. 72, &c.)

The general condition of the patient is excellently described by Sir Charles Bell: — After noticing the hectic fever which preys upon her, he observes, the countenance is pale and anxious, with a slight leaden hue; the features have become pinched, the lips and nostrils slightly livid; the pulse is frequent; the pains are severe. In the hard tumors, the pain is stinging, or sharp; in the exposed surface, it is burning and sore. Pains, like those of rheumatism, extend over the body, especially to the back and lower part of the spine, the hips and shoulders, &c. Successively the glands of the axilla, and those above the clavicle, become diseased. Severe pains shoot down the arm of the affected side: it swells in an alarming degree, and lies immovable. At length, there is nausea and weakness of digestion. A tickling cough distresses her. Severe stitches strike through the side; the pulse becomes rapid and faltering; the surface cadaverous; the breathing anxious; and so she sinks." (*Med. Chir. Trans.* vol. xii. p. 223.)

One of the most deplorable effects, occasionally resulting from cancer, is so great a fragility of the bones, that those of the limbs are broken by the most trifling causes, as merely turning in bed, &c. Sir Astley Cooper mentions several examples of this fact. In the collection at St. Thomas's Hospital is the thigh-bone of a Mrs. Edge, which broke on her merely rising in bed; and also the thigh-bone of another cancerous patient, that was fractured by her turning in bed. (*Lectures, &c.* vol. ii. p. 184.) I have seen several instances of this fact myself. A female patient was in the North London Hospital under Mr. Liston with a cancerous breast, and a humerus which broke spontaneously. She had also had some other bone fractured in the same way; and, what deserves attention, the union had taken place very well. In the museum of University College is a thigh-bone, which gave way in a coachman as he was turning in bed, while he was labouring under cancer of the bladder. (See *Med. Chir. Trans.* vol. xvii.) Other cases are recorded by surgical writers. (See *Fragilitas Ossium.*) It seems that the scirrhous substance is deposited in the structure of the bones, as the sternum of Mrs. Edge, above mentioned, fully illustrates; and in the Museum at St. Thomas's are two curious specimens of diseased spine, in which much of the bone is absorbed, and scirrhous tubercles are deposited in the spaces produced by absorption. In University College Museum is a portion of the skull, containing a similar deposit, in lieu of osseous matter: it was taken from a woman, who died of a cancer of the breast.

In the above species of carcinoma described by Mr. Abernethy, the part is peculiarly hard, and rarely attains considerable magnitude. He admits, however, that there are varieties, and speaks of another case, in which the integuments sometimes remain pale and pliant; "and a surgeon who first sees the breast in this state, may doubt whether the disease be actual cancer or common sarcoma. The substance of the tumor is also much less hard than in the specimen first described; yet it is more compact and weighty than most other diseases of the same bulk which are not carcinomatous. If the history of the disease accords with that of carcinoma; that is to say, if it began in a small district, and regularly and unabatingly attained its present magnitude; if the surface of the tumor be unequal, having produced in various parts roundish projecting knobs, the disease will almost invariably be found to be carcinoma. The skin will soon adhere to one or more of these prominences; it will ulcerate and expose the subjacent parts; and the future progress of the disease will accord to that of the harder and smaller specimen," except that the absorbents are much less liable to be affected.

The edges of a cancerous ulcer are hard, ragged, and unequal, very painful, and reversed in different ways, being sometimes turned upwards and backwards, and, on other occasions, inwards. The whole surface of the sore is commonly unequal: in some parts there are considerable risings, whilst, in others, there are deep excavations. The discharge, for the most part, is a thin, dark-coloured, fetid ichor; and is often possessed of such a degree of acrimony, as to excoriate, and even destroy, the neighbouring parts. In the more advanced stages of the disease, a good deal of blood is often lost from the ulcerated vessels. A burning heat is universally felt over the ulcerated surface; and this is the most tormenting symptom that attends the disorder. Those shooting, lancinating pains, which are sometimes very distressing in the occult state of the complaint, become now a great deal more so. (*B. Bell.*)

According to Sir Charles Bell, scirrhus of the breast belongs to that period of life when the uterine functions cease. Menstruation becomes irregular, both in respect to time and quantity. Long intervals occur, after which the discharge is profuse, with unusual disturbance of the general system. The mamma, in particular, sympathises with the condition of the uterus; pains shoot through it, and it swells; and when the general fulness and tension subside, a partial hardness, an indurated lump, is left, with irregular margins, which mix with the substance of the breast. The hardness extends, until the whole gland is unusually firm, the disease becoming at the same time tuberculated, or knobby and irregular. The veins enlarge, and assume a deep blue colour. In the meantime, the strength declines, and the patient becomes emaciated. The nipple is now not only drawn in and incapable of erection, but retracted in comparison with the irregular convexity of the mamma. In a later stage, the skin is puckered and tucked in. These parts now firmly adhere to the subjacent mass, and sometimes there is bleeding from the nipple; in which case, the axillary glands are affected early.

The disease may begin very differently. A small hard tumor is felt deeply seated in the mamma. It is difficult to distinguish whether or not it is a part of the proper gland. It becomes painful, approaches the surface, becomes attached to the mamma and to the skin, and is gradually incorporated with them. The skin becomes discoloured, the surface moist, and the patient is apprehensive of the occurrence of a sore. At length the part does ulcerate, and begins to discharge. The bottom of the sore is foul and sloughy; the smell is offensive; and the constitution sympathises with the state of the sore. The whole gland is now hard, and adherent to the pectoral muscle. The edges of the sore are particularly hard, and present a dark red, glazed appearance. They are not everted and curling, but rather depressed under the general convexity of the tumor. This will certainly be the appearance in a fat woman. The chasm is deep, with solid, abrupt, sharp edges. In proportion as its depth increases, the surrounding hardness extends, and the whole breast feels of a stony hardness.

Cancer of the breast sometimes assumes another form, which is also well described by Sir C. Bell: although the disease commences in the mamma, it rather propagates itself by extending its peculiar structure to the cutaneous glandular texture. Around the nipple, tubercles are felt in the skin, which extend to the skin of the breast, neck, and shoulders, and soon become painful. At first, they assume a high red colour; then a yellowish transparency in the centre. They do not suppurate and break, but change into corroding ulceration.

It is a form of the same disease, says Sir C. Bell, when the breast presents a tumor elevated, tuberculated, and remarkably firm, without any elasticity, but, on the contrary, fixed to the side, and presenting one consolidated mass. The surface is granular, and of a deep, or rather dark red colour, with a bluish cast, somewhat like the colour of a peach. This tumor ulcerates, and sloughs, and bleeds profusely. The disease is propagated by tubercles under the skin, towards the sternum and clavicles; and it is a case soon accompanied with effusion in the chest. (*C. Bell*, in *Med. Chir. Trans.* vol. xii. p. 216, 220.)

On dissection, Sir Astley Cooper observes, that the breast is one solid mass like cartilage, with very little vascularity except at its edges, and internally fibrous. When the breast has acquired any magnitude, he says, there is generally an opening in it, in which case it has the appearance internally of being worm-eaten, and spongy. In the situation of the ulceration it is very vascular, and bloody serum is met with. The absorbent glands put on the same character as the scirrhous breast. The cellular membrane, skin, and muscles are also affected. Sometimes the diseased glands above the clavicle press upon the thoracic duct, and thus interrupt the transmission of chyle into the blood. Hence the appetite is sometimes voracious, though the patient is rapidly wasting. In the chest, on the same side as the disease, hydrothorax prevails, and the absorbents on the pleura are in a morbid state, and small white spots, like pins' heads, are visible. Traces of scirrhous disorder Sir Astley Cooper likewise represents as occasionally existing in the liver, uterus, &c.

[M. Velpeau's experience in the diseased states of the breast has been so great, that it seems very desirable to present a brief account of the several forms of cancer which he recognises according to naked eye inspection. He makes two principal varieties (1) *Ligneous* scirrhus, and (2) *Lardaceous* scirrhus. The principal characteristics of the former are hardness, " the inextensibility of wood, and no fixed limits, so that they are continuous with the neighbouring tissues, without appreciable line of demarcation." The first subvariety (*a*) *Globular* scirrhus, seldom is larger than a nut or hen's egg, it is continuous with the mammary gland, and as it grows involves the skin, which assumes a grey or speckled aspect. It is pretty easy to ascertain its limits.

(*b*) *Ramose*, or *Arborescent scirrhus* extends itself like roots amidst the neighbouring organs. The fibrous tissue, interwoven with and around the gland, seems to be indurated, and to have undergone the ligneous transformation. "Thence arises an irregular, hard, ill-circumscribed tumor, which becomes lost insensibly towards the skin, or towards the circumference of the mamma, in the form of rays, bridles, irregular septa, or divergent cords." This species, with its central nucleus, from which the radii proceed, gave origin to the name cancer, the appearance presented being not unlike that of the body of a crab and its claws. On a section being made, the mamma is found partitioned by hard layers, lardaceous, and creaking under the knife. These often stretch far up into the axilla, or in other directions; they do not so much seem to result from a new growth as from a transformation of the normal elements of the part. Removal is very difficult.

(*c*) *Tegumentary scirrhus*, or in the form of a breast-plate (*en cuirasse*). This subvariety sometimes occurs as a single disc, sometimes at various points of the skin, each tolerably distinct from the other. "In the first variety, the integuments are hard to the touch, roughened, stiff, thickened, of a reddish tint, and of a stencilled grey colour, which is altogether abnormal." They look as if tanned, or like a portion of stiff leather. In the second subvariety, the plates are smaller, and disseminated, but of the same characters. On section it is easily seen that the skin is the exclusive seat of the disease, and that in degenerating it has (sometimes doubled in thickness) acquired a density like the hide of a pig, or some large animal. The patches of disease, at first small in size, attract little attention; afterwards, as they enlarge, they fuse together, "forming plates of larger and larger extent, and sometimes even a regular cuirass." After a time, pain and heat are felt in the diseased part, with general distress and anxiety; "and still later, the respiration becomes difficult, the movements of the chest are interfered with; it appears as if surrounded with an iron girdle, which, becoming smaller and smaller, threatens to stifle the unfortunate patient. Death, indeed, does sometimes occur in this way, the respiratory movements being no longer possible, but often also in the way of exhaustion from ulceration, with discharge taking place at various points. This peculiar form of cancer is seldom confined to the integuments throughout, it may even commence as such in the deeper parts. It is sometimes associated with one of the other forms. All surgical treatment is useless.

(*d*) *Ligneous scirrhus en masse.*—A large portion on the whole of the mammary gland seems to be attacked at once; the breast in the space of two months may acquire the density of cartilage, "without undergoing any marked change in form." The secreting tissue is always the primary seat of the disease.

(*e*) *Atrophic scirrhus* forms a "tumor, sometimes flattened and tolerably accurately limited, at others somewhat lobulated, or furnished with roots, presenting a depression towards the skin of greater or less extent, which proceeds to increase in size until it ulcerates, or becomes excoriated." The nipple becomes retracted, and the integuments mottled, and then buried in the tumor. It is often exceedingly chronic, lasting ten — twenty years, and almost invariably occurs at an advanced period of life. Ulceration is very gradual, and may be interrupted by temporary cicatrisation.

(*f*) *Tuberculous* (*pustule-like*) *scirrhus.* — The size of the tubercles varies from that of a pin's head to that of a hazel-nut. Their number may be four or five, or as many hundred. They may have their seat on the surface of the skin, in its texture, in the subcutaneous tissue, or in the glandular parenchyma. They somewhat resemble the pustules of ecthyma, only that they have no tendency to softening or ulceration.

(*g*) *Scirrhus of the lactiferous ducts.*—The existence of this form is not positively determined by M. Velpeau, but seems to be very probable. "Externally, as regards the integuments, it is not distinguishable from ordinary scirrhus." The cut surface of one is described as being covered with a large number of open orifices, which admitted a probe. Some of these were thus followed to the root of the nipple, so that M. Velpeau was convinced they were really the excretory ducts. All the other constituents of the part were indurated, changed in character, as in scirrhus. In this case, no recurrence had taken place at the end of a year; but in another similar one fresh cancerous formation appeared around the cicatrix at the expiration of a few months. I have examined one instance of labial cancer in which gland tubes appeared to be distended by a cell growth containing numerous cancer nuclei.

(II.) *Lardaceous scirrhus* appears "in the form of hemispherical tumors, somewhat irregular, or slightly lobulated on the surface. For a long time the tumor remains independent of the skin, and even of the subcutaneous structure; a large part of the mamma is usually at once affected, and the swelling is continuous, without any line of demarcation whatever with the glandular parenchyma." The density is less than that of ligneous scirrhus, and there is at first no tendency to pucker or retract. On section, the part affected appears somewhat marbled, and presents shades of a light brown, yellow, white, or reddish white. It is with some difficulty that a little "suc cancereux" can be expressed from it. Its progress is rapid; it returns after removal with the greatest obstinacy, and is most certainly fatal, but does not at first affect the general health much.

M. Velpeau concludes by remarking that these different varieties of scirrhus are but slightly distinguished from each other in their commencement and in their termination, as also in their intimate nature. In their middle period, however, they present well-marked differential characters.

The best account I have found of the ulceration occurring in scirrhus is that given by Mr. Paget, of which I subjoin an abridgment. There are two principal modes, "in one of these the ulceration begins superficially, and extends inwards; in the other, the changes leading to ulceration begin in the substance of the cancer, and thence make progress outwards." In the first, as the skin becomes infiltrated by the cancer, it becomes highly congested, afterwards more and more thinned as the cancer gradually replaces it, until at last it is all converted into cancer, and then its surface is excoriated. If the superficial ulcer thus formed deepen, it does so "like a common chronic ulcer, deepening by sloughing or acute inflammation." In the second form, softening of the cancer occurs in the interior of its mass, whether as the result of simple or inflammatory degeneration, and the softened material, when discharged, leaves a deep excavated ulcer. The edge of this ulcer is raised and everted by the exuberant growth of cancer in and beneath the adjacent skin, and it is hard, nodular, and sinuous in correspondence with the characters of the underlying growth. Cancerous formation proceeds all around, and at the base of the ulcer, at a greater rate than the destructive process, and the morbid material may even take the form of granulations. "In all its course, it (the ulcer) yields a thin, ichorous, and often irritating discharge, that smells strongly and peculiarly."

In some rare cases cancer undergoes a spontaneous regress, and becomes obsolete. This is especially rare after it has ulcerated. A highly interesting instance is recorded by Mr. Paget, in which recurring cancerous disease, after it had gone on to ulceration, subsided and cicatrised contemporaneously with the development of pulmonary tuberculosis. I have seen two instances of the converse, cancer destroying life while tubercle had retrograded and become obsolete. Rokitansky notices the rare occurrence of spontaneous cure of cancer by its destruction from saniation, the mass sometimes gradually consuming away, sometimes sloughing off in larger masses. In the First Lines of Surgery, p. 353, a case is mentioned of the mother of a young woman, who died of cancer uteri, having had both her breasts entirely destroyed by cancerous disease which had terminated in extensive sloughing. The woman survived to at least the age of eighty, with of course a very mutilated deformed condition of the chest.

Mr. Paget writes: "Among the many inconsistencies in the life of cancers, none, I think, is more striking than that which relates to the attendant pain. One sees cases sometimes that run through their whole career without any pain." He considers the pain, and probably with justice, to be of neuralgic character from the circumstance that "if we compare the most painful and the least painful cancers with each other, we may find their structure and relations exactly similar." In the earlier periods of the disease the pain is generally slight, and does not assume the lancinating character till a later period. When growing quickly, inflamed, ulcerating, or about to slough, the pain of scirrhus is increased; and when ulceration is progressive a burning or scalding sensation is added to, or replaces, the lancinating.]

Abernethy pointed out the error of dwelling too much on lancinating pain, as a test of a scirrhous tumor: first, because it does not prevail in every case, or in every stage of cases in which it does occur; and, secondly, because it is a symptom attending other tumors which are unlike scirrhus in structure. (See *Abernethy's Surgical Works*, vol. ii. p. 69, *&c.*) The fact of scirrhous tumors being often unaccompanied by such pain is now so familiarly known, that I shall merely add the evidence of Mr. Travers, on this interesting point. "Not unfrequently (says he) the scirrhous tumor is perfectly inert, from the period of its formation to the close of life, undergoing very slight, if any, increase, and giving, when mental apprehension is appeased, no trouble to the subject of it. A lady now under my observation has been many years so situated, enjoying uninterrupted health, though considerably above seventy years of age. The tumor is of the size of a hen's egg, and has the genuine scirrhous character. She takes sarsaparilla as a beverage, and the probability is, that what in no degree affects her health will not eventually shorten her life." (See *Med. Chir. Trans.* vol. xv. p. 214.)

[Mr. Paget gives the following account of the conditions favouring the origin of scirrhous tumors. (*a*) *Female sex*, from the great frequency with which the breast is attacked in them. (*b*) *Middle period* of life, or more exactly the years intervening between thirty-five and fifty. The comparative frequency of scirrhus relatively to the whole number of women living is given in the following table : —

Ages 20 to 30	6	Relative frequency of origin of scirrhus.
30 to 40	40	
40 to 50	100	
50 to 60	76	
60 to 70	38	
70 to 80	32	

(*c*) *Cessation of the catamenial discharge* does not seem to be an important "moment" in the origination of cancer. Among fifty-two women thus diseased twenty-seven menstruated for a least a year after their discovery of the cancer, and sixteen had ceased to menstruate for a year or two more previous to it. (*d*) *Hereditary taint* does not seem to be of very much influence, it is estimated as being present in about one out of six sufferers. It does not seem to determine the occurrence of cancer at an earlier age than usual. (*e*) The influence of previous injury or disease is but slight. "Only sixteen out of ninety-one ascribed their hard cancer to injury or any such local cause." (*f*) The general health, in a remarkable majority, is good at the time when the cancer is first observed. Of one condition, often supposed to be a powerful exciting cause, viz. *mental affliction*, so accurate an observer and thinker as Dr. Walshe writes, "I have myself met with cases in which the connection appeared so clear and decisive, that to question its reality would have seemed a struggle against reason." He adds, however, immediately, "but the extent to which this influence works practically has doubtless been over estimated."]

[ENCEPHALOID.]

[This species appears as a tumor resembling more or less the white cerebral substance, white, and softish, sometimes even to the point of affording the most marked fluctuation. The softer are estimated as being twice as numerous as the former by Mr. Paget. They may, he proceeds, occur either as separable tumors or infiltrations. "In the former condition they are most frequent in the intermuscular and other spaces in the limbs, in the testicle, the mammary gland, and the eye: rarely they are thus found in the bones. In the latter condition they most frequently occupy the substance of the uterus, the digestive canal, the serous membranes, the periosteum, and the bones." The shape of *soft* encephaloid growths is generally round, but they may be variously lobed, and their outgrowths may extend to a considerable distance from the main mass. Occasionally a distinct capsule is formed around an encephaloid tumor, and it may be either adherent or not to the surrounding tissues. When compressed a milky fluid oozes out from these tumors, the so-called "cancer juice," which is the best rough test of their nature, if the attention be confined to inspection of the dead mass, and not extended to its vital actions. The *firm* medullary cancers, as Paget describes them, are tense, compact, and moderately tough, and "merge into exact likeness to the less hard and more elastic scirrhous cancers." They sometimes present a strongly marked grain as if from fibres, but usually tear or split, as very firm coagulated albumen might. Some of them are uniform, others lobed, even to the degree of presenting the conglomerate appearance like a salivary gland (pancreatic sarcoma?) In some instances the characteristic cancer juice cannot be obtained on pressure, "the firmest tumors may give only a thin turbid fluid." Rokitansky notices as extreme conditions some growths which are loose, pulpy, and diffluent, and others which in density and resistance approximate to scirrhus. This difference, he says, depends as well on the quantity and density of the fibrous stroma, as also on the relative quantity of the nuclei and cells and fluid intercellular substance constituting the cancer juice in the meshes of the stroma. He thus describes the varieties of the cancer *cell-growth*, and of the *stroma*. (*a*) Cells, equalling or exceeding the 1-30th millim. ($\frac{4}{3000}$ in.) in size, round, or oval, angular, with processes, polyhedric, like ganglion globules, or various epithelial cells, and provided with one or several nuclei; sometimes cells containing an endogenous *growth*. (*b*) Club, spindle-shaped, caudate cells. (*c*) Naked round or oval nuclei, of ordinary or larger size, elongated like a staff or spindle. Several of these elements occur very often together, one or other usually predominating. (*d*) The nuclei, whether in cells or free, grow on very often far beyond the normal size into round, oval, structureless vesicles, around which fibrously elongated cells and nuclei arrange themselves concentrically so as to form alveoli. Rokitansky considers that tumors such as these are often identical with Lebert's "fibro-plastic." (*e*) The structureless vesicles may throw out pouch, or tube-like, processes.

The *stroma* may consist of an exceedingly delicate areolated tissue, with wide meshes. This condition (as I have myself noticed) may prevail at the periphery of a growth, while at its base the trabeculæ and lamellæ are very much stronger, and the meshes smaller. The delicate stroma may itself be altogether absent, so that the cancer consists of a mere cell-mass; in this state it occurs as an infiltration of spongy osseous tissue. The loculi enclosed by strong trabeculæ may be as large as a bean or millet seed, or more. They may form tubes, with terminal dilatations. The trabeculæ may assume a dendritic arrangement, as in the *villous* cancer to be presently described. Sometimes the stroma is osseous. Growths in and on bones are penetrated by thorn-like, or lamellar osteophytes springing from the bone, and produced also by partial ossification of the stronger portions of the fibrous stroma. Sometimes such bony skeletons present a meshed or tubular arrangement. They are quite independent of the osseous shell formed in some cases by the growth of an expanding tumor within the bone. Ossified trabeculæ and lamellæ occur not uncommonly in encephaloid cancers of soft parts. Müller's malignant osteoid seems to be an encephaloid growth with a bony skeleton. The supply of *blood-vessels* to encephaloid tumors is sometimes very great. They do not differ from those of normal tissues except in being more delicate and lacerable. Some growths resemble erectile tumors in the number of large vessels they contain, and vary in size according to the repletion of the latter with blood. "When the blood-vessels are chiefly arterial, the whole mass of the tumor may have a soft full pulsation — a condition which seems peculiarly apt to occur when the tumor is in part imbedded in or supported by bone, and in part held down by fibrous tissue, such as that of the periosteum." (*Paget.*) Extravasations of blood are apt to take place into the substance of these tumors, and if wounded, they may bleed almost as if a vessel had been opened.

(*a*) The *female sex* does not so powerfully favour the production of medullary as it does that of scirrhous cancer. (*b*) *Early age* is far more liable to its occurrence than it is to that of scirrhus. Out of 171 cases, 25 occurred before the tenth year, and 79 before the thirtieth. Paget and Lebert agree that the eyes, the testicles, and the bones, are the situations most often affected at the earliest age. (*c*) The influence of *hereditary tendency* is probably about the same in medullary as in scirrhous cancer. (*d*) *An injury to a part* seems not unfrequently to act as the determining cause of the production of cancer of this kind in it. (*e*) The *light-complexioned* appear far more liable to be the subjects of encephaloid; the darker, of scirrhus. Indications of failing health occur more often at the commencement of the former than of the latter. The *rate of growth* of encephaloid may be very rapid. Mr. Paget has known it to exceed a pound per month. "In general, the more rapid the growth, the less is the firmness, and the less perfect the development of nuclei and cells." The growth in other cases may be very gradual, and this in one tumor while others are increasing rapidly. The ulceration which takes place over encephaloid growths is not such as is occasioned by scirrhus; "it is only such as may ensue over any quickly growing tumor." The skin and covering parts become stretched and thinned, at last inflame and ulcerate; and so an opening is formed, out of which the growth protrudes and fungates luxuriantly. Encephaloid cancers, though themselves diseases, have their normal mode of life, and also their abnormal deviations, or their own diseases. They may simply degenerate, by a kind of shrivelling or condensation, gradually decrease, and at last disappear; or they may undergo fatty metamorphosis, or calcareous, just as the scirrhous cancers. They are prone to be the seat of hæmorrhage, especially when they protrude, and also of apoplectic extravasations into their substance, by the changes in which they may come to present various colours. "The extreme examples of such bleeding cancers constitute the *fungus hæmatodes.*" "Acute inflammation, also, is frequent, especially in such as are exposed through ulcers. It may produce, not only enlargement of the blood-vessels and swelling of the tumor, but softening, suppuration, and I believe, other of its ordinary effects. The softening is often attended with a rapid fatty degeneration or disintegration of the cancer structures." "By sloughing, also, a medullary cancer may be wholly ejected; and this event is more likely to happen than with any other kind of cancer, because no other is common in the form of an isolable mass." Mr. Paget proceeds to relate a case in which a whole large cancer in the thigh, of nine months' growth, came away, together with nearly three inches of the femoral artery and vein which ran through it. This was after an attempt at removal. The pain occasioned by encephaloid tumors seems to depend more on the pressure they exert on surrounding parts than on any peculiarity in their structure. Cachexia is often very apparent in the early stages of the disease.]

[Epithelial Cancer. (Cancroid, Epithelial Cancroid, Epithelioma.)]

[It occurs chiefly on mucous membranes, or the general tegument, but frequently penetrates deep into the subjacent tissues, even into the bones. While thus extending, separate masses are often formed in the vicinity of the original growth.

The special situations it affects are the mucous surfaces of the larynx and trachea, of the buccal cavity, the pharynx, the œsophagus, the stomach, the rectum, the urinary bladder, vagina, and uterine cervix; the skin and sub-cutaneous tissue of the face, lips, and cheeks, alæ nasi, scrotum, prepuce, glans, labia, extremities. Its occurrence in internal organs, as the absorbent glands, the liver, lungs, heart, and the bones, is rare. Rokitansky (whose account I am following) describes the disease on mucous membranes as forming roundish, warty-laminated, whitish, reddish-white, or reddish-blue, tumors, more or less vascular and circumscribed; or appearing as a flat, degenerated patch, with a warty, granular surface. On the skin it may form tumors like the above mentioned; or, more often, a spreading degeneration of the tissue, changing it into a warty-laminar, granular, whitish-red mass. Some of these growths are stiff, dry, brittle, with a nacreous reflection from their cut or broken surface; others are softer and looser, succulent and fragile, of more medullary aspect.

As to structure, they consist (1) of *a framework* or skeleton; (2) of *a cell-growth*. The *skeleton* in some cases is absent, so that the growth is a mere mass of cells; in others, the skeleton forms meshes of various forms; in others, again, it has a papillary or dendritic arrangement. The *cell-growth* is especially characterised by its being made up mainly of particles resembling those of the normal epidermis or epithelium of the surface affected. The mature ones are flattened, and often of colossal size; but the younger and smaller have a more spherical form and granular contents. Free nuclei also occur in notable quantity. The production of *brood-cells* seems also to be a feature in some good degree peculiar to this form of cancer; as well as the arrangement to which the name of "laminated capsules," or "epidermic globes," has been applied. The brood-cells result from an endogenous formation taking place in the cavity of the parent cell. The nucleus expands into a large clear vesicle, within whose cavity secondary nuclei appear and develope into cells; a similar process taking place to a greater or less extent, and in more or fewer of their number. If the primary nucleus remain as a clear vesicle it is barren. The laminated capsules are formed by the great expansion of one nucleus of a group within a primary cell, which so compresses the other cells that they come to lie as flattened scales disposed around itself, between its own cell wall and that of the parent cell. These structures are not absolutely peculiar to epithelial cancer; they have been seen in sebaceous cysts and myeloid tumors; but they are "nowhere so frequent or so well marked as they are in nearly every epithelial cancer."

"The grey substance of epithelial cancers commonly yields to pressure only a small quantity of turbid yellowish or greyish fluid; but, with rare exceptions, one may squeeze or scrape from certain parts of the cut surface, as if from small cavities or canals, a peculiar opaque white or yellowish material. It is "like the comedones, or accumulated epithelial and sebaceous contents of hair follicles, or even more like scrapings of macerated epidermis of the sole. This material, which is composed of structures essentially similar to those of the firmer substance of the cancer, but differently aggregated, supplies one of the best characteristics of the disease." (*Paget.*) This great authority describes a peculiar variety of epithelial cancer which has not been noticed, I believe, by others. He terms it the *deep-seated*, and describes it as essentially consisting in a primary infiltration of submucous or subcutaneous tissue with the material of epithelial cancer. In its primary form, the disease is very rare; but is more frequent in recurrences "near the seats of former operations, or as secondary deposits about the borders of primary superficial growths." It is very curious that, at least in the first case detailed by Mr. Paget, the cancer substance consisted of scaly particles, although the epithelium of the surface was of the ciliated columnar kind. This certainly shows that, whatever be the cause determining the special morphical character of the cancer, it is not its situation; and, further, that the epithelial cancer is by no means a mere hypertrophic and abnormal development of an existing cell growth, to serve the purpose of eliminating cancer material from the blood.

The ulceration which takes place on these diseased growths is thus described by Mr. Paget:— "The surface of the base of the ulcer (formed by a layer of infiltrated cancer) is usually concave, unequal, coarsely granulated, nodular or warty; it is florid, or often of a dull vermilion, or rusty red colour; it bleeds readily, but not profusely; and yields a thin ichorous fluid, which is apt to form scabs, and has a peculiarly strong offensive odour, something like that of the most offensive cutaneous exhalations. The borders of the ulcer, or some parts of them, are generally elevated, sinuous, tuberous, or nodulated; frequently they are everted, and, to a less extent, undermined." Such ulcers are, he states (especially when the lymphatic glands are affected), more prone to lay open great blood-vessels than any other. Thrice he has seen the femoral artery perforated by ulcerations extending from the inguinal glands. Epithelial cancer occurs in one remarkable form, which seems to deserve some detailed notice. This is the cauliflower excrescence of the os uteri described by Sir C. Clarke, whose structure is thus described by Virchow (quoted by Paget). It "begins as a simple papillary tumor, and, at a later period, passes into cancroid (epithelial cancer). At first one sees, only on the surface, papillary or villous growths, which consist of very thick layers of peripheral flat and interior cylindrical epithelial cells, and a very fine interior cylinder, formed of an extremely little connective tissue with large vessels. The outer layer contains cells of all sizes and stages of development; some of them forming great parent structures with endogenous corpuscles. The vessels are, for the most part, colossal, very thin-walled capillaries. At the beginning of the disease, the villi are simple and close-pressed, so that the surface appears only granulated, as Clarke describes it; it becomes cauliflower-like by the branching of the papillæ, which at last grow out to fringes an inch long, and may present almost the appearance of an hydatid mole. After the process has existed for some time on the surface, the cancroid alveoli begin to form deep between the layers of the muscular and the connective tissues of the organ." On this Mr. Paget justly remarks, "that which he (Virchow) calls the simple papillary tumor is an excessive outgrowth of epithelial cancer; the later stage of the same, when it passes into cancroid, is the usual extension of such a cancer into deeper parts — a continuous growth of the same thing in a new direction." Some cauliflower excrescences seem, however, to be rather of medullary than epithelial character.

An epithelial cancer, in a state of ulceration, might be confounded with a *rodent ulcer*, a term which best expresses such diseased conditions as have been called *noli me tangere*, *cancroid ulcer*, *ulcus exedens*. In that the ulceration is constantly progressive, extending to and destroying the most various tissues, and even the bones; it is much like unto cancer, but it differs in these notable particulars:—the lymphatic glands do not become affected; it does not recur if completely destroyed; it is not associated with similar disease in other parts, and there is no layer of special morbid substance surrounding it, and forming its base; the bordering tissues are merely infiltrated with common exudation matter. I think it cannot be denied that these ulcers, though certainly not identical with cancerous, do yet show a real affinity with them; they belong to an intermediate place in the series between the cancerous παραδειγμα and the innocent ulcer of ordinary inflammation. They form a good example of the truth of the statement that what we cannot see is far more important than that which we can see. Mr. Paget states that ulcers with prominent warty growths may imitate exactly to the naked eye the appearance of epithelial cancer, no cancerous elements, however, being discoverable with the microscope. Dr. Bennett is inclined to separate epithelial cancer from the other species, distinguishing it as epithelial cancroid growth, and not considering it as truly cancerous (see p. 181 of his work). He coincides with Prof. Simpson in the conclusion that cauliflower excrescence of the os uteri rather belongs to the class of simple papillary growths, as condylommata and soft warts, than to carcinoma. In this view (as an exclusive one) I cannot join, believing rather with Simon that "epithelial cancer is, in regard of its function, as true a cancer as any;" though not, on the other hand, adopting Velpeau's teaching entirely, "that epithelial cancer is one of those which returns with the greatest obstinacy, both at its original seat, and in the neighbourhood, and even far distant." One of Dr. Bennett's own cases, obs. lvi., shows, in its fatal sequel, that a "cancroid" may be to all intents and purposes a cancer.

The male sex is liable to this form of cancer, compared with the female, in the ratio of 86 to 19. The tendency to the production of epithelial cancer increases with advancing age. Injury, or some previous morbid condition of the affected part, is found in an unusually large proportion of cases of this cancer—in 19 out of 34, according to Mr. Paget's figures. "It is," he says, "as if it were necessary that the part should be considerably changed in structure before it is appropriate for a cancerous growth." This fits in well with the acknowledged less intensity of the constitutional element of the disease in epithelial cancer. If a lip, for instance, be constantly irritated by the contact of a pipe, or a scrotum by soot, these parts are very apt to become the seat of warty development, which often proceeds to something worse. "No primary cachexia can be observed" before the appearance of epithelial cancer, and that which occurs subsequently is not more than would result from the severity of the morbid action. The rate of progress in this disease may be very slow, or very rapid. The general opinion is that the lymphatic glands are less prone to be affected in this form of cancer than in others. On this point there is much discrepancy between the observations of Mr. Paget and Lebert and Hannover. The former finds the glands diseased 20 times in 42 cases. The others not oftener, if so often, as 3 times in 60. I feel much inclined to think that this difference arises from the circumstance that the continental observers have ranked many instances of simple non-cancerous epithelial growths together with actual epithelial cancer.

Rokitansky describes epithelial cancer as not unfrequently becoming destroyed more or less completely by saniation, and undergoing therewith a more or less perfect cure; its place being occupied by tendinous contracting cicatrices. The cancer mass may wither up into a yellow crumbling tubercle-like detritus. One of the most frequent changes, according to Rokitansky, is to the so-called cholesteatoma, the epidermic cells losing their nuclei, and becoming filled with fluid, and yellow granular fat, and cholesterine.]

[Colloid Cancer.]

[Its "most frequent primary seats are the stomach, the intestinal canal, uterus, mammary gland, and peritoneum; as a secondary disease, it affects most frequently the lymphatic glands and lungs, and may occur in other parts." (*Paget.*) Dr. Walshe thus describes the naked-eye appearance of colloid:—" The cut surface is divided into a vast number of distinct loculi, regularly arranged, of an oval or rounded shape, varying in size from that of a grain of sand to the largest pea. The septa composing the walls of these loculi possess distinctly fibrous characters; their thickness is pretty uniform throughout; occasionally, however, they are broader in some situations than in others; in this case, the thicker septa may generally be found to give off productions forming the walls of secondary loculi, and these again others, constituting a tertiary order. The loculi sometimes form shut sacs, in other instances communicate with the circumjacent cells; it is not very unusual to observe some of these loculi in which the walls seem to have collapsed, and almost coalesced from the removal of the contained matter. In point of consistence, a colloid mass, of which the loculi are perfect, usually resembles firm cheese, but may be much harder. The general colour of the divided surface is greenish yellow, the tint being mainly dependent on that of the contained matter, which is besides semi-transparent, tenacious, and clammy, and resembles, in respect of density, as of other physical properties, soft jelly. It is not easily expressible from the containing loculi, but may be picked out with the point of a scalpel, or removed by maceration." Uniformity of appearance, in different parts of the mass, is considered, by this author, as a remarkable character of this structure. Mr. Paget and Rokitansky give a somewhat different account. The former says, "when the fibrous texture is predominant, it forms a very tough, white, fascia-like mass, in which are small separate cysts or cavities filled with the colloid substance. In the opposite extreme large masses of the colloid substance appear, only intersected by fibrous white cords, or thin membranes, arranged as in areolar tissue, or in a wide-meshed network. These extremes often exist in different parts of the same mass." The form of colloid growths is either rounded, or flattened, with a tuberous surface. The latter feature seems to depend on the prominence of alveoli tensely filled with gelatinous matter.

When colloid growths exist on the peritoneal surface, one of their commonest habitats, they may project considerably into the serous cavity, and the latter may even contain prodigious quantities of free colloid matter, which has prolapsed out of the alveoli on their dehiscence. Rokitansky describes the framework of a colloid growth, taking, for instance, one of the intestinal canal, as a small-meshed network with thick septa at its attachment to the submucous tissue; the septa becoming slenderer, and the meshes wider towards the surface, till at last the former terminate by free extremities. The enclosed meshes, or areolæ, communicate freely with one another, and are compared by Lebert to the pulmonary air-cells. The septal tissue appears as of homogeneo-fibrous material, and contains elongated nuclei, and sometimes elastic fibres.

The colloid, gelatinoid contents of the areolae present a good deal of variety. Rokitansky describes them as consisting of structureless vesicles $\frac{1}{10-5}$ millim. $\left(\frac{1}{250-125}\text{ inch}\right)$ in diameter, surrounded by a clear, often laminated, colloidal matter imbedding elongated or fibre-developing nuclei, and presenting itself a kind of wavy fibrillation in some cases. In this matter are also seen cells with very large nuclei developing into clear vesicles. The large vesicles contain a cell-growth, which may be very manifest indeed (as in Dr. Bennett's drawings, fig. 136), or almost absent. In the latter case, the cells have probably fused down into the colloid jelly, which seems to exist in a ratio inverse to that of the shaped elements. Lebert mentions cells lying free in the colloid substance, or large brood-cells (filled with endogenous cell-growth), or mere colloid jelly, as forming the contents of the alveoli of the stroma. Fattily degenerating cells (glomeruli) are seen both within and without the large vesicles. One very peculiar arrangement is described and figured by Rokitansky, in which the stromal septa send off hollow clavate processes, in the interior of which colloid matter and structureless vesicles are produced. The stroma may even extend so as to form a pedicle of some length, at the extremity of which a small pouch-shaped or granulated mass of colloid growth is developed (see *Rokit.* figs. 114, 126). Certain changes, in all probability of the nature of degenerations, occur in the colloid substance. Cruveilhier has noticed a pearl-like condition of the cell-contents, and another in which they are opaque, yellowish and tallow-like, with granular fracture and feel, and the chemical constitution of casein. Fatty transformation, together with deposit of yellow pigment, such as occurs in the other cancers, would produce very much such appearances. The pearly aspect probably depends on the presence of cholesterine.

A very unequivocal affinity subsists between colloid cancer and cystic formation, sufficient almost to warrant the adoption of the term "cystic cancer," which has been proposed for the former. Mr. Paget alludes to the existence of a cystic form of medullary cancer, in which the cysts are so numerous "that the tumor appears almost wholly composed of them, the cancerous structure only filling the interstices between their close-packed walls." Between this condition and that of colloid there is evidently no very wide difference. On the other hand, we easily pass from cancerous colloid structure to similar formations whose cancerous character is quite, or well nigh, effaced. Rokitansky says that his third form of colloid occurs especially in the bones and in the ovaries. In the former, the growths are very often numerous; in the latter, commonly single. Frerichs and Virchow would erase ovarian colloid from the list of cancers, and in this I would certainly agree. If, however, it seem to some to stand on the border ground of cancer (which I do not deny), a step further brings us to the gelatinoid connective tissue (embryonal) tumors, of which a good case is recorded in the Transact. of the Pathol. Soc. for 1854, p. 319, or to the cystic disease of the thyroid gland, which no one would rank among malignant conditions.

The truly cancerous nature of colloid growths, as above described, seems to me well established by the following enumeration of the features which it has in common with the cancer family. "Its seats of election are remarkably those in which the medullary cancers are, at the same time of life, most apt to occur." It "infiltrates, and at length supersedes and replaces by substitution, the natural tissues of the affected part." "It is prone to extend and repeat itself in lymphatic glands, the lungs, and other parts near to or distant from its primary seat." It "is often associated with other forms of cancer in the same mass, or in different tumors in the same person; it appears as apt as any other form to recur after removal; it may be derived hereditarily from a parent having scirrhous cancer, or a parent with colloid may have offspring with medullary cancer." According to Lebert, sex has no special influence in determining the appearance of colloid. It occurs mostly in the middle period of life, and is very rare in childhood. "It more slowly affects the lymphatics, and the organs distant from its primary seat," than medullary cancer. "In general, its symptoms in each part correspond with those of other cancers affecting the same part." Rokitansky says that the marasmus (cachexia) ensuing on colloid cancer agrees in its stamp with the cancerous, but presents notable differences according to the degree or form. Thus it is less in the alveolar form, appears late in ovarian cystic colloid, but is early and rapidly developed in colloid of the bones, especially when the tumors are multiple.

MELANOID VARIETY.

These growths may, with but very rare exceptions, be considered as medullary cancers plus a certain amount of black pigment. This pigmentation may occur in all degrees. Mr. Paget has the interesting remark that, even in cancers that look colourless to the naked eye, the microscope may detect single cells or nuclei having the true melanotic characters. Of 25 cases noted by him, 17 were females, 8 males. "In 14 cases the primary seat of the disease was in the skin or subcutaneous tissue; in 9, in the eye or orbit; in 1, in the testicle; in 1, in the vagina." In 10 of the 25 cases the disease appeared before the age of thirty. The remarks which Mr. Paget makes respecting one curious point in the history of melanoid cancers, viz. their tendency to occur primarily in or beneath pigmentary moles, are worthy of special notice. He says: — "The fact, I suppose, is quite inexplicable; but it may be usefully suggestive. It seems a striking illustration of the weakness in resisting disease which belongs to parts congenitally abnormal. It seems also to be an evidence that a part may very long remain apt for the growth of cancer, and not become the seat of such a growth till the cancerous diathesis, the constitutional element of the disease, is established." I cannot adopt the opinion of this high authority to the effect that melanoid may be regarded as a pigmental degeneration of medullary cancer. In a case which I examined lately, the morbid growth showed no evidence of withering or degeneration; the nuclei were large and vigorous looking. One would not think the black colour of the choroid, or of the hair, a sign of degeneration. The multiplicity of the melanotic tumors was well exemplified in the case I have mentioned, and which is recorded, by Dr. Sanderson, in the Path. Soc. Trans. for 1855. Cancerous growths pigmented in various degrees existed in the left lobe of the cerebellum, the posterior mediastinum, the right lung, the left ventricle of the heart, the liver, the post-peritoneal cellular tissue, the pancreas, and the subcutaneous tissue of the thorax and abdomen, especially around the mammary glands.

HÆMATOID. — FUNGUS HÆMATODES.

Dr. Walshe applies the first of these names to unusually vascular encephaloid, the vessels, as in a case he refers to, forming a dense and somewhat spongy rete. The second he applies to sanguineous infiltration of an encephaloid mass, or to considerable extravasations into its substance, and especially to the case of a rapid development of fungating growths after perforation of the skin by ulceration. The terms have a practical use, indicating a cancer which has either a great tendency to bleed, or has already been the seat of bleeding, and therefore are worth retaining, but they imply no special peculiarity of the cancer substance.

VILLOUS CANCER.

This variety is shortly described by Rokitansky as a medullary cancer, with a stroma vegetating dendritically. Its chief seats are the mucous surface of the urinary bladder, the stomach, the rectum, the gall-bladder, the interior of cystic cancers in the ovaries, the peritonæum, the skin, the inner surface of the dura mater, the parenchymata of the brain, liver and uterus, and almost certainly in the bones. These parts are mentioned in the order of the frequency of their affection. The colour of these growths is usually dark red while recent, by reason of their great vascularity. They may appear as pediculated, cauliflower masses, sometimes crisp and tense, sometimes more soft and lax. Often they are constituted by an aggregate of delicate and slender, or pretty extensive spongy villous excrescences, branched at the free ends, and rising from a circumscribed base. In some instances they appear over a largish patch, as a diffuse growth of numerous scattered villous tufts, or isolated excrescences. For some distance around them, the surface from which they spring has an areolated appearance. This depends on its being traversed by a very delicate or more developed fine-meshed trellis-work, from the trabeculæ of which fine vesicles or villi arise, giving the whole structure a tumid felt-like aspect. The dendritic stroma of villous cancer is minutely described, and illustrated by Mr. Paget, after Rokitansky. Its varieties of form seem to depend chiefly on the length and breadth which the primary and secondary divisions attain before they break up into their terminal sprouts, which are flask-like, or clavate. In structure the stromal trabeculæ consist either of a hyaline membrane containing only serous fluid; or of more fibrous tissue. In both cases the cancerous cell-growth, in greater or less amount, may occupy the interior of the trabeculæ, appearing in the dilated extremities as structureless, or concentrically laminated vesicles. The exterior of the stroma is covered by a mass or layer of medullary cancerous cell-substance, which invests it like an epithelium, and, according to its abundance, imparts a greater degree of fulness and tenseness to the whole formation. The vessels are large ("colossal"), and follow the ramification of the stroma, just as they do in the placenta, with the occasional curious peculiarity, mentioned by Mr. Paget, that in some of the terminal sprouts there is but a single vessel, which terminates by a rounded end. The stress of the circulation in the terminal loops often gives rise to considerable hæmorrhages. Villous cancer may exist as a secondary growth, together with a primary one of medullary. Mr. Z. Lawrence doubts the cancerousness of this form of disease, or at least suspects that two distinct species of growths have been confounded under the one term, the non-malignant one "containing little or no solid material in its construction, but consisting nearly entirely of vascular, villous, pencil-like processes." I should agree in this view so for as to regard the latter form as cancerous in a less degree than the former. It would rank as a transitional instance toward simple papillary or warty tumors. The same degenerations which befall the other cancers occur in this. It may wither, or slough, or degenerate fattily.

OSTEOID CANCER

Is more completely described by Mr. Paget than by any author that I have seen, and from his account the following abstract is taken. Lebert, who cites Müller's description at length, does not rank this form among cancers, although he is aware of its co-existence in the same tumor with encephaloid. The primary seat of osteoid cancer is usually some bone, but it is not limited to bones. It may occur in the intermuscular spaces, and in the lymphatic glands. Its most frequent site, however, by far, is the lower part of the femur, where it forms an elongated swelling, with smooth surface, incompressible and painful. The periosteum usually is continued over the surface, but is scarcely separable from it. "A section generally shows that the exterior of the growth is composed of a very firm, but not osseous substance ; while its interior part is partially or wholly osseous. The two substances are closely interblended where they meet, and their relative proportions differ much in different specimens, according to the progress already made by ossification. The unossified part of the tumor is usually exceedingly dense, firm, and tough, and may be incompressibly hard." Its cut surface is pale, greyish, or with a slight yellow, or pink tint, marked with irregular short bars of a clearer white. The *bony part* of the tumor, when cleaned by maceration, has characters altogether peculiar. In the central parts it is (in the best marked specimens) extremely compact, scarcely showing even any pores, white and dry. To cut it is nearly as hard as ivory, yet, like hard chalk, it may be rubbed or scraped into fine dry powder. At its periphery, it is arranged in a tuberous form, and is very brittle, flaky, and pulverulent. "In the osteoid cancers of the lymphatic glands, and other soft parts, the bone is finely porous, spongy, or reticulated, or it may be finely lamellar, and look fibrous on its surface. It is always soft and brittle, and often it has in these parts no regular plan, but is placed in small close set grains, or spicules, which fall apart in maceration." The interstices are filled with cancer-substance.

The *unossified part* of the tumor is made up of fibrous tissue of a peculiar kind, the fibres being short and imperfect, but densely matted together. Cancer cells like those of scirrhus my be imbedded in the interstices of the fibres, together with glomeruli and minute oil molecules. They and their nuclei may, however, be entirely absent, as in a case recorded by Mr. Laurence, *Assoc. Journal*, Aug. 23, 1856. Acetic acid renders the fibrous tissue more translucent, .and brings into view numerous oval well defined nuclei.

"The microscopic characters of the ossified part of the cancer are those of true bone, but rarely of well formed bone. In some parts—especially in the secondary cancers—that which appears to be bone is only an amorphous granular deposit of lime salts, like those in ordinary calcareous degenerations. In other parts the lacunæ of true bone are distinct, but they are small and their canaliculi are few, and short, and without order. Haversian canals also exist with these, but they have not a large series of concentric lamellæ like those in normal bone." In some instances bone of a very fairly perfect structure is found, and this not exclusively in primary cancers, or near the natural bone on which the mass grows ; but it may be found also in the secondary growths in the glands, and elsewhere.

Between such osteoid cancers as have been now described, and encephaloid growths penetrated by foliaceous osteophytes springing from the bone on which they are seated, there is much apparent difference, but not any absolute and essential ; a greater ossifying tendency would convert the latter into the former. But between the osteoid cancer, and exostoses, and such growths from bone as are of innocent nature, there is a very wide difference. The visible structural distinctions between the two are stated at length by Mr. Paget (p. 246, vol. ii.) ; but the dynamic characteristics are more decisive. After removal the osteoid cancers recur either in the original or in the encephaloid form ; in the adjacent lymphatic glands, or in internal organs. They grow rapidly, cause much pain, and are attended with cachexia sometimes early and intense. The habits of exostoses are very different. Of 20 cases of this form of cancer, 15 occurred in the male and 5 in the female sex. Of 19 patients, 5 were between 10 and 20 years old; 9 between 20 and 30 ; 4 between 30 and 40 ; 1 between 40 and 50.

CARCINOMA FASCICULATUM SIVE HYALINUM

Requires a brief notice as a variety, although rather a rare one. It forms sometimes a considerable tumor as a single mass, or a conglomerate of smaller ones, which partly are separated from each other by investments of connective tissue, partly are fused together. Its cut surface has a uniform aspect, varies from translucency to a whitish opacity, and is more or less firm and consistent. It splits on pressure, so as to give the idea of a fibrous structure, the fibres being arranged into bundles. A sticky clear fluid, coagulable by acetic acid, is diffused through its substance. The microscope shows that the mass is made up of nuclei or cells, more or less and variously elongated, in fact, in various stages of transformation into fibre. These lie closely together, packed in bundles, which run parallel or interlace variously with each other. This kind of tumor occurs mostly in the female breast, also in the ovary, rectum, subcutaneous tissue, and internal organs. It returns (when in the breast) after removal with great rapidity in the cicatrix and vicinity. Respecting its vital actions and tendencies we have no further account from Rokitansky. It seems to me difficult to forbear the suspicion that there is no material difference between the above variety of cancer, and the group of formations to which Mr. Paget has given the name of malignant fibrous tumor, which behave as cancers, though their structure is identical with that of simple, innocent growths. The recurring fibroid seems also to be a variety of tumor structurally much like the fasciculate cancer, but deficient in some of the main tendencies of cancer life.

CHEMISTRY OF CANCER.

Our knowledge on this head is very imperfect, and there seems to be very small prospect at present of its being otherwise. The minuter differences of chemical composition escape the efforts of the analyst, and the constitution of organic substances is so varying and uncertain that one can hardly feel any confidence as to whether the differing results of several analyses depend on some slight error in manipulation, or on an actual difference in the composition of the specimens. Lehmann affirms that the blood-albumen of different individuals, and even the albumen of different albuminous fluids in the same individual, does not exhibit quite the same reactions. As a basis for a chemical theory of cancer it would be needful to prove that some special material, or modification of it, was found in cancer constantly, which by its presence in the blood might be regarded as affording a stimulus to the development of a new formation, and supplying material wherewith to build it up. It is needless to say that not the slightest step has been made towards obtaining such evidence. All that we know amounts to this that the common materials out of which the tissues are constructed are found abundantly in both scirrhus and encephaloid. Albuminous and fatty matter, and the usual salts and extractives form the list of constituents, and there is nothing to show that there is any special modification in any of them. The presence of gelatine-yielding material in scirrhus, encephaloid, or colloid is doubtful; on the other hand it certainly exists in tumors which behave malignantly, viz. the malignant fibrous tumor of Mr. Paget. The species which contains the most special kind of material, viz. the colloid, is certainly that in which the malignant characters are less strongly marked. The analysis of colloid by Wurtz shows that it is quite distinct from any kind of gelatine, and is a feebly nitrogenised substance, differing in this respect notably from the albuminoid constituents of scirrhus and encephaloid.

Causes of Cancer.

Relative to the conditions which give rise to cancer but little can be said that has any claim to rank as real positive knowledge. The facts detailed in the foregoing pages afford abundant proof that the disease is, in very many cases, if not in all, constitutional; that the local malady is in fact only the expression of a general disorder. Encephaloid, with its manifold growths springing up in different parts, and its early and grave cachexia, illustrates the constitutionality of cancer. On the other hand the influence of local agencies is not to be rejected. The indubitable effect of an injury in arousing a latent predisposition to cancerous formation, and the special tendency of melanotic cancer to appear in the site of moles, show that the constitutional element is materially favoured in its development by whatever weakens the life and nutrition of the part in which it is to have its seat. The constitutional tendency, the cancerous diathesis, must be regarded as far the most essential condition of the disease; the local injury or imperfection can only be considered as a promoting, and site-determining cause. This is well put by Mr. Paget, vol. ii. p. 534. But can we go any further, and point out with any probability in what the constitutional tendency consists? Mr. Paget thinks that there exists some specific material in the blood, which is "the essential constituent of the cancerous diathesis or constitution; and when its existence produces some manifest impairment of the general health, independently of the cancerous growth, it makes the primary cancerous cachexia." He admits that neither the microscope nor chemistry have afforded one particle of evidence in favour of this view; and he relies for its support on the conformity of cancer to other specific diseases, such as syphilis, hydrophobia, gout, rheumatism, the exanthemata. Of these he says, "their theory in its most general terms is that each of them depends on a definite and specific morbid condition of the blood; that the local process in which each is manifested is due to the disorder produced by the morbid blood in the nutrition of one or more tissues; and that generally this disorder is attended with the accumulation, and leads to the discharge, or transformation of some morbid constituents of the blood in the disordered part." It would occupy far too much space to enter upon anything like a full discussion of this question, but I will instance two points in which the weakness of Mr. Paget's view seems very apparent. He assumes the conformity of cancer to the specific diseases, but may it not most fairly be asked, Whether a cancerous tumor is not greatly more like, more analogous to, a fatty tumor, or a fibrous, than it is to gout or syphilis, or variola? Now, no one will surely contend that a fatty or fibrous tumor arises because there is much fat or fibrine in the blood. These, it is true, supply the necessary materials for their formation, but would never cause their production apart from some unknown perversion of organising power. Why does an ovary rush into such strange aberrations from its normal life as are displayed in huge colloidal cystic, or sarcomatous growths, or such as contain fat, skin, teeth, bone, or even brain? Is it because the necessary constituents (chemical) of these structures were overabundant in the blood? Is there not much more resemblance between an ovarian growth and a mammary or uterine cancer than there is between the latter and variola, or gout, or eczema? Secondly, if it be true that (as Mr. Paget states) the increasing eruption of eczema or herpes may be ranked with the multiplication of secondary cancers, as manifesting that peculiar character of specific diseases, viz. self-augmentation, there seems to be pretty certain evidence that in the case of the skin diseases his theory (the usually accepted one) of a specific *materies morbi* is incorrect, and so it may be also in the case of the cancer. Not the least evidence exists to show that the scale of psoriasis or lepra, the crusts of impetigo or eczema, or the fluid of pompholix blebs contain any peculiar morbid matter, anything which retained in the blood would reproduce the disease. On the other side, the fact that these desquamations or discharges can be altogether arrested, and the healthy state of the skin restored without any detriment, but with marked improvement of the health, is very strong counter-evidence. The skin eruptions are in fact simple inflammations or exudations of nerve origin, depending, *i. e.* on paralysis of the vascular nerves, and the remarkable influence which arsenic exerts upon them when well managed may be most justly compared (as a similar action) with its effect in curing a neuralgia or an ague. A huge ague-cake, as far as we know, consists simply of albuminous matter which, after repeated floodings of the spleen with blood, exudes and becomes lowly organised. There is no reason to believe that any special morbid substance is accumulated in the splenic tumor, and the possibility of obtaining its absorption by the use of quinine, and by change of air without any particular evacuating measures point to the same conclusion. These considerations seem to me to leave it quite open to consider that cancer has nothing to do essentially with any supposed *materies morbi* in the blood, but that it is simply an unexplained perversion of the normal nutritive power.

It appears to me rather strange that so many seem reluctant to recognise fully and frankly the vast supremacy of the organising power, that wonderful vital energy which caused the shapeless blastema of the embryo to take form in the various tissues and organs, each in their appointed locality, and of the ordained measure and figure. Who could believe that a tendon was formed because there existed a gelatigenous substance in the blood? So neither can I believe that a cancer is formed because a carcigenous matter has become evolved in the blood. That power which once made the living machine, continues to maintain its composition; and its aberrations and perversions from the normal mode of acting are, I believe, the root, though unseen cause of all morbid changes in which the development and increase of a new formation are prominent phenomena. Mr. Paget's own statement of the transmission of cancerous tendency by hereditary descent is quite in accordance with the above view. He does not suppose that cancerous material is furnished by either parent, but that "one or more of the materials, normal as they may seem, are already so far from the perfectly normal state, that, after the lapse of years, by their development or degeneration, they will engender or constitute the cancerous material in the blood, and it may be the locality apt for a cancerous growth. But now let it be observed this tendency to cancerous disease is most commonly derived from a parent who is not yet manifestly cancerous; for most commonly the children are born before cancer is evident in the parent; so that as we may say that which is still future to the parent is transmitted potentially to the offspring." This passage, and more might be quoted, seems to me to admit what I contend for, that it is a tendency which is transmitted, a power, and not a material thing of any kind whatsoever.

One cannot surely err in believing that that which makes the ultimate difference in the evolution of the embryos of the carthorse and the racer is not at all a chemical difference in their component materials, but a difference of vital endowments. There may be the very same oil and albumen and salts in each, but the power that builds with and fashions them acts surely not alike in both. That which is transmitted in hereditary descent is a power, a force, which determines the development of material in a direction according with the ancestral. If a family for several generations are web-footed, or six-fingered, surely this is not from a superabundance of such material in the blood of the original parent, but from a peculiarity of developmental force.

To not a few, I believe, such expressions as the last are a very abomination, because they refer to something unseen, untangible, not to be weighed and measured. To refer any phenomenon to the working of vital power, is, according to them, to abandon all sound investigation. Yet it does appear to me, after full consideration, that it is quite necessary, according to the degree of knowledge we possess at present, to think of vital force and endowment as independent of chemical composition. I cannot possibly conceive that a liver is constantly formed in one place, a heart in another, and a kidney in a third, because the materials fit to form them are contained in the circulating blood. Some power, then, must exist, utterly mysterious and incomprehensible though it be, under whose sway the indifferent homogeneous matter becomes differentiated, shaped, and endued with particular qualities in particular sites. This power, though resident in matter, yet varies without corresponding variations in that matter; it may be wholly annulled, and cease as at death, the organic structure and composition for a short time remaining unchanged. This power, for instance, at first constructs a uterus, or mamma, out of the liquor sanguinis, and gradually developes it up to its complete state, which it then preserves. If it continue in proper exercise, the nutrition of the organ will be duly performed, a certain amount of material will be withdrawn from and returned to the blood, and the parts will remain healthy. But if this power become somewhat perverted, then some portion of plasma, probably effused in excess, becomes a focus of independent and indefinitely limited growth. In the commonest case it is influenced in its development by the nutrition force of the surrounding tissue, and so becomes a fibrous tumor, or fibro-muscular tumor (see *Dr. Bristowe's paper*, p. 218, *Path. Soc. Trans.* 1853), which thenceforth assimilates plasma, and grows, it may be, to a far larger size than the uterus itself. Is not the one grand "moment" here the origination of a new abnormal focus of growth? If we could annul that dynamic modification, would not the crasis of the blood remain quite ineffectual to produce the fibrous tumor? In conformity with this view, I believe cancer to depend upon a peculiar perversion or disorder of the normal assimilative force, not at all upon any specific alteration of the composition of the blood.

Hereditary transmission is observed in a comparatively small proportion of instances, only one-sixth of the whole, according to Mr. Paget, and in a far smaller proportion according to Leroy d'Etiolles. There is very little reason to think that cancer is ever produced in the way of contagion or inoculation. The experiment of injecting cancerous matter into the veins of animals, has very rarely succeeded, and in the one or two successful instances it cannot be quite certainly affirmed that cancer did not previously exist. In dogs, which were the subjects of Langenbeck's experiments, as well as in other animals, cancer is by no means infrequent. Dr. Walshe considers that there is no fact in the history of cancer more absolutely demonstrated than the influence exercised by sex on its development. His figures show, "that the female population of this country is destroyed to about 2¾ times as great an extent by cancer as the male," although the rate of mortality is rather higher among males than it is among females.

Mr. Paget does not speak so positively, and it would seem not impossible that the number of cancers occurring in males may be under estimated in consequence of their real nature not being so apparent as in the common mammary and uterine of the female. In 130 cases collected indifferently, I find 5 cases of cancer in males, and 4 in females. The number is small, but the autopsies were all pretty thoroughly performed.

Both Mr. Paget and Dr. Walshe agree as to the influence of age. The conclusion of the latter from the records of death, and that of the former from the periods of first detection of the cancers, coincide to show that the liability to the disease is always increasing from childhood to the age of eighty.

Dr. Walshe has collected evidence to the effect that certain regions of the globe are peculiarly exempt from cancer; Africa, East Indies, and the tropical parts of America are particularly instanced. China, on the other hand, suffers more; but the maximum of the disease occurs in Europe. It is, however, by no means ascertained whether the diminished prevalence of cancer is to be ascribed to modes of life or to the influence of climate. "Wherever the disease is particularly rare, it may be remarked that a low state of civilisation prevails; wherever social organisation is of a highly perfect kind, there cancer flourishes." As regards the comparative influence of a *rural* or *urban* life in inducing cancer, the result of statistical inquiries is opposed to *à priori* anticipation. Dr. Walshe, from examination of the registrations for a series of years, concludes that a town life is far from exercising any serious influence on the production of cancer. It would appear, however, that a greater proportion of males perish from cancer in the country than in towns, while in the case of females the proportion is reversed. It does not appear that temperament is materially concerned in the causation of cancer. Yet Sabatier, Lever, and Tanchou are supported by Dr. Walshe in the opinion that mammary and uterine cancer are more frequent in women of high colour and sanguineous temperament than in others. It is a valuable remark which Mr. Paget makes, that the liability of a part to be affected by cancer depends not so much upon any peculiarity of texture or tissue in it as upon its mere locality. Thus, medullary cancer "may occupy from the first many tissues both within and around the eyeball," and after all, of a mammary gland has been removed the growth recurs still in the same site. This indicates that morbid growths have their *loci* determined by special laws, something like those which govern the original development of the various organs. Mr. Paget's experience is opposed to the view that other tumors in course of growth may become cancerous. With regard to ovarian cysts, however, he allows that they may become, after they have existed simply as such for a time, the seat of cancerous formation, but in other tumors he believes this to be an event though possible, yet "of the greatest rarity."

DISSEMINATION OF CANCER.

This may take place in three ways. First, by *immediate contact.* The opposite serous surface to some viscus in which a cancerous growth exists, may become similarly diseased at the point of contact; or the mucous surface over which cancerous discharge passes towards the outlet, may come to present patches of the disease along its extent.

Secondly, if a cancerous growth penetrates in any part the veins, either growing into a large trunk, or opening some small radicle at its origin, the particles which may become detached, and carried along in the blood, will give rise to secondary formations at any part where they may be arrested, usually in the next capillary plexus. From hence again fresh particles may be carried on and give rise to tertiary formations. It is clear that if the cancer germs reached the left side of the heart, as they would from masses contained in the lungs, they would be dispersed all over the body, and might thus cause an abundant development of cancer growths in most various parts. This mode of dissemination may be distinguished as that *effected through the circulation.*

Thirdly, through *the lymphatic channels.* These vessels take up the fluid which saturates a cancerous growth, and convey it back to the veins, just as they do the residuary fluid of normal assimilation. In its transit, it has to pass through masses of nuclear substance, the so-called lymphatic glands, and is apt to impart to these nuclei its own evil properties, and set them vegetating and growing in a cancerous manner. The reason why the glands for a time remain unaffected, though traversed by the diseased fluid, is, I suppose, that as long as their native power retains a certain degree of vigour they are able to resist the influence of the cancerous fluid, and compel it to behave nearly as normal lymph would do. When, however, the cancerous diathesis increases in strength, and the normal forces of the system fail, then the glands yield to the overmastering influence.

Cancerous growths appear, in some instances, in the vicinity of a primary growth. Mr. Paget terms this "*irradiation*," and says they spring up in an area which gradually widens, and of which the primary cancer is the centre. Thus, tubercles may form in the skin and muscles near a scirrhous breast, and I have seen small islets of cancer in the mucous membrane adjoining a mass of pyloric disease. The following passage from Mr. Paget's work, vol. ii. p. 580, contains the same opinion as I advanced in the *Manual of Pathol.* independently: — "We need not assume that corpuscles of pus or cancer, or any kind of germs already formed, must be thus carried for the multiplication or dissemination of disease. A rudimental liquid, an unformed cancerous blastema, mingled with the blood, may be as effectual as any germs, and must almost necessarily be assumed in the explanation of cases in which the dissemination takes place, not in the lungs or liver (the common sites), but in organs beyond them, in the course of the circulation."

DIAGNOSIS OF CANCER.

In cancer, as in all other diseases, there are two classes of phenomena to be regarded with a view to diagnosis. One of these is the physical peculiarities, the other the vital actions. I will consider each of these briefly. To describe the former, would be to enumerate again the characters of the several species already noticed, both those apparent to the eye and the microscopical. The latter consist in a tendency to recur after removal, to repetition of the growth in the lymphatic glands, and to dissemination in other parts of the body, as also in a great proneness of the mass to decay by sloughing or ulceration even while growing rapidly, and to affect the general system with a peculiar cachexia. To these may be added a special power of infiltrating all tissues of every kind which it approaches, and causing their disappearance by substitution of its own substance. These vital actions are far more strongly declarative of the existence of cancer than the physical peculiarities. One would be fully justified in affirming the existence of cancer in any case where the majority of these were decidedly apparent, whatever might be shown by observation of the former. In proportion as less and less trace of the vital actions are discernible, in the same degree would the cancerous character be effaced or diminished. For the most part the physical peculiarities accord well with the dynamic manifestations, but not invariably. With regard to the common request that the microscope may be used for determination of the nature of a tumor, whether cancerous or the reverse, it may be stated, that this instrument will in very many cases enable us confidently to affirm that a specimen is a cancer, but that its negative information is much less trustworthy. If we find certain structural peculiarities we may be sure that we are dealing with a cancer, or almost; but the absence of these will not be sufficient warranty for us always to conclude the reverse. Great multiformity in the cell substance of a tumor, the presence of a large proportion of the peculiar nuclei and cells described p. 377, the vesicular expansion of nuclei, and endogenous growth within parent cells would afford almost infallible evidence of the cancerous character of a growth. Yet M. Velpeau adduces instances in which the best authorities in Paris found cancer cells in growths which clinically, *i. e.* in their vital actions, showed no resemblance to cancer. Moreover it must be allowed that in the great majority of cases where the information afforded by the microscope is positive and clear, that obtained by the unaided eye is almost equally so. Again, from the absence of microscopic characters of cancer, we cannot positively in all cases predicate the absence of cancerous quality any more than we can affirm that a tissue is not contractile because it does not correspond either to the striped or to the unstriped variety of muscular fibre. In this, as in a multitude of other cases, we find that structure and endowment are not necessarily linked together. Fibrous cancers, osteoid, and some varieties of the medullary are instanced by Mr. Paget as presenting cancerous qualities without cancerous structure. M. Velpeau mentions a case where he removed a testis affected with encephaloid, as he considered, but in which M. Lebert found no cancer cells, and therefore disbelieved its malignant character. In a few months after the operation the patient died with enormous soft medullary masses filling the abdomen. In these, again, no cancer cells were found. Yet surely the disease was to all intents and purposes cancer. In a second case, "a lardaceous scirrhus of the worst kind" from a woman's breast, was pronounced by five of the leading French observers to contain no cancer cells. Yet in a short time the growth recurred in the cicatrix, and the patient "fell into the most complete cancerous cachexia." Dr. Bennett proposes that during an operation every suspected tissue should be examined with a microscope at hand before the wound is closed, so that there might be some certainty that every particle of existing diseased structure is removed. This cannot, he states, positively be ensured by mere naked-eye inspection, and I quite agree with him. The following case, however, from my note book, shows how difficult even with the aid of the microscope it might be to say positively where all cancerously affected tissue ceased. Josephine R., cook, large and fat, had the right breast amputated for an enormous scirrhous growth at least as large as two fists. About the centre there was a roundish, firm, whity-grey mass, the size of a walnut, but the rest of the tumor was made up of fatty lobes intersected by patches of a greyish, dense fibrous tissue, continuous with the central mass. This consisted of a very abundant fibrous stroma, the fibres being often very perfectly formed, and interlacing in a dense irregular network. Their interspaces were filled up either by imperfectly formed fibroid stroma, or by oily or granular matter, with many nuclei and granulous corpuscles. The nuclei were for the most part of that large clear kind, almost diagnostic of cancer; they appeared to expand as it were into the granulous cells. Sometimes there were seen longish strands made up of nuclei imbedded in a granulous matter, suggesting the idea of their having been formed in the ducts. In one part there were two spherical cystlets full of a celloid growth, which perhaps resulted from distension of the terminal gland cavities. A portion of the growth, some distance from the centra nucleus, exhibited to the naked eye nothing but large fat masses separated by bands of firm whity fibrous tissue; these, however, consisted of the same fibre and cell structure as the central nucleus. In the most distant part of the removed mass the layers of fibrous tissue presented generally no trace of cells except some imprisoned fat ones. At one part, however, I found a large group of corpuscles, more like ordinary nuclei than cancerous, some of them were elongated. Between these, however, and some of those in the central nucleus there was no marked difference; the latter, I noted particularly, when of smaller size, were indistinguishable from healthy nuclei. This was a case of scirrhus with predominance of fibrous stroma; only in one part was cell formation notably proceeding. Yet it cannot be supposed that the fibrous stroma which extended out indefinitely into the surrounding fat was not of cancerous quality. The group of small nuclear corpuscles in the most remote part one cannot but think might have developed into large evident cancer nuclei, and were potentially equivalents. What hope could there be in such a case as this that the microscope could determine where disease ceased!

Masses of *tubercle* may occasionally be taken for cancer, as Dr. Bennett states was the case in *Obs.* xxxii. of his work; the mistake being, however, easily rectified by microscopic examination. Tuberculated glands, he says, may present to the naked eye all the external characters of cancerous growths. Infiltrated tubercle, he thinks, would generally be easily distinguished, but I think I have seen a case where the presence of numerous enlarged cervical glands, and of a greyish solidified state of the lung made the distinction by no means easy. The absence of fibrous stroma, and of any notable amount of peculiar cell growth, with an abundance of the faint, withered-looking tubercle corpuscles imbedded in much granular and oily matter, would be the guiding points of the diagnosis.

From *enchondroma* cancer can usually be distinguished without much difficulty, but when the former is softened, it may present, says Dr. Bennett, all the external characters of encephaloma. Even on microscopic examination the two may be confounded, "as the cartilage cells which then float loose mixed with granules and the debris of a tumor closely resemble those in cancerous growths." Mr. Paget describes, after Bruch, the cells of enchondroma as closely imitating in their utter diversity the multiform character of the cancerous. It is therefore clear that in cases of doubt we must look rather to the vital actions of the tumor than to its structure for determination of its nature. Slow and painless growth; the absence of cachexia, of recurrence after removal, of affection of the lymphatics or distant parts, would evidence in favour of the non-cancerousness of a tumor. Patches of enchondroma may, however, occur in the substance of cancerous tumors, as was the case in a specimen I recently examined.

Fatty tumors can rarely be mistaken for cancer, but Dr. Bennett cites a case from Sedillot, in which a fatty growth assumed all the symptoms and signs of encephaloid, and was so pointed out by a professor to his pupils. The patient not only presented the cachectic aspect, but all the local lancinating pains, the form, feel, and appearance of an encephaloid growth; yet the microscope showed the tumor to consist solely of adipose and filamentous tissue. Though the case certainly is remarkable, one can hardly think that it was one of ordinary fatty tumor, as it had returned after excision twice.

To distinguish *fibrous growths* from scirrhous in their early stages, Dr. Bennett declares to be "utterly impossible." This of course applies to their condition in the living body; after removal a microscopic examination would in most cases readily decide, except where the cancer was of the rare fibrous variety. The presence of any of the peculiar cells or nuclei would of course distinguish positively the malignant from the innocent growth.

Sarcomatous tumors constitute an ill-defined group which, it may be well conceived, are often not easily distinguished from cancer. They seem in some instances to be as it were undeveloped fibrous tumors, consisting of a jelly-like fibrine, containing fluid traversed by bands of fibrous tissue, which is scanty and imperfectly developed. This is the Collonema of Müller. In proportion as the fibrous structure becomes more perfectly developed they approach the common fibrous tumor. Cutaneous outgrowths and mucous polypi belong to the same class, as well as many ovarian tumors. The lobulated masses which grow into the interior of mammary cysts, till they sometimes fill them, are in some instances made up of nuclei imbedded in fibroid tissue, and not of imitative gland structure. Such formations are well termed by Rokitansky cysto-sarcomata. A tumor I examined from the region of the pectoralis major consisted of nuclei and lowly developed celloid corpuscles with much granular matter. Its exterior was lobulated much like a conglomerate gland, but less minutely; in this respect, and in its colour, it resembled the pancreas, and might be considered a specimen of Abernethy's pancreatic-sarcoma. Lebert's fibroplastic tumors are termed by himself sarcomatous, though I do not feel sure that this term applies to them all. The most distinctive features of sarcoma are that its vital actions are unlike those of cancer, and that it differs from fibrous tumors in yielding much proteine when boiled with liquor potassæ, and treated with acetic acid. Many of these tumors can be readily distinguished from cancer by these characters, and by the simple form of their cell growth (which resembles that of normally existing organs), but others approach very close to the malignant groups, and perhaps are not to be separated by any absolute line. The interesting history recorded by Mr. Paget, at p. 260, 261 of his work, illustrates this well. He says, in conclusion, "The main fact of all the cases is, that three daughters of a cancerous mother had mammary tumors; in two of them at least the structure was probably not cancerous; and yet the rapid growth, the recurrences in one of them, and the defective or disordered modes of growth in both, were such as marked a wide deviation from the common rules of mammary, glandular, or any other innocent tumor, and a deviation in the direction towards cancer."

Adenoid tumors (chronic mammary) are distinguished from cancer in the following particulars. They occur at an earlier period of life; they not unfrequently disappear spontaneously; they are commonly painless; they do not contaminate the system; they are easily moveable in the surrounding tissue; and if removed they do not return. Their structure is that of conglomerate glands, often resembling very exactly that of the mammary; so much so that M. Lebert seems to consider the tumor as the result of simple enlargement of the gland, and distension of its cavities with accumulated epithelium. By Velpeau and his able translator, Mr. Henry, they are regarded as essentially new formations, and no doubt correctly. A capsule, which surrounds their surface, completes their unlikeness to cancer, and, as Mr. Paget suggests, probably proceeds from the original cyst into which the growth advanced, and which it has filled.

Myeloid tumors might be confounded with cancer of the bones, but the following list of their characters, as stated by Mr. Paget, will aid in diagnosis. They are usually single, occur most frequently in youth, and very rarely after middle age, grow slowly and painlessly in most cases, have no proneness to ulcerate or protrude, are not apt to recur after complete removal, and have not in general any features of malignant disease. Often they are of a peculiar dark ruddy colour, either in patches or throughout, and constantly they present as a structural characteristic large cells containing 2—10 nuclei; these are mingled with fibre-forming cells or nuclei.

The general conclusion in the matter of diagnosis I think must be; (1) that the history of a growth, and naked-eye inspection of it, will in most cases enable the experienced man to predicate its character; (2) that the microscope may often afford confirmative, and sometimes corrective information; (3) that the vital actions of a growth must be mainly regarded as the exponents of its invisible qualities.]

Treatment of Cancer.

Cancers have sometimes been supposed to be a general disorder of the system; sometimes merely local affections. This is a point of much importance in practice; for if cancers are originally only local affections, no objection can be made to extirpating them. They who think that cancer is a constitutional disease, will have much less confidence in the operation, which they may even regard as useless, perhaps hurtful, inasmuch as it may convert a scirrhus into an open cancer, or bring on the affection in some other part.

Some practitioners, however, reject the doctrine of cancer depending on constitutional causes; and Sir E. Home's sentiments, in opposition to it, have been laid before the reader. When cancer breaks out again in the same part, after the performance of an operation, it is often owing to some portion of the disease having been blameably left behind, or to the operation having been put off too long. How likely it is that some of the cancerous disease may be left unremoved by the operator, is obvious on considering the manner in which the white bands, resembling ligament, shoot into the surrounding fat; and that even the fibres of the muscles, beneath a cancerous disease, are frequently affected. At the same time, it must be allowed, that the disease is sometimes to all appearances, so freely and completely removed, that its recurrence may be imputed, perhaps with equal probability, to the continued operation of the same unknown cause which originally produced the first cancerous mischief. Sir Astley Cooper, and many other very experienced men both of the past and present time, consider cancer as decidedly a complaint connected with a peculiar state of the constitution. But, if this be true, it may be asked, how can any cure be expected from the removal of the part, as the continued operation of the same constitutional causes must occasion a relapse? And so they sometimes do, no doubt, independently of the accident of any portion of the disease not being completely removed with the knife. However, experience proves, that the operation frequently effects a radical cure, and no other organ is afterwards attacked; which is analogous to what is seen after the amputation of a scrofulous limb; a case in which frequently no other part is afterwards attacked, though the constitution is unsound.

From the description which Sir Astley Cooper has given of the dissection of persons destroyed by scirrhus, it must be inferred, not only that the disease is constitutional, but that the hope of radically curing it, either by medicines or an operation, must very often fail in advanced cases. He says, that a scirrhus in the breast is generally accompanied by several smaller tumors of the same character in different parts of the glandular structure. He notices the deposition of the scirrhous matter in the axillary glands, and those above the clavicle. On the left side, he says, the latter sometimes press upon the termination of the thoracic duct. According to his observations, the glands behind the cartilages of the ribs, when the disease is on the sternal side of the nipple, are generally diseased. The axillary glands on the other side of the body he has also seen in the same state. The lungs are often found inflamed, and adherent to the pleura; serum is effused in the chest; and the pleura costalis studded with scirrhous tubercles. He also describes the liver, uterus, ovaries, and bones, as participating in the morbid changes. (See *Lectures, &c.* p. 182, vol. ii.) In addition to all these facts, we are to remember the occasional presence of scirrhous matter in the blood-vessels themselves. Under such circumstances, the inutility of any treatment must be obvious.

Until late years, the accounts given of the results of operation for cancers were so unpromising that they deterred many patients from undergoing a timely operation, which for cancerous complaints is the only remedy with which we are as yet acquainted, entitled to any confidence. As Mr. B. Bell remarks, the great authority of Dr. Alexander Monro must have had no inconsiderable influence even with practitioners, in making them much more backward in undertaking the extirpation of cancers than they otherwise would have been. "Of near sixty cancers," says he, "which I have been present at the extirpation of, only four patients remained free of the disease at the end of two years: three of these lucky people had occult cancers in the breast, and the fourth had an ulcerated cancer on the lip." (*Edin. Med. Essays*, vol. v.) Dr. Monro also observes that in those in whom he saw the disease relapse, it was always more violent, and made a quicker progress than it commonly did in others on whom no operation had been performed. Hence he questions, "whether ought cancerous tumors to be extirpated, or ought the palliative method only be followed?" and, upon the whole, he concludes against their extirpation, except in such as are of the occult kind, in young healthy people, and have been occasioned by bruises or other external causes.

More modern experience, however, has afforded a very different result, and given rather more encouragement to the early performance of an operation, and even to making an attempt to cut away the disease, in every instance, both of the occult and ulcerated kind, when such a measure can be so executed as not to leave a particle of the cancerous mischief behind.

Mr. Hill, in 1772, published some valuable remarks on the present subject. At this period, he had extirpated from different parts of the body eighty-eight genuine cancers, which were all ulcerated, except four; and all the patients except two recovered of the operation. Of the first forty-five cases, one only proved unsuccessful; in three more, the cancer broke out again in different parts; and in a fifth, there were threatenings of some tumors at a distance from the original disease. These tumors, however, did not appear till three years after the operation; and the woman was carried off by a fever before they had made any progress. All the rest of the forty-five continued well as long as they lived; or are so, says Mr. Hill, at this day. One of them survived the operation above thirty years; and fifteen were then alive, although the last of them was cured in March, 1761.

Of the next thirty-three, one lived only four months; and, in five more, the disease broke out afresh, after having been once healed. The reason why, out of forty-five cases, only four or five proved unsuccessful, and six out of thirty-three, was as follows: "The extraordinary success I met with (says Mr. Hill), made cancerous patients resort to me from all corners of the country, several of whom, after delaying till there was little probability of a cure by extirpation or any other means, forced me to perform the operation contrary both to my judgment and inclination."

Upon a survey, in April, 1764, made with a view to publication, the numbers stood thus:—Total cured, of different ages from eighty downwards, sixty-three; of whom there were then living thirty-nine. In twenty-eight of that number, the operation had been performed more than two years before; and, in eleven, it had been done in the course of the last two years. So that, upon the whole, after thirty years' practice, thirty-nine, of sixty-three patients, were alive and sound; which gives Mr. Hill occasion to observe, that the different patients lived as long, after the extirpation of the cancers, as, according to the bills of mortality they would have done had they never had any cancers, or undergone any operation.

The remaining twenty-five, which complete the eighty-eight, were cured since the year 1764.

Twenty-two of these had been cured at least two years; and some of them, it may be remarked, were seventy, and one ninety years old.

In the year 1770, the sum of the whole stood thus: — Of eighty-eight cancers, extirpated at least two years before: not cured, two; broke out afresh, nine; threatened with a relapse, one; in all, twelve, which is less than a seventh part of the whole number. At that time, there were about forty patients alive and sound whose cancers had been extirpated above two years before.

Mr. B. Bell, who was present at many of these cases, bears witness to Mr. Hill's accuracy; and states, that "from these and many other authenticated facts, which, if necessary, might be adduced, of the success attending the extirpation of cancers, there is, it is presumed, great reasons for considering the disease in general as a local complaint, not originally connected with any disorder of the system." With respect to Mr. Bell's opinion, that a general cancerous taint seldom, or perhaps never, occurs, but in consequence of the cancerous virus being absorbed into the constitution from some local affection, much doubt attends even this supposition, though the practical inference from it is what cannot be found fault with, viz. in every case of real cancer, or rather in such scirrhosities, as, from their nature, are known generally to terminate in cancer, we should have recourse to extirpation as early as possible; "and if this were done soon after the appearance of such affections, or before the formation of matter takes place, their return would probably be a very rare occurrence." (*System of Surgery*, vol. vii.)

Sir Astley Cooper admits, that the operation is followed by a return of the disease in many cases, the average number of which, however, he does not state, though he says that they do not amount to one fourth.

How often is the operation determined upon, because the nipple is retracted, and true cancer thereby announced! Yet, says Sir Charles Bell, with reference to the cause of this change, as previously explained, "it is quite clear, that if the nipple be fully retracted, and if this has been evident for any considerable time, the operation has been too long deferred." (*Med. Chir. Trans.* vol. xii. p. 223.)

Sir Astley Cooper is adverse to the performance of the operation when dyspnœa is present; for he has known patients die in two or three days, who had been operated upon while labouring under that symptom. On examination after death, water was found in their chests, and tubercles in the pleura.

The same experienced surgeon gives it as his opinion, that a breast should never be removed, unless the patient has undergone a course of alterative medicines, as compound calomel pills and the compound decoction of sarsaparilla, or (what he prefers) the infusion of gentian with soda and rhubarb. Thus he thinks the constitution may be improved, and the danger of a relapse diminished.

After comparing the different accounts of success given by Monro and Hill, well might Richter say: "*Jure sane dixeris, de uno eodemque morbo hos viros loqui, dubitari fere potest.*" (*Obs. Chir. fasc.* 3.)

Medicines and Plans which have been tried for the Cure of Scirrhus and Cancer.

It is a contested point, whether a truly cancerous disease is susceptible of any process by which a spontaneous cure can be effected. It appears certain, however, that a violent inflammation, ending in sloughing, may sometimes accomplish an entire separation of a cancerous affection, and that the sore left behind may then heal. Facts confirming this observation are occasionally exemplified where caustic is used, and accidental inflammations have led to the same fortunate result; as we may be convinced of by examples recorded by Sir Everard Home, Richerand, &c. The latter writer, adverting to the effort which nature sometimes makes to rid herself of the disease by the inflammation and bursting of the tumor, takes the opportunity to relate the following case: — A woman, aged forty-eight, of a strong constitution, was admitted into the Hospital of St Louis, with a cancerous tumor of the right breast. The swelling, after becoming softer, and affected with lancinating pains, was attacked with an inflammation, which extended to the skin of the part, and all the adjacent cellular membrane. The whole of the swelling mortified, and was detached. A large sore, of healthy appearance, remained after this loss of substance, and healed in two months. (*Nosographie Chir.* t. i. p. 381, edit. 2.)

I once attended a woman who died of cancer of the uterus, and in the same room was her mother, all the forepart of whose chest was in a most mutilated state from the effects of sloughing, by which, at different periods, she had been freed from cancers of both her breasts. Baron Dupuytren believed that it was particularly when the cancerous mass was encysted, that the whole of it was capable of being destroyed by gangrene, and the patient completely cured. (See *Journ. Hebdomad. de Med.* t. iv. p. 38.) Many years ago, Mr. Cline had a patient in St. Thomas's Hospital, in whom the sloughing process went on to such an extent, under a linseed poultice, that the ulcer afterwards healed soundly. "I have seen (says Mr. Travers) more than one case in which extensive cicatrices of ulcers existed, with much puckering and stretching of the skin of the chest, and no vestige of the breast remained. In one of these, the patient a lady in Berkshire, resisted the pressing advice of a consultation of London surgeons to allow the extirpation of the tumor many years since. She has been in the constant habit of taking the medicine there prescribed, the extract of hemlock, almost *ad libitum.* She is still a stout healthy looking person, as formerly, and attributes her cure to the medicine. (See *Med. Chir. Trans.* vol. xv. p. 213.)

In general, however, inflammation renders things worse instead of better, and by converting occult cancers into ulcerated ones, hastens the patient's death, or at all events renders the cure more difficult, and forbids any attempts, which, on such a principle, might be made for his relief.

Of the general remedies, narcotics, as conium, opium, belladonna, &c. have been employed with most hope.

Cicuta, or conium maculatum, owed its reputation to the experimenting talent of Storck, who has written several treatises on it. According to him, cicuta, possesses very evident powers over cancer, and has cured a great many cases; but, in less prejudiced hands, it has not been found successful; and even in many of the instances, adduced by Baron Storck of its utility, it is by no means proved that the disease was really cancer.

The public have now little or no reliance on this medicine as a means of relieving cancer. Mr. J. Burns declares that in cancerous ulceration he never knew hemlock produce even temporary melioration. (See Conium.)

Belladonna was highly recommended by Lambergen. During its use, he kept the bowels open with clysters, administered every second day. The dose should be, at first, a grain of the dried leaves, made into a pill. The quantity may be gradually increased to that of ten or twelve grains. The extract is now frequently exhibited, the dose being at first one grain, and afterwards increased by degrees to five. The reputation of belladonna has not been supported by any decided success in cases of true cancer.

Hyosciamus has often been tried, and was held in great estimation by the ancients. Mr. J. Burns employed it occasionally, but with little effect. The common dose, at first, is three grains of the extract.

Aconitum has also been given; and as it is a powerful and dangerous narcotic, a patient usually begins with only half of a grain of the extract night and morning. Solanum dulcamara, Paris quadrifolia, phytolacca, &c. have also been recommended; but they are now hardly ever employed, which is a sufficient proof of their inefficacy. Mr. J. Burns tried the hydro-sulphuret of ammonia; and Richter prescribed the laurus cerasus, without success.

Digitalis lessens vascular action, and may act on schirri like abstinence, bleeding, &c. It has, however, no specific virtue in curing cancerous diseases.

Opium is seldom employed with the intention of curing cancer, although probably it has just as much power of this kind as other narcotics which have been more frequently used. For the purpose of lessening the pain of cancerous diseases, it is very freely prescribed.

Tonics sometimes improve the general health; but they never produce any specific effect on the local disease.

Justamond thought arsenic a specific for cancers. Further experience has not, however, confirmed the truth of this opinion, though there are practitioners who continue to think highly of the efficacy of this mineral in certain forms of disease which have sometimes been classed with cancer. It cures numerous ill-looking sores on the face, lips, and tongue, and is one of the best remedies for lupus. Arsenical powder and paste, employed with considerable success by Dupuytren, as external applications, in the treatment of inveterate ulcers of the lips, nose, and other parts, are noticed in the article Arsenic. The powder I have tried in some cases, in the North London Hospital, and found its effects correspond to Dupuytren's account. Mr. Hill even thinks that arsenic will, "in a great majority of cases, retard the progress of the true scirrhous tumor, and often prevent its becoming cancer. In some, it has appeared to dissipate such swellings completely." (See *Edin. Med. and Surgical Journ.* vol. vi. p. 58.)

Mercury, in conjunction with decoctions of guaiacum, sarsaparilla, &c. has been recommended, but, as Mr. J. Burns remarks, no fact is more certainly ascertained than that mercury always exasperates the disease, especially when in the ulcerated state.

Muriate of barytes at present retains no character as a remedy for cancer.

Carbonate of iron was particularly recommended by Mr. Carmichael. Besides the carbonate of iron, he sometimes prescribed the tartrate of iron and potass, and the phosphate, oxyphosphate, and suboxyphosphate of the metal. Some constitutions can bear these preparations only in small quantities; they affect most patients with constipation, and many with headach and dyspnœa. Mr. Carmichael has seldom given less than thirty grains, in divided doses, in a day, or exceeded sixty. He prefers the suboxyphosphate for internal use, and states, that it answers best in small doses, frequently repeated. It should be blended with white of egg, have a little pure fixed alkali added, and then be made into pills with powdered liquorice. Aloes is recommended for the removal of costiveness. When half a grain is combined with a pill, containing four grains of carbonate of iron, and taken thrice a day, the constipation will be obviated. When the internal use of iron brings on headach, difficult respiration, a quick, sometimes full pulse, which is also generally hard and wiry, excessive languor, lassitude, &c. the iron is to be left off, and four grains of camphor given every fifth hour.

At the same time that preparations of iron were internally administered, Mr. Carmichael employed externally, for ulcerated cancers, the carbonate, phosphate, oxyphosphate, and arseniate of iron, blended with water, to the consistence of a thin paste, which was applied once every twenty-four hours. To occult cancers, the same gentleman applied a solution of the sulphate of iron, ℥j. to lbj. of water. The acetate of iron, diluted with eight or ten times its weight of water, was also used. These lotions were put on the part affected by means of folded linen, wet in them, and covered with a piece of oiled silk to prevent injury of the clothes. (See *An Essay on the Effects of the Carbonate and other Preparations of Iron upon Cancer, &c.* 2nd ed. 8vo. Dublin, 1808.)

Many remedies have acquired celebrity in cases of cancer, because very bad and malignant diseases, only supposed to be cancers, have got well under their use. Such is probably the case with the carbonate of iron.

The only mode of treatment which Mr. Pearson ever saw do any particular benefit to cancer, was that of keeping the patient on a diet barely sufficient for the support of life, such as barley-water alone, tea, &c. A milk diet has also been recommended.

With respect to the effects of a very low diet, Sir Astley Cooper protests strongly against the plan: if the patient be already weak, he says, you will thus render her still weaker, and soon bring her to the grave: in proportion as the strength declines the pulse is quickened. He further declares, that we possess no medicine, which has any specific power over the disease, though the state of the constitution may sometimes be improved by Plummer's pills given at bedtime, and the following draught in the day: ℞ Infus. Gentian. ℥iss. tinct. columbæ ʒj. Ammon. carbon. gr. v. Sodæ Carbon. ʒss. Misce. Climate he also regards as having no particular effect on scirrhous disease. Sir Astley Cooper only sanctions the use of steel medicines, when the uterine secretion is defective. In such cases he recommends the compound calomel pill at night, and the following draught twice a day: ℞ Vini ferri ʒj. Ammon. Carbon. gr. vij. Aq. Menth. Vir. ℥j. Tinct. Cardam. c. ℥ss. He also approves of anodynes for the relief of the suffering; as the tinct. opii, the liquor opii sedativus, or the black drop, combined with the camphor mixture, and a little of the spir. ætheris comp. One of his patients derived much relief from the following pill: ℞ Ext. Stramonii gr. ½ Camph. gr. ij. M. ft. Pil. Bis. terve in die sumend. (See *Lectures, &c.* vol. ii. p. 193.)

The old surgeons dressed cancerous sores with narcotic applications. Vesalius used cloths dipped in the juice of the solanum; whilst others employed it mixed with oil of roses, and preparations of lead and antimony. Others had recourse to hyoscyamus, or hemlock poultices, which in many cases, as Mr. J. Burns observes, have abated pain, and diminished fetor; but this is all which can reasonably be expected. He thinks carrot poultices better than those of hemlock, as they produce as much ease, and more powerfully diminish the fetor.

Sir Astley Cooper has no confidence in the utility of evaporating lotions. Warm applications he also represents as improper. The dressing, which he mostly prefers for scirrhi is a plaster, made by blending ℥j. of the extract of belladonna with ℥j. of soap cerate. When inflammation is present, he does not object to the use of leeches. All local applications, as well as internal medicines, he considers merely as palliatives.

The fetor of cancers having been thought to resemble that of the sulphuret of potash (liver of sulphur), and the oxygenated muriatic acid being the best agent for decomposing and destroying such smell, it has been recommended as an application to cancerous sores. It may correct the fetor, but it will never accomplish a cure. Carbonic acid has been said not only to correct the fetor, but, in some instances, completely to cure the disease. It was long ago proposed, says Mr. J. Burns, by Peyrilhe, and was again brought forward by Dr. Ewart. Experience, however, has not shown that the efficacy of carbonic acid, in cases of cancer, is very great. Fourcroy remarks: "After the first applications, the cancerous sore appears to assume a more favourable aspect; the sanies which flows from it becomes whiter, thicker, and purer, and the flesh has a redder and fresher colour; but these flattering appearances are deceitful, nor do they continue long, for the sore speedily returns to its former state, and its progress goes on as before the application." The method of applying carbonic acid was by means of a bladder, the mouth of which fastened round the sore with adhesive plaster. The air was introduced by a pipe, inserted at the other end. Sometimes the fermenting poultice is employed. That iodine commonly fails, is now universally admitted, and this even in very large doses. (See *Paper by Dr. Buchanan of Glasgow*, in *Lond. Med. Gaz. of Oct.* 1836.)

Tar ointment, gastric juice, absorbent powders, &c. have been tried; but without any evident good. (See *J. Burns*, *On Inflammation*, vol. ii.)

Mr. Fearon rejected all internal remedies, as inefficient in the treatment of cancer, and, in the early stages of the complaint, recommended a method of practice founded on his idea of the inflammatory nature of the disease. "In the beginning of scirrhous affections of the breast and testis, the mode I have adopted of taking away blood, is by leeches repeatedly applied to the parts. In this course, however, I have often been interrupted by the topical inflammation produced by these animals around the parts where they fastened. In delicate female habits, I have often lost a week, before I could proceed to the re-application of them. When the symptoms lead me to suspect the stomach, uterus, or any of the viscera to be so affected that the complaint either is, or most probably, soon will become cancerous, I then have recourse to general bleedings. But whether topical or general, perseverance for a sufficient length of time is necessary. Though the pulse never indicated such practice, yet the patients have not suffered by repeated bleedings; on the contrary, when they passed a certain time without losing blood, they felt a return of their symptoms, and, of their own accord, desired to be bled again. To this plan of repeated bleedings, I joined a milk and vegetable diet, avoiding wine, spirits, and fermented liquors." Mr. Fearon used also to keep the belly open, and employ saturnine applications.

Methodical compression was first recommended and practised in this country, as a means of curing cancer, by Young; and the same practice was afterwards put to the test of experience in the Middlesex Hospital; from which institution the report of Sir Charles Bell tends to prove, that compression, applied either to scirrhous or to ulcerated cancer, is decidedly hurtful. MM. Breschet and Ferrus also came to the same conclusion. (See *Dict. de Méd.* 1822.) The principal advocate for it, at present, is M. Récamier, who attributes the failures of it in the Middlesex Hospital to its not having been applied in a suitable manner, nor modified according to the stages of the disease. M. Récamier combines likewise the administration of hemlock with a very low diet, without which he observes that the latter medicine produces scarcely any effect. (See *Recherches sur le Traitement du Cancer par la Compression*, *Simple ou Combinée*, 8vo. 2 tomes, Paris, 1829.) I lately tried Récamier's plan in a case of scirrhus in the North London Hospital; but it seemed only to accelerate the conversion of the disease into open cancer.

From the preceding accounts we may infer that no reliance is to be placed on any known remedy, or plan, in cases of real scirrhi and ulcerated cancers. The operation is the only rational chance of getting rid of the disease; and to waste time, so as to allow the disorder to increase in a serious degree, merely for the sake of trying various unpromising medicines, is conduct unworthy of a wise surgeon's imitation.

Perhaps, in the early stage, it may be right to make trial of arsenic, conium, preparations of iron, or those of iodine, and of friction, with the ointment of the hydriodate of potass. In this country the ointment employed varies in strength from ℈j. to ʒiss of the hydriodate to each ounce of lard. Graefe is alleged to have succeeded in bringing about an absorption of the whole of the diseased breast, by applying an ointment composed of ʒj. of hydriodate of potass, and ℥ij. of lard. Mr. Hill, of Chester, has recorded one case very favourable to trials of iodine. The cancer was in the ulcerated state. He dressed it with an ointment consisting of ʒj. of the hydriodate to ℥j. of lard; and gave the patient internally thirty drops at a time of a solution of thirty-six grains of the hydriodate in an ounce of distilled water. The result was such amendment of the disease, that a cure was confidently expected; but in the end, the ulcer resumed its former dimensions and malignant character. (See *Edin. Med. Journ.* No. lxxxvii. p. 283.)

Upon the whole, the operation is the most likely means of getting rid of cancerous diseases. It is always admissible when every particle of the disease can be removed by it; when the absorbent glands are unaffected; and the constitution is not too far deranged. Even open cancers, if they can be entirely cut away, may yet admit of it.

The removal of cancerous disorders, even in the slightest and most trivial cases, should always be effected with the scalpel, in preference to caustic; the use of which, though it may sometimes succeed, by producing a complete destruction of the diseased parts, causes severe agony, and, in the event of its not acting sufficiently on all the diseased parts, often renders the complaint more aggravated, and kills the patient in a very short space of time.

In cases of cancer, the irritation, generally occasioned by every application of the caustic kind, together with the pain and inflammation which commonly ensue, are strong objections to the practice. Plunkett's remedy, which is chiefly arsenic, is equally objectionable. Nor can we at once so certainly extirpate every atom of cancerous mischief with any caustic as we can with the knife; for, with this, we immediately gain an ocular inspection of the surface surrounding the disease, so as to see and feel whether the disordered parts are completely removed, or whether any portion of the disorder requires a further employment of the instrument. With respect to the pain, that of caustics is infinitely greater, more intolerable, and more tedious than that occasioned by the knife. When caustic also fails in destroying every particle of the disease at once it almost always tends to enlarge, in a very rapid way, the original boundaries of the mischief. For an account of the method of removing scirrhi and ulcerated cancers, see MAMMA, REMOVAL OF.

An escharotic, which has been of late strongly recommended for cancerous affections, is the chloride of zinc, employed in the form of paste. On this subject my friend Mr. Crosse, of Norwich, observes, "It can of course only avail when the disease is still local; but the cases related by Drs. Canquoin, Ure, and Rioffrey, many of which occurred under the eye of most able surgeons, prove that this escharotic destroys the scirrhous tumor speedily, leaving an ulcerated surface, which often readily heals; and, moreover, it induces no danger from absorption, which is a recommendation not possessed by the arsenical paste." The cuticle being first removed by a blister, the phagedenic paste is applied, composed of one part of chloride of zinc, and two of sulphate of lime. (See *Ure*, in *Lond. Med. Gaz.* vol. xviii. p. 287; *Canquoin, Mém. sur un Nouveau Mode de Traitement des Affections Cancéreuses*, Paris, 1835; and *Rioffrey, New Treatment of Malignant Diseases and Cancer*, Lond. 1836.) This writer states, that the paste not only destroys the tumor, but purifies the surrounding atmosphere. He uses the chloride of zinc mixed with different proportions of flour, and has applied it to a tumor on the inside of the mouth, and also to the os uteri, with a good result. (See also *J. G. Crosse*, in *Prov. Med. Trans.* vol. v. p. 25.)

Dr. Ure, in some observations on lupus, recently published, communicates the following particulars respecting the chloride of zinc:—"The preparation of the chloride, which I proposed and introduced into practice in this country, differs in a most important feature from that originally employed by M. Canquoin. The wheaten flour, prescribed in the French formula, is apt to envelope the chloride in a glutinous dough, which blunts its power, or, at any rate, tends to confine its action to the particles on the surface of the paste; but the anhydrous gypsum of my formula, while it can exercise no chemical action upon the chloride, forms a porous medium, through which the whole of the particles of the delitescent chloride may transude upon the morbid albuminous tissue, with the effect of decomposing, or destroying it, with certainty, to any definite depth. This preparation of mine has been adopted in several of the London Hospitals, and has been found to be unfailing in its escharotic powers." (See *Lond. Med. Gaz.* Dec. 3, 1836.) The action of the chloride, and also of the nitrate of zinc upon albumen, and their consequences, in relation to the albumen of cancer, are discoveries to which this gentlemen lays claim. (See ZINC.)

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TREATMENT.

[Since the publication of the first edition of this work our acquaintance with the structure and relations of cancer has been greatly advanced, as the foregoing *resumé* of the labours of others fully shows. But of the treatment of cancer we cannot say nearly as much. We look over the long list of internal remedies that have been tried, and we lay it down with the sorrowful conviction that there is not one on which we can put any reliance. Local treatment seems to offer somewhat more of hope, especially if timely and judiciously employed. Iodine and arsenic are the only internal remedies that seem to deserve any particular notice, and their compound the iodide of arsenic. M. Velpeau, though disbelieving entirely in the power of iodide of potassium to remove any tumor whose cancerous nature is positively apparent, at least as a general rule, yet gives two cases in which tumors, which, at any rate very much resembled scirrhus, disappeared under full doses (14 to 20 grains daily) of this salt with inunction of iod. plumbi ointment. Dr. Walshe (whose calm and accurate judgment commands confidence) is evidently not inclined to reject *in toto* the accounts given of cures effected by it. He prefers, however, the iod. arsenic in doses of gr. $\frac{1}{16}$ *bis die*, and in cases of non-ulcerated mammary scirrhus he has witnessed the following effects from its use. The pain of the tumors decreases in violence. Its bulk diminishes, and its enlargement is arrested. The general health improves. The remedy may be taken without risk for several months. Of arsenic, Velpeau says, that not being able to do good by its agency, he has feared to do injury. This feeling, though not unreasonable, is yet, I am inclined to think, often allowed to operate to too great an extent. Practitioners are averse to the use of arsenic because it sometimes disagrees decidedly, and because its good effects are slowly produced, and then only with careful and skilful management.

External remedies.—Local abstraction of blood in the way recommended by Fearon does not seem advisable. Dr. Walshe coincides with Mr. Burns in the opinion "that the obstinate and senseless reiteration of leeching can only tend to weaken the patient, and sooner break up the constitution." "In the very earliest stages of diseased induration one or two applications of leeches are advisable, even as a guide to the diagnosis of tumors of doubtful character." Or if inflammation arise in the vicinity of the diseased growth, it may be combated by leeching. But if a tumor has become adherent to the skin, it is not to be thought of, as the leech bites may become permanent ulcerations.

Ligature of nutrient arteries has produced, according to repeated testimonies, good effects, sometimes even complete cure. It seems, however, difficult to believe that this could be other than a most rare occurrence, even where the anatomical disposition rendered such a proceeding possible.

Congelation by means of a mixture of pounded ice (four parts), and bay-salt (two parts) is considered by Velpeau as capable of being employed as a palliative if not curative measure in certain cases of cancer. After its application "the parts become blanched, assume a dead colour, and harden, and should the congelation be continued beyond a quarter of an hour it transforms the tissues into a genuine eschar, which, at a later period, will be eliminated by inflammatory reaction." One advantage it has, is that of checking for the time all flow of blood, discharge, or other fluid, and therefore may be employed with benefit in ulcerated cancer or fungous growths. A remarkable case has been recorded by Mr. Simon in the report of the *Path. Soc.* for 1854, of a female æt. 36, or more, who was treated for a mammary scirrhus by the application of a bladder of pounded ice to the breast. It was applied at first for half an hour, afterwards for two hours or more daily. Its use afforded great relief to the pain, and produced such diminution of the tumor that in thirty-four days there only remained some flat fibrous-feeling induration, over which the skin was adherent. The general health had greatly improved. In about nine months after leaving the hospital she returned, and was readmitted suffering with a large hard tumor in the epigastrium. In about six weeks she died, when cancer was found in the liver to a great extent, in the peritoneum, pleuræ, pericardium, and breast. The latter part, which was not of large size, was indurated and scirrhous, and its integuments presented small cancerous tubercles. Such a case certainly shows the power of cold in checking morbid growth, and indeed arresting it, but at the same time, makes it probable that actual mortification and destruction of the tumor by the cold would have been preferable.

Preparations of Iodine.—Of these Dr. Walshe gives the preference to the iodide of lead. His experience (corroborated by that of others) does not allow him "to conceive a single doubt that tumors actually and truly scirrhous in structure,—tumors which would have run the common course of cancer,—may be arrested in their progress by early and judicious use of these agents." Such recommendation should certainly not be forgotten in dealing with non-ulcerated cancer of any external part.

Velpeau states that he has employed *compression* in cancer with a hearty and sincere desire of finding it efficacious, but that he has been entirely disappointed. Some apparent temporary diminution in size, he says, may be effected by the tumor becoming flattened, and getting hidden between two of the ribs, but this is all. He does not seem to have used the apparatus invented by Dr. N.

Arnott, and described in detail by Dr. Walshe in his work. This appears to be more effectual than any means of the kind yet employed, and more free from defects. The testimony of Dr. Walshe respecting this mode of proceeding in appropriate cases is as follows: — "The effects produced by pressure are removal of existing adhesions, total cessation of pain, disappearance of swelling in the communicating lymphatic glands, gradual reduction of bulky masses to small hard flat patches, or rounded nodules (which appear to be both locally and generally perfectly innocuous), and in the most favourable cases total removal of the morbid production. The relief of pain afforded by this instrument is, without exaggeration, almost marvellous; this effect is insured by the peculiar softness and other properties of the air-cushion, the medium through which the pressure of the spring is transmitted to the surface. Females unable to obtain sleep even from enormous doses of laudanum cease instantaneously to suffer on its application, and sleep thenceforth as though they were perfectly free from the disease." If the growths be very large, or of the encephaloid species, or infiltrated instead of tuberous, or if the situation be unfavourable, more than some degree of palliation cannot be hoped for. The same is to be said of growths that are extensively softened, ulcerated, or in a state of fungous vegetation, or are adherent to the skin. In one case, treated by Dr. Walshe with iodide of arsenic, iodide of lead ointment, and compression, a tumor which, in November, 1843, was fully two inches in breadth and length, had totally disappeared at the end of April, 1844, and had not reappeared there or elsewhere in August, 1845. M. Velpeau would affirm that such a tumor was not cancerous, principally from the circumstance of its having been thus cured; but to my mind such scepticism is unreasonable.

Caustics. — M. Velpeau, though in most cases preferring the use of the knife, would yet adopt caustics as curative means in certain conditions, which he thus specifies. (1.) When the cancer is ulcerated in patches, and is rather sprouting than narrowed; (2.) when even with a cutting instrument it would be impossible to preserve a portion of the integuments of the part invaded by the tumor; (3.) in all cases in which the cancer is fungous, exactly bounded, and the patient has an extreme dread of the knife; (4.) ulcerated, cavernous, and disseminated scirrhus may be treated with caustics more advantageously than by incision; (5.) ulcerated cancers which are adherent to the summit of the axilla, or to the clavicle, or extend to the neighbourhood of the bones. He also recognises the possibility of certain caustics producing "some important action" (alterative) in the tissue around them. On the whole, therefore, he thinks that considerable attention should be paid to this class of remedies. (*a.*) *Chloride of antimony,* on account of its deliquescence, is difficult to manage, but is very powerful. (*b.*) *Vienna paste* and *caustic potash* are tolerably manageable, but their action is interfered with by the sanguineous exudation to which they give rise. (*c.*) *Nitric acid* acts rapidly and deeply, causes no bleeding, and may be applied with tolerable facility if made into a paste with lint, tow, or wadding. (*d.*) *Sulphuric acid* mixed with saffron, so as to form a paste, seems to be much used by M. Velpeau. He says no other caustic has seemed to him to possess such advantages. Its action is rapid, energetic, and as deep and extensive as we can desire; easily limited without giving rise to any bloody discharge, and after the succeeding day producing neither inflammatory reaction, redness, pain, nor swelling on or around the cicatrix. I have seen fungous encephaloid cancers larger and thicker than the fist, completely subside in this way, and become reduced to the level of the surrounding parts in the space of twenty-four hours. The eschar shortly sinks in, and forms a black dry excavation, as if carbonised, which remains in place of the tumor. Its disadvantages are, that it causes acute and long continued pain, and is often difficult to apply. (*e.*) *Chloride of zinc.* Nothing more needs be said respecting this caustic in addition to what is contained in the original article, except to mention that its use is exceedingly painful, the suffering being prolonged for more than twenty-four or thirty-six hours. (*f.*) *Arsenical preparations* have been employed from an early period, and are beyond doubt capable of producing good effects, especially where the cancer is superficial. The objections to their use are, that they cause much pain and inflammation in the surrounding parts, and that the absorption of more than a certain small quantity of the mineral may cause even fatal poisoning. The various susceptibility of different persons to the action of arsenic makes the risk of injurious consequences more to be apprehended; the quantity which circulates in the blood of one person without injury may affect another severely. The principal preparations that may be employed are Rousselot's powder (*arsenic* 8 parts, *cinnabar* 64, *dragon's blood* 64); Frère Côme's (*cinnabar* 64 parts, *arsenic* 8, *burnt savine* 16, *dragon's blood* 16); Dubois' (*arsenic* 4 parts, *cinnabar* 64, *dragon's blood* 34). These powders are to be made into a paste with saliva, and spread like an ointment somewhat thickly on the surface to be destroyed. It is important, however, to operate on a small extent of surface only at one time, lest too much arsenic should be absorbed. M. Manec thinks he can prevent all risk of danger from too early a reapplication of the arsenic by examining the urine daily so as to ascertain when it ceases to be eliminated from the blood, which generally occurs from the fourth to the sixth day. This surgeon states that the arsenical caustic he uses (a modification of Frère Côme's) "has so strong an affinity for abnormal tissues, and such a predilection that it searches them out in the very midst of the healthy tissues, and poisons and destroys them."

The mode of treatment employed by Dr. Fell, which, as long as it was kept secret, excited great curiosity, requires some notice. In cases of ulcerated cancer he uses the following ointment: ℞ *Sanguinariæ Canadensis* ℥ss — ℥j, *Zinci chloridi* ℥ss—℥ij, *aquæ* ℥ij, *Pulv. semin. tritici hiberni* q.s. Mix, and form a paste of the consistence of treacle. This is spread on lint, and the ulcerated surface covered therewith on the first day. A superficial layer of the growth is thereby killed. On the following days incisions are made about half an inch apart, into the necrosed tissue, avoiding the living structures, into which strips of cloth, cotton, or wool, saturated with the ointment, are inserted. The deeper parts of the growth are thus attacked, the incisions being gradually carried deeper, and the necrosing agent further introduced, until at last the whole tumor is converted into a dead mass, which is enucleated by a natural process of ulceration (as in the case of a gangrenous limb), and falls out from ten to fourteen days after. If the tumor is not ulcerated, but it is judged requisite to remove it *en masse*, the skin covering it is first destroyed with nitric acid. "Cases of an incipient nature, where the disease, though fully developed, is still in a quiescent or dormant state, are often cured by means of absorption. The absorbing agent is the following ointment. ℞ *Sulphat. Zinci* ℥vi, *Sanguinariæ* ℥ij, *Myricæ conifera* ʒi, *Extract. opii aquos.*, *Extr. conii* āā ʒvi, *Ungt. cetacei* ʒij, *M. et ft. Ungt.* In conjunction with this preparation, I use an ointment of the iodide of lead, generally applying each twelve hours alternately. The following is the formula used. ℞ *Iodid. plumbi* ʒi—*Glycerinii* ʒi, *Ungt. cetacei* ℥ij *M. ft. Ungt.* With a steady persevering use of these two ointments, I have often dispersed incipient tumors, which I have no doubt were cancerous. These are the external means of treatment I employ, which although in themselves eminently successful, yet I am not content with them alone, but also pay particular attention to the general health, ordering a nourishing and sustaining diet, besides giving internally the puccoon (*Sanguinaria Canad.*) in small and repeated doses. A remedy that exerts so much influence when applied externally must be exhibited with caution, I therefore seldom exceed half-grain doses, three times daily. This is given in the powder or decoction ; in the former cases I give it either alone or combined with the sixteenth or twentieth of a grain of the iodide of arsenic and one grain of the extract of cicuta made into pills ; or if given in decoction, I generally combine it with the fluid extract of taraxacum. The ointment of sulphate of zinc I have been in the habit of applying with marked success in cancer of the womb. Unlike the Vienna paste, it can be applied not only with safety, but with impunity, as it does no injury to the adjoining tender parts. I have also used these preparations with marked benefit in cases of lupus, both exedens and non-exedens ; indeed I have never known a case in which the judicious use of these remedies has failed. Indolent ulcers have long been an opprobrium to the profession, from their intractable nature ; in such cases these applications are most efficacious, as I have known phagedenic and indolent ulcers of long standing to be speedily and permanently cured in the course of two or three weeks."

The experience of the surgeons of the Middlesex Hospital, as to the truth of Dr. Fell's pretensions, is to the following effect. (1.) The *Sanguinaria Canadensis* appears to be practically inert for the purpose of destroying cancer. Dr. Fell himself does not advise its use in internal cancer, or hopeless external. It may be observed that, with the half-grain doses of puccoon, *iodide of arsenic* was also given. The puccoon, in one case of gastric cancer, I gave internally, but only with the effect of causing some irritation. (2.) The method of introducing caustics by gradual incision places in the hands of surgeons an important advantage. Those whose tumors have hitherto been judged unfit for the use of the knife, or of ordinary caustics, have been subjected to this method with very decided benefit. The shrinking and retraction of the necrosed part brings deep prolongations of the tumor within reach of the paste, which at first appeared hopelessly beyond it. "The average of pain was in these very patients the least ; and nothing could be more striking than the contrast between the distressed condition of such patients before they were treated, and their comparative ease afterwards ; healing sores or temporary scars, taking the place of fœtid, tender, discharging, and constantly growing masses of cancer. . . . This plan of treatment is a clear advance upon the past." (3.) As to the tendency to relapse, although there has not yet been sufficient time to form a complete opinion, yet the present results are such as indicate that the new method has in this respect no superiority over the old. "There has already (in barely two months) been a return of the disease in four out of the fourteen cases, and a failure in extirpating it in three others out of the whole number of twenty-one." It does not appear that any satisfactory evidence was obtained of the absorbing power of the ointment applied by Dr. Fell to tumors in a more quiescent state.

The tediousness, and the not unfrequently severe pain, attending Dr. Fell's proceedings, must be accounted grave objections to it ; and, for all that yet appears, it cannot for a moment be compared with excision under chloroform, in any case where the tumor is easily accessible to the knife. But in the class of cases specially pointed out by the surgeons of the Middlesex Hospital, the writer cannot but think its employment may be highly beneficial. It has been stated that the method of gradual incision is not new, having been used by Justamond, surgeon to the Westminster Hospital. The following extract shows what he performed. "In expectation of facilitating this separation, I made a few scarifications on the destroyed surface, and filled the crevices with more of the powder (arsenical), applying over it a pledget of the same kind as the former. But this second application did not, as I imagine, produce any effect, for it caused no pain. I then waited a few days to observe what would happen. The separation began to take place more evidently at the edges, which now looked florid, though the tumor did not yet seem ready to come away. To hasten this event, I judged it proper to put some of the powder all round the separating edges, as low down as it could be insinuated between the diseased gland and the sound skin. I soon found this contrivance had its effect, for the pain it occasioned was more violent than that produced by the first dressing (which was very great). I was, however, obliged to repeat the application of the powder to different parts of the edges at intervals, but never in so large a quantity as before. By this method, the separation of the tumor was effected in little more than two months, and the gland came out as entire as a nut out of its shell, or as if it had been cleanly dissected with a knife." It does not appear that Justamond attached much importance to this procedure, or particularly urged its adoption ; and we do not think it fair to speak of it as an anticipation of Dr. Fell's. To him belongs certainly the credit, whatever it be, of introducing this method of using caustics. We would remark that the action of the paste is not properly that of a caustic, as it were burning and destroying the parts it comes in contact with, it is rather a necrosing agent, killing the tissues, and converting them into inert sequestra. That the chloride of zinc (or the sulphate) is the real potential means employed is plain, from the circumstance that Mr. Moullin has succeeded perfectly well with it alone in necrosing and enucleating eighteen tumors. He has favoured me with the following statement relative to recurrences. Of seven cases which were operated on two years ago, there has been no return in any. Two, however, have died from other causes within the period. No return of the disease has occurred in any of six cases which were operated on about eighteen months ago; nor in four cases which have been operated on about one year ago. In one case, operated on two years ago, the tumor was only partially removed, and is still kept in abeyance by the application of tannin. The patient is a female, æt. seventy-four; her health at present is very fair. He does not by any means affirm that all these tumors were cancers, but he cannot doubt that the majority were.

M. Landolfi's treatment of cancer, which he conducts in a most open candid manner, demands some notice. He applies the paste, of which the following is the formula, to the diseased parts, and gives at the same time pills containing a minute proportion of the chloride of bromine internally. *Chloride of bromine*, three parts; *chloride of zinc*, two parts; *chloride of antimony*, one part; *chloride of gold*, one part; *liquorice powder*, q. s. to make a paste. The chloride of bromine is the principal agent, and has lately been used by itself. Cancers of the skin, the epithelial variety, lupus, &c. are treated by a combination of *chloride of bromine, with basilicon ointment*. Lint pledgets, spread with the caustic paste, are allowed to remain on twenty-four hours, and then removed, when a line of demarcation is observed separating the altered from the healthy tissues. Bread poultices or other soothing applications, are then to be employed until the eschar separates, which occurs from the eighth to the fifteenth day. The only independent testimony I have met with regarding this mode of proceeding is that of Dr. Lambe, in a communication respecting villous cancer, contained in Virchow's Archiv. vol. 8, p. 136. He says, "the advantage of this caustic application consists in its causing the morbid growth to be replaced by a purulent layer of the same shape, while the borders of the excavation at the same time become smooth and clean, and closely approximated to the base. This advantage, however, is counterbalanced by the long continuance of the pain (twenty-four to thirty-six hours); and, still more, by the circumstance that the inflammation provoked in the tumor excites a more rapid growth of the morbid formation, and that one is never done with cauterizing." It appears sometimes that the slough adheres to the surface, as a protective covering, and that growth proceeds more rapidly beneath it, as under a hot-bed. This is especially the case with more homogeneous, gelatinoid formations, which shoot up under the slough in a night, while the epithelial formations require a longer time.

Operations by Knife.

The importance of the question as to whether a cancer should be submitted to the knife or not, requires a fuller discussion than was possible when the original article was written. M. Velpeau takes exception to the unfavourable opinions formed by physicians, because they only (he says) see the hopeless cases of disease, on whom surgeons have exhausted their skill in vain. The deliberate judgment of Dr. Walshe, which I first cite, is not formed on the personal experience of any class, but rests on the evidence of facts admitted by all. "First: Inasmuch as the number of permanent recoveries is infinitely small, and as no combination of circumstances, however favourable, protects the patient from relapse,—*the operation cannot, in any individual case, be recommended as likely to cure the disease.* Secondly: Inasmuch as no operation by excision is performed without the chance of some of the diseased structure being left behind, an accident which hastens the progress of the malady,—inasmuch as absolute certainty of the freedom of internal organs from the disease is unattainable;—inasmuch as the dormant cancerous diathesis is sometimes roused into activity by removal of a tumor; inasmuch as cancers in a state of active growth acquire increased energy of vegetation if reproduced after extirpation;—and, lastly, inasmuch as the operation itself has not very unfrequently proved both the occasion and the cause of death; *excision cannot be undertaken without imminent risk of placing the patient in a worse condition than he or she was previously to the use of the knife.* Thirdly: As a corollary from the first and second inferences; and inasmuch as the disease has unquestionably been cured, or arrested in its progress by milder measures;—and inasmuch as the disease does not by any means, inevitably and unfailingly, run a course destructive of life;—and inasmuch as quiescent cancers have sometimes been succeeded by most active and virulent growths in consequence of untimely extirpation; and inasmuch as life has sometimes fallen a sacrifice to operations for the removal of putative cancers; *the operation should, as a general rule, be abstained from.* These inferences refer to the general propriety of extirpation." More particularly, it may be stated, that "patients, having a cancerous tumor distinctly traceable to a blow as its apparently exciting cause, whose constitution is as yet unimpaired, and in whom no hereditary taint can be discovered; in whom the lymphatic system is unaffected; in whom the new growth is of the scirrhous species, tuberiform, and not infiltrated, free from adhesion, of moderate size, unaccompanied with morbid changes in the skin, and springing from bone (except the skull), or connected with the lip," may entertain "some faint hopes of permanent recovery" from the operation. On the other hand, "the operation is absolutely contraindicated as a curative measure" in patients "who have cancers either so placed that any part of them must of necessity be left behind, or manifestly in a state of active growth; in whom the presence of internal cancer is even matter of faint likelihood; in whom the cancerous cachexia is clearly established; in whom the communicating lymphatic system has even apparently grown cancerous; in whom the morbid mass is of the encephaloid species (unless it be connected with bone), and of large dimensions; in whom the tumor is so placed and constituted, that the manual part of the operation (or its immediate consequences) is in itself attended with serious risk to life; or when the age and debility of the individual are such as to entail similar danger. . . . Persons in whom, on the other hand, the disease has existed for a number of years in an almost stationary condition, giving rise to no serious derangement of health, and forming rather a local inconvenience than a malady, should certainly not be interfered with."

Mr. Paget estimates the average duration of life in persons affected with scirrhus at something more than 49 months. But out of 60, there were 22 dead in 2 years, 32 dead in 2½ years, and only 15 lived beyond the average. In these cases there was no operation. "In 47 cases, in which the cancer was once or more removed by operation, the average duration of life after the first observation of the disease was again something more than 49 months." The removal of the local disease, therefore, does not increase the average duration of life, but it appears from the table as if the course of disease that would otherwise be very rapid is retarded by it. Recurrence of the cancer took place within 3 months in 23 cases, and within 6 months in 45 cases, out of 74 (21 Lebert's, 53 Paget's). In only 8 cases was the recurrence delayed beyond 2 years. The result of Dr. Macfarlane's experience, as stated by Dr. Walshe, is that the chances are 7 to 1 that extirpation either proves fatal alone, or is followed by reproduction of the disease within 12 months.

The *period* which should be selected for the performance of extirpation is not absolutely determined. The weight of general conviction, says Dr. Walshe, is in favour of early operation, and it is considered that this gives a better chance of avoiding the injurious influence of the local disease on the system. In this view the first appearance of cancer is a local morbid change. Mr. Paget remarks that, "if this opinion were true we ought to find that the average interval between removal of the disease and its recurrence bears an inverse proportion to the time of duration of the cancer before removal. No such proportion, however, exists; nor does it even appear that recurrence is on the whole later after early than after delayed operations." The evidence collected by Leroy d'Etiolles is to the same effect. Out of 801 extirpations of cancer, 117 were performed in less then a year after the appearance of the tumor; out of these recurrence took place in 61 within the first year. Out of the remaining 56 in which recurrence had not taken place at the end of the year there were 52 in which the morbid growth had, when removed, existed for 5 years. Some indeed have advocated late operation, provided the disease continued limited, as affording a better chance of cure.

Mr. Paget, by examination of the facts he has collected, does not obtain any proof of the correctness of the common opinions that cancerous disease of the communicating lymphatic glands, or adhesion of the cancerous tumor to the skin, cause an operation to be followed by more speedy recurrence and fatal termination than when such is not the case. Dr. Walshe's and Mr. Liston's opinions (condemnatory) on this point are very strong. M. Velpeau thinks that the presence of diseased axillary glands in mammary cancer renders the success of extirpation extremely doubtful, but is not a formal contraindication.

Dr. Walshe and Mr. Paget are both agreed as to the conclusion that the extirpation of cancer by the knife cannot possibly be regarded with any reasonable hope as a final remedy for the disease. From the figures, however, which the former adduces he further concludes that it is not to be expected, that the operation shall prolong a sufferer's existence. The latter, though scarcely questioning the correcness of the conclusion, and indeed as it seems adding no little to its probability by the statement that the mortality from the operation itself is, at least in hospital practice, as high as ten per cent. yet contemplates certain cases in which the risk and alarm of an operation may wisely be encountered for the sake of the relief that may be anticipated. There are (1.) cases of acute hard cancer; (2.) cases where, while the cachexia is not very great, the local disease is producing very dire effects; (3.) where it is not probable that the operation will shorten life. He discountenances operation (1.) in chronic cancers, especially of the old; (2.) where cachexia is intense; (3.) where there is any reasonable suspicion of internal cancer; (4.) where the system, from any cause, is in an unfavourable condition for surgical operation. The above remarks have reference to *scirrhus*, but they do not require much modification to make them applicable to *encephaloid*. Mr. Paget thinks the operation justified as a means of lengthening life, and alleviating suffering whenever the disease can be wholly removed, and the cachexia is not so manifest as to make it most probable that the operation will of itself prove fatal. The average duration of life in unoperated cases is something more than two years; in operated ones is something more than twenty-eight months. The difficulty of diagnosing a myeloid tumor in a bone from a medullary cancer during life is so great that, where the doubt is considerable it is better to act on the most favourable supposition, as thus a life may be preserved which would otherwise be lost.

In *epithelial cancer* Mr. Paget estimates four years as about the true average duration of life, and the effect of operations is to obtain only "a very trivial prolongation of life." Still this surgeon thinks the operation is to be advised as a general rule, "whenever the whole of the disease can be removed without great risk of life, or producing worse deformity than already exists." His reasons are that in some rare cases a cure is effected, or a long immunity from the disease obtained; and that the removal of the disease gives great comfort for a time in most. He does not consider the extension of the disease to the adjacent lymphatic glands as an insuperable objection to operations.

In certain cases the cancerous growth by its mere presence causes such distress that an operation may be undertaken merely to procure temporary relief. A good instance of this kind is recorded by M. Velpeau, p. 483 of the *Syd. Soc.* translation. A vast encephaloid fungus discharging a pint of nauseous sanious fluid every twenty-four hours, as well as bleeding occasionally was removed at the earnest request of the patient and her friends. It was considered by all, including M. Cruveilhier, so certain that the encephaloid (microscopically examined) would return that nothing else was thought of except some temporary alleviation. However, the wounds cicatrised, health returned, and there had been no reproduction of the disease for three years.

It would be a great omission to close this article without citing the opinion of M. Velpeau, as to the circumstances under which an operation is advisable. His observations refer to the various kinds of mammary cancer only, but of course may apply to the disease in other parts. Generally, he thinks, "extirpation ought to be the rule, notwithstanding the naturally refractory nature of cancer, when the whole of the external tumor or tumors can be removed without too much difficulty or danger; but it ought on the contrary to be rejected in those instances where the reverse of these conditions is present." He specifies the following conditions as forbidding the operation. "Scirrhus in plates, or *en cuirasse*, should never be extirpated. Even at the commencement, and when there is but a single plate," recurrence invariably takes place, and usually with great rapidity. "The same must be said of tubercular pustular cancer, whether discrete or confluent. I am persuaded that cancers of this kind have never been cured by operation. Stony scirrhus *en masse* and diffused lardaceous scirrhus stand in precisely the same position. Even when the integuments are unaffected, these species of cancer invariably return. Whenever the scirrhous mass and the skin are confounded together in a diffused form, when the scirrhus is rather protuberant than depressed, and the tegumentary degeneration has no appreciable limit, and the whole mamma is more or less thickened, there is also nothing to be hoped for from the operation. Even when it is possible to remove with certainty all the diseased parts, when even there is no appearance of a tumor, either in the axilla, or under the border of the pectoralis major, or on the clavicle, or around the principal diseased mass, we may still be assured that the disease will return. Experience also enables us to affirm still more broadly that every cancer, whether in the form of scirrhus or encephaloid, which presents itself with the aspect of a diffused or disseminated tumor, will infallibly return after operation." "In the other varieties, on the contrary, if the boundaries of the disease are evident, and the degenerated glands under the pectoralis major, or on the side of the axilla are still moveable, and if in short it does not seem to be too difficult to remove all the tumors with certainty, the operation is permissible, affords some chance of success, and should be performed. Whether an encephaloid cancer be ulcerated or not, if the tumor be still intact, or if it be flattened externally, like a mushroom, and whether it be moveable or not amidst the tissues, extirpation is indicated so long as there is no cancerous tumor elsewhere, either in the form of a tubercle or of a mass in the neighbourhood, and when the general health of the patient affords no proof of cachexia or of internal disease. The operation ought not to be rejected because there may be swelling upon the clavicle, along the neck, or in any other more distant part. It ought, however, to be renounced if the axilla be filled either with disseminated glands, or with masses situated deeply under the clavicle, or amidst the pectoral muscles."] *C. Handfield Jones.*

Bibliography.—[*Walshe*, on Nature and Treatment of Cancer. *Bennett*, on Cancerous and Cancroid Growths. *Simon*, Lectures on Pathology. *Paget*, Lectures on Tumours. *Velpeau*, on Diseases of the Breast. *Fell*, on Cancer and its Treatment. Report of the *Surgical Staff of the Middlesex Hospital on* Dr. Fell's Treatment.]

CANCER SCROTI. CHIMNEY-SWEEPERS' CANCER. (See Scrotum.)

CAN'CRUM ORIS. A deep, foul, irregular, fetid ulcer, with jagged edges, on the inside of the lips and cheeks, attended with a copious flow of offensive saliva. It is a perfect specimen of phagedenic ulceration, and in its worst forms not unlike hospital gangrene, as I have seen several deplorable instances of. It also resembles the ulceration and sloughing in the mouth, produced by mercury. The gangrenous inflammation of the pudenda of children is of a similar character. (See *Kinder Wood*, in *Med. Chir. Trans.* vol. vii.)

The disease is rarely seen in adults; but most commonly in children from the age of eighteen months to that of six or seven years. The gums, as well as the lips and cheeks, are sometimes affected, in which circumstance the teeth are generally carious and loose. The ulceration is occasionally attended with abscesses, which burst either through the cheek, lip, or just below the jaw. Exfoliations are not unfrequent, and, when the disease is neglected, extensive sloughing sometimes happens.

According to Dr. Cuming, in most instances, the ulceration, commencing in the gums, extends to the lips and cheek, but sometimes it begins in the mucous membrane of the lips or cheek, and thence extends to the gums. This disease is set down by Dr. Cuming as most frequently making its attack during the period of the first dentition, though often met with in children between three and seven years of age.

"When the disease occurs in infants at the breast, it is generally attended with a purplish and spongy appearance of the gums and roof of the mouth; and the ulceration, which lays bare the necks of the teeth, both externally and internally, is of a greenish, or ash-colour, and very much disposed to bleed. The salivary discharge is increased; the tongue is white; the mouth feels hot; the bowels are for the most part confined: and the child in general labours under a greater or less degree of fever." (See *Dublin Hospital Reports*, vol. iv. p. 331.) Dr. Cuming has not seen this form of the disease, previously to the irruption of the four superior incisors, but he has frequently seen it when the child had only six or eight teeth; and he has constantly observed, that, when it occurs thus early, it is the upper gum that is first and principally attacked. This appears, to Dr. Cuming, the mildest and most manageable form of the disease; and he describes it as rarely attended with sloughing.

The second variety noticed by Dr. Cuming, occurs in children between the ages of twenty months and seven years. The ulceration generally begins in the gums, whence it extends to the lips or cheek. Sometimes it is of an acute, sometimes of a chronic nature, and attended accordingly with more or less sloughing. In the very worst forms, however, though the sloughing is considerable, the ulceration is always predominant. (Op. et vol. cit. p. 341.)

The third variety described by Dr. Cuming is, at first, confined principally to the cheek or lips. It begins with ulceration of their membrane, which is soon followed by that hard, red, shining, and circumscribed swelling, which, if the disease be not arrested, will speedily pass into gangrene. In this variety, gangrene predominates over ulceration; and the constitutional disturbance resulting from it may prove fatal.

Living in a marshy situation, want of wholesome food, and inattention to cleanliness, are conducive to this disorder, which is often met with in houses where children are crowded together. One of the worst cases, however, which I have ever seen, was in a child of an opulent family in Essex. The complaint is sometimes suspected to be contagious.

The first, or mildest form, is well known generally to admit of being cured by purgatives, aided by some of the applications presently specified.

In the second form, Dr. Cuming, after clearing out the bowels with a brisk cathartic, confides chiefly in an alternative of mild mercurials with aperients. The local applications preferred by him, are the black wash and a dilute solution of muriatic acid in honey. When the ulcerated surface is in contact with carious, or loose teeth, these should be removed. Dr. Cuming tried the liquor arsenicalis and cold salt water bath, without advantage.

In the third variety where gangrene is predominant, the disease mostly proves fatal. Dr. Cuming has employed various local applications, such as the mineral acids, dilute and pure, the oxymel æruginis, the butter of antimony, solution of the nitrate of silver, the black wash, &c., but mostly without any good effect. I have likewise tried all these applications in vain, as well as solutions of the chloride of soda of different strength. With such external means, cinchona, sulphate of quinine, carbonate of ammonia, opium and wine, have been prescribed ; yet, for the most part, unavailingly. (See *Cuming*, in *Dub. Hosp. Reports*, vol. iv. p. 343, 345.)

The treatment recommended by Dease, consisted in administering muriatic acid internally, using it as an application to the disease ; giving the patient a nourishing diet, with jelly, wine, &c., and occasionally prescribing an emetic.

In the worst form of the disease, I have found the concentrated nitric acid one of the most useful applications, especially when assisted with the internal exhibition of sulphate of quinine and dilute sulphuric acid.

Mr. Pearson extracted diseased teeth and loose pieces of bone ; directed a milk and vegetable diet, with a prudent quantity of fermented liquors ; and prescribed bark, sarsaparilla, and elm bark with sulphuric acid. The best applications seemed to him to be diluted mineral acids ; burnt alum ; the decoctum cinchonæ, with sulphate of zinc ; tincture of myrrh ; lime-water, with spirit of wine, &c. (See *Pearson's Principles of Surgery*, ed. 2, p. 287.)

CANTHARIDES. Spanish flies, with which the common blistering plaster is made. In surgery, the tincture of cantharides is sometimes prescribed in incontinence of urine, gleets, &c. It is occasionally added to stimulating liniments, to increase their effect. Cantharides applied to the skin, or taken into the stomach, have a peculiar tendency to act upon the urinary organs, and especially to irritate and inflame the neck of the bladder, and occasion strangury. In children these effects are particularly frequent. (See Blisters.)

[CANULA-INSTRUMENTS. The minute instruments which recent ingenuity has introduced into ophthalmic practice under the names of canula forceps, canula scissors, and canula lancet may often be used with good effect in operations on the eye. The idea of converting the end of a bit of steel wire no thicker than a cataract needle, into a pair of forceps, the blades of which are to open by their own clasticity, and to be shut by means of a canula pressed forwards on the wire, belongs, it seems, to M. Charrière, a well known surgical instrument-maker in Paris. To Mr. Bowman we owe the adaptation of the same mechanism to the working of a minute lancet, which is used for piercing the obstructed lachrymal sac to admit the passage of probes, &c.

Mr. Bowman, to adapt the canula scissors for snipping the border of the pupil at a given point, without risking the lens, has had the short blade made blunt, instead of sharp-pointed, so that it might be passed behind the iris, and not wound the capsule of the lens, if it touched it.] *C. Bader.*

CAPILLARY FISSURE. A very minute crack in the skull. The term came into use from its presenting the appearance of a hair.

CAPISTRUM. (See Bandage.)

CARBUNCLE (from *carbo*, a burning coal), is divided into the *benign* and *malignant* kinds, or into what are termed by French pathologists *anthrax* and *charbon*, examples of which last are afforded, in what is sometimes termed the *malignant pustule*, and in the carbuncle of plague, called therefore *pestilential.* Fortunately, all cases met with in England correspond to the anthrax of Dupuytren ; for no opportunities of remarking the *pestilential carbuncle* have occurred in England since the deplorable periods of 1665 and 1666.

Besides the diffuse forms of gangrene and sphacelus of the subcutaneous cellular tissue, there is likewise "a circumscribed form, which is observed in furunculus, carbuncle, or anthrax. The great accumulation of blood, and the still greater and rapid effusion of serosity, which takes place in these circumscribed acute inflammatory affections, produce a state of extreme induration of the cellular tissue, a greater or lesser portion of which, being thus as if strangulated, dies from want of nutrition, becomes separated from the living parts, and is expelled in the form of a grey or straw-coloured spongy or pulpy mass, through an opening made in the skin by a similar process, by ulceration, or a surgical operation." (See *Carswell's Illustrations of the Elementary Forms of Disease*, p. 7.)

Anthrax, or common carbuncle, resembles a boil (see Furunculus), in being attended with gangrene of the subcutaneous cellular tissue, and, if one high authority can be credited, of certain processes of that texture within the skin. (*Dupuytren, Clin. Chir.* vol. iv. p. 109.) It is remarkable for constituting a circumscribed dark red, or livid swelling, accompanied by burning heat, stiffness, and soreness in the part. It occurs most frequently in parts of the body where the skin is thickest, and abounds most in those processes of cellular tissue which are described by Dupuytren as extending between its areolæ. Thus, the nape of the neck, the back, and spaces over the scapulæ, the sides of the chest, and the nates, are the ordinary situations of anthrax.

Anthrax differs from a boil, not only in being of more considerable size, but in being usually single, and bursting by several small apertures ; whereas several boils frequently form together, or occur in succession, and when one of these tumors bursts, it does so by a single opening in its apex. The skin, which covers the anthrax, and especially what lies over its centre, is of a deeper and more livid red colour than what is seen over a boil. The mortified cellular tissue is deeper and more extensive in anthrax than a boil, in which it forms only a central nucleus, or *core*. The surface of the tumor is flatter than that of a boil, which always rises in a conical shape above the level of the skin, while its base does not penetrate so deeply as that of a carbuncle, which is a great deal broader than the more superficial part of the tumor. Boils chiefly occur in children, and young plethoric persons; the anthrax is mostly seen in subjects beyond the middle period of life, whose constitutions have been seriously impaired by intemperance, or other causes.

The occurrence of anthrax on the limbs is uncommon. Mr. Hunter, however, had seen the disease so situated: I have met with examples of it on the occiput, side of the neck, in various parts of the back, and on the nates.

Anthrax, or common carbuncle, is essentially different from the malignant pustule, so frequent in some of the southern parts of Europe (see *Larrey*, *Mem. de Chir. Militaire*, t. i. p. 104, &c.), in not being contagious. It differs also from pestilential and malignant carbuncle (the *charbon* of French pathologists), in the same important respect. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 111.) The latter author also regards the malignant pustule and pestilential carbuncle as essentially gangrenous diseases, whereas simple anthrax seems to him to be so merely from strangulation of the processes of cellular tissue extending into the structure of the true skin. The correctness of this statement seems to be rather doubtful; because there can be no carbuncular disease, whether benign or malignant, without a gangrenous disorganisation of the cellular tissue, and the influence of constitutional causes. This is certain; but, whether constriction of the inflamed tissues, as alleged by Dupuytren, be the principal cause of gangrene, is a point which is far less clear. We find, indeed, that it is the character of carbuncular inflammations, first to produce sloughing of the cellular tissue, even where this may not be covered by any dense unyielding parts, though occasionally it afterwards destroys all textures down to the vertebræ, or scapulæ, themselves. The gangrene, I should say, is independent of the constriction and confinement of the textures affected. The first symptoms are great heat and violent pain in some part of the body, on which arise one or several vesications, attended with great itching and a burning heat; below which a circumscribed, but very deep-seated and extremely hard tumor may be felt.

The progress of carbuncles to the gangrenous state is generally quick. Their size is various: they have been known to be as large as a plate. Considerable local pain and induration always attend the disease. The skin, indeed, has a peculiar feel, like that of brawn. As the complaint advances, several little vesicles arise, and under these, apertures generally form in the tumor, through which a greenish, bloody, irritating matter is discharged. The internal sloughing is often extensive, even when no sign of mortification can be outwardly discovered.

The degree of peril may generally be estimated by the magnitude and situation of the tumor, the age of the patient, and the state of his constitution. Carbuncles on the head are often fatal.

Anthrax, or common carbuncle, sometimes appears in persons affected with typhoid symptoms, in which case it is attended with great weight and stiffness of the adjacent parts; the patient is restless and pale, the tongue white, or of a deep red, and moist; the pulse low, urine sometimes pale, sometimes very turbid, with all the other symptoms, in an exaggerated degree, which attend typhoid fevers. The patient often complains much of his head, either from pain or giddiness. Sometimes he is drowsy; at other times, he cannot get the least sleep. Occasionally, he is delirious. The case is also apt to be attended with chilliness or rigors, and profuse perspirations. The patient is sometimes costive, sometimes afflicted with a profusion of stools; he generally complains of loss of appetite, nausea, and vomiting; takes but little nourishment; complains of difficulty of breathing, and is extremely low, with palpitations of the heart, and sometimes faintings. (See *Bromfield's Obs.* vol. i. p. 122.)

With regard to the local treatment, the principal thing is to make an early and free incision into the tumor, so as to allow the sloughs and matter to escape. If the carbuncle be large, a crucial incision is mostly preferred, because the compact mass of disorganised cellular tissue will be long in getting completely out, unless the opening be made very free. The extremities of each cut should go two or three lines beyond the boundaries of the disease. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 112.)

As much of the contents as possible should at once be pressed out, and the part covered with a poultice. Until the tumor is opened, no applications are more proper than an emollient poultice; but after an incision has been made, the poultice should be made rather stimulating; like that composed of oatmeal and port wine, the common fermenting poultice, or a linseed one, with which a proportion of Peruvian balsam is blended. Fomentations also afford considerable relief, both before and after an opening has been made. Poultices are to be continued, till all the sloughs have separated, and the cavity becomes clean, after which the ulcer may be dressed with red precipitate ointment, Friar's balsam, Peruvian balsam, or a solution of nitrate of silver, 10 grains to the ounce of water. Dupuytren, after opening the tumor sometimes continued the poultice, and, in other instances, employed gently stimulating dressings. When the carbuncle is situated on the posterior part of the trunk, the patient should not lie on his back; for then the skin would slough, notwithstanding the incision. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 113.)

The manner in which the disease is protracted, by not making a proper opening in due time, cannot be too strongly impressed upon the mind of every practitioner, and it may justly be regarded as a frequent reason of the fatal terminations of numerous cases. Mr. Bromfield long ago forcibly inculcated the necessity of making a timely opening for the discharge of the sloughs; for, says he, "in case you rely on the opening made by nature, the thin matter only will be discharged, the sloughy membranes will remain, and the orifice close up." (See vol. i. p. 128.)

It was formerly not an uncommon custom to remove the most prominent portions of carbuncles with the knife, or to destroy them with the actual and potential cauteries. Many foreign surgeons are partial to the hot iron, the employment of which was sanctioned by Pouteau. (See his

Œuvres Posthumes.) Even now they sometimes touch the apex of the swelling with muriate of antimony, or the actual cautery, especially when the pain is excessively severe; and the practice is alleged to be the most expeditious mode of relief. However, Dupuytren makes a distinction between anthrax and malignant carbuncles, observing that the proper cure for the former is an incision, but for the latter, the actual or potential cautery. In America, emollient poultices are continued until vesications appear, openings form, and a bloody serum begins to be discharged : the surface of the tumor is then freely covered with caustic vegetable alkali, which of course produces a good deal of pain, but this soon subsides, and the severe burning agony, peculiar to the complaint is now quite removed. It was Dr. Physick who first explained the proper period for the application ; without which knowledge, Professor Gibson says, much mischief has resulted from ill-timed incisions and the actual and potential cauteries. (*Institutes of Surgery*, vol. i. p. 52.)

With respect to the constitutional treatment, the continental surgeons, in the beginning of the case, before a slough has formed, usually prescribe gentle diaphoretic drinks, containing a sufficient quantity of tartrate of antimony to open the bowels. After this stage, they have immediate recourse to tonics and cordials. It should always be remembered, that the disease is for the most part met with in bad constitutions, and in persons who are weak and irritable. Hence bleeding is rarely allowable. Bark, sulphate of quinine, camphor, wine, opium, æther, and the regulation of the bowels, with calomel and other means, are the internal medicines most commonly needed. The diluted sulphuric acid is highly proper, as well as aromatics and a nourishing diet. As the pain is severe, opium is essential. The constitutional treatment is analogous to that of mortification. (See MORTIFICATION.)

[M. Nélaton takes a different view of the pathology and local treatment of carbuncle and boil to that generally received. He denies that the core, or yellow pulpy mass, constituting the characteristic feature of these ailments, is composed of a slough of the subcutaneous cellular tissue. He maintains that it is of the nature of a false membrane, a membrano-gelatinous secretion, resulting from an inflammation of a peculiar type. "Gangrenous masses," he observes, "from the time of their elimination, possess a peculiar infectious odour, while the so-called slough of a boil or carbuncle is devoid of smell ; that, in a slough are found the greater portion of the elements of the organ which has been deprived of life, especially the vessels ; but that in the core of a carbuncle no trace of organisation is observed ; that cellular tissue, which dies from violent inflammation, is struck with death at the time only when the inflammation has attained its highest degree of intensity, and that the core (bourbillon) exists long before this period, for it is found completely formed from the first appearance of the swelling, and that then and afterwards it offers no appearance of vessels. In proof of his assertion that the core is the product of a pseudo membranous secretion, he adds, "when serous membranes inflame they become covered sometimes by false membranes; cellular tissue, which has a great analogy with serous surfaces in its structure, functions, and diseases, secretes also, under some circumstances, a yellowish white albuminous gelatinous matter, which is deposited in its meshes, where it concretes." M. Nélaton objects to incisions in carbuncles, which he conceives have been practised under the erroneous impression that a slough existed under the skin and required a free opening for its escape.

It has been long known that carbuncle and boils have been associated with diabetes. Dr. Prout says,—"Diabetes very frequently (as far as my experience goes, *always*) accompanies carbuncles and malignant boils, or abscesses allied to carbuncles." (*Prout*, *On the Nature and Treatment of Stomach and Renal Diseases*, p. 35.) Dr. Garrod, however, although he admits that diabetic patients are very liable to carbuncles or boils, denies that persons suffering from these latter affections exhibit any trace of sugar in their urine, unless previously diabetic. He says,—"In one instance, a gentlemen aged about seventy, suffering from a large carbuncle between the shoulders, from which he subsequently died, I examined the urine very carefully when the disease was fully developed,—no trace of sugar was discovered. In the second, a gentleman about sixty years old, the urine, at the time when a carbuncle existed on the back of the neck, exhibited no trace of sugar. I have also made several other examinations of the urine of patients suffering from boils and carbuncles, without being able to find any saccharine impregnation. I think I am justified, therefore, in concluding that, although carbuncles and boils are of very common occurrence in diabetic subjects, the presence of sugar in the urine of patients suffering from these affections is by no means constant, probably very rare ; and that, when carbuncles and boils occur in patients not previously diabetic, sugar is very seldom found in their urine." (*Gulstonian Lectures*, *British Medical Journal*, April 18, 1857, p. 319.)]

CARIES (from *caries*, rottenness or worm-eatenness in wood). Caries is a disease of the bones, supposed to be very analogous to ulceration of the soft parts ; and this comparison is one of great antiquity, having been made by Galen. However, by the generality of the ancients, caries was not discriminated from necrosis.

It was from the surgeons of the eighteenth century, that more correct opinions were derived respecting caries. Until that period, writers had done little more than mention the complaint and the methods of treating it. Some new light was thrown upon the subject by J. L. Petit, in his remarks upon exostosis and caries. (*Mal. des Os*, t. ii. chap. xvi. p. 27.) But as he only spoke of the disorder as one of the terminations of exostosis, he has not entered far into the consideration of it. The best observations on caries were first made by Dr. A. Monro, *primus*. (*Edin. Med. Essays*, vol. v. art. 25.) This memoir contains the earliest correct ideas of *dry caries*, or *necrosis*, which is rightly compared to mortification of the soft parts, and named *gangrenous caries*.

[There need no longer be any hesitation about pronouncing caries to be the affection of the osseous tissue, which corresponds to ulceration in soft parts. It is a molecular death and disintegration of the bone, attended with suppuration, resulting from inflammation, (osteitis); to the particular inflammation which so results, the terms *ulcerative* and *rarefying* have been applied, the latter being used to illustrate a fact alluded to by Mr. Syme, viz:— that although the spongy bones are the most frequent seat of caries, yet that the compact osseous tissue is often affected, and when so, the affection is invariably preceded by a form of inflammation which expands, softens, and separates the dense tissue, causing it to resemble the cancellous texture in appearance. Caries, then, is the molecular death of bone, and corresponds to ulceration, while necrosis is the death of bone on a larger scale, the sloughing, gangrene, or mortification of bone, both being the result of inflammation. Simple superficial ulceration of bone, the result of local inflammation, becomes readily amenable to proper treatment, while, *incorrigibleness*, as Mr. Syme says, is the peculiar characteristic of a carious bone.]

The bones, like other parts of the body, are composed of arteries, veins, absorbent vessels, nerves, and cellular texture; they are endued with vitality; they are nourished, they grow, waste, are repaired, and undergo various mutations according to the age of the individual; and they are subject to diseases analogous to those of the soft parts. To the phosphate of lime, which is more or less abundantly distributed in their texture, they owe all their solidity; and, perhaps, it is to the same inorganic substance that the difference in their vital properties and in their diseases, from those of the rest of the body, is to be referred. In fact, this particular organisation and inferior vitality of the bones, are generally supposed to account for the small number, peculiar character, and generally slow progress of their diseases. (*Dict. des Sciences Méd.* t. iv. p. 80.)

Bones of a spongy texture are more frequently attacked by caries than such as are compact. Hence, the vertebræ; astragalus, and other bones of the tarsus; those of the carpus; the sternum; the bones of the pelvis, and the heads of the long bones, are often affected; and the bones of young persons are unquestionably more frequently the seat of caries than those of old subjects.

But though the soft and spongy bones are most subject to caries, they sometimes suffer a degree of injury sufficient to produce the death of a portion of their texture. Thus in a case, where a musket-ball had struck the head of the tibia, a sequestrum was found in it, with a cloaca leading down to it. (*Liston*, in *Edin. Med. and Surg. Journ.* No. lxxviii. p. 50.) In the fine plates of Weidmann, and the cases recorded by him, the same fact, as the effect of disease, was long ago illustrated.

According to the observations of Mr. Syme, when caries occurs in the tables of the skull or the cylindrical bones, it is uniformly preceded by a morbid expansion of the compact structure into a state resembling that which naturally belongs to those where the disease usually resides. He notices that the shafts of bones, and especially that of the tibia, are frequently enlarged and thickened, in consequence of chronic inflammation, and at the same time loosened in their texture, so as to present nearly the same appearance as that of the spongy articulating extremities. "In bones so altered, caries occasionally occurs, or, I should rather say, a condition resembling caries, since it differs from this disease in one important feature, viz. *incorrigibleness.* I have hardly ever known this pseudo-caries resist the local application of blisters, and internal use of oxymuriate of mercury; and I have felt very uncomfortable in seeing extensive incisions, rasping, trephining, actual cauteries, &c. employed ineffectually to cure complaints admitting of such easy remedy." (See *Edin. Med. and Surg. Journ.* vol. xxxi. p. 257.)

In necrosis, the bone is entirely deprived of life: in caries, the vital principle exists; but a morbid action is going on, whereby the texture of the bone is altered, and rendered softer and lighter than natural. But, though these disorders are essentially different from each other, they frequently occur together in the same part, as Weidmann, Liston, and others have correctly explained. In syphilis, this fact is often exemplified, the degree of necrosis predominating over that of caries.

In the most common species of caries, a loose, fungous flesh grows out of the interstices, formed on the surface of the diseased bone, and bleeds from the slightest causes; while, in the soft parts, a sinus generally leads down to the caries, and emits a fetid, dark-coloured sanies. These symptoms, however, as well as the tendency in the accompanying ulcer or sinus to produce large fungous granulations, are more constant in cases of necrosis than in those of caries, some of which may remain a considerable time unattended with any outward sore, abscess, or sinus, as is illustrated in caries produced by various diseases of the joints.

[Mr. Stanley gives the following very clear and practical account of the affection. "Caries exhibits in its progress the following phenomena. Inflammation extending from the bone to its investing soft parts, these become swollen, thickened, and tender; and abscesses are formed in them, which contract into fistulous passages leading to the diseased bone. The periosteum covering the diseased bone becomes thickened, very vascular, and readily separable from it. The bone itself is at first very vascular, then its cells become filled with a reddish-brown fluid, apparently a mixture of blood and pus, and occasionally combined with oily particles. Absorption of the bone, but chiefly of its animal part, ensues; that which remains is porous and fragile, and of a grey, brown, or black colour, probably from decomposition of the matter within its cells; to which cause, likewise, the fetid odour of the matter discharged through the fistulous passages may be ascribed." "Ulceration, in some instances, commences within the bone, hollowing it out, and reducing it to a thin shell; in others, ulceration commences in the outer surface of the bone, and extends progressively inwards. Whilst these changes are in progress, granulations, very loose and spongy, and bleeding on the slightest touch, often arise from the diseased bone, filling the cavities in its interior, and protruding through the fistulous passages in the soft parts covering it." May not these peculiar granulations be regarded as essentially pathognomonic of diseased bone? "The phenomena just described occur most frequently, and most distinctly in the caries of bones composed wholly of cancellous texture; but they are also observed in long and in flat bones; and among the former, most frequently in the tibia. In bones that are deeply situated, caries is often accompanied by very little evidence of inflammation, either in the bone or in its investing soft parts. Thus the scrofulous caries of the spine often advances to the destruction of the bodies of many vertebræ, without tenderness in the bones or in the soft parts investing them." (*Stanley, On Diseases of the Bones*, p. 52.)

The condition of bones just described, and to which M. Gerdy has given the name of *soft caries*, is generally described by pathologists as the *first period* or *degree* of caries. In this condition the bone is rendered unnaturally soft, and a probe passed in at one of these fistulous openings, surrounded by the very peculiar granulations alluded to above, when firmly pressed, penetrates into the osseous structure, breaking down the softened tissue with a crackling sensation perceptible both to the hand and the ear. The *second period* or *degree* presents the same characteristic lesions in a more advanced form; the softening has advanced, even to loss of substance; the cancelli have become much enlarged, and then contain the blood, or pus, or oily fluid mentioned above; the surface of the bone has become rugous by the destruction of its superficial lamella, and resembles pumice stone. The portions destroyed by ulceration may either be removed molecule by molecule, and may sometimes be felt as grit in the discharges, or, as is common in cases of scrofulous caries, the ulcerative process may have so completely surrounded a larger portion of osseous tissue as to cut off from it all supply of nutritive material, and thus cause its death; such instances, although in their origin essentially caries, have, frequently, as the writer believes, been mistaken for cases of necrosis (or, death of bone from a totally different cause), and when such portion of dead bone (*sequestrum*, as it has falsely been supposed to be) has been removed, delusive hopes of recovery have been entertained by the surgeon and given to the patient. (See NECROSIS.) It is in this stage of the disease, that the new osseous secretions, which are so constantly seen to accompany the ulcerative process, take place as the result of the neighbouring periostitis. In some instances they resemble spines and tubercles; in the case of scrofulous disease of the vertebræ they often unite together the remains of the bodies of several vertebræ which have been partially destroyed, and thus maintain the erect position of the vertebral column. They seem to have their chief seat in the anterior and posterior ligaments of the spine. M. Gerdy, under the term *hard caries*, describes very closely what I have already alluded to above as frequently occurring in scrofulous caries; viz. the formation of something like a sequestrum.

The tendency to new formation, and thus to reparation and cicatrisation, is very marked in syphilitic caries, spots may be detected in close proximity, where the two actions are going on pari passu; it is probably owing to this double action that the syphilitic caries is, of all forms of the disease, the most amenable to judicious treatment.]

"The absorption of bone, like that of soft parts (says Dr. Thomson), may be distinguished into interstitial, progressive, and ulcerative. We have ample proofs of the interstitial absorption, or that which is daily, hourly, and unceasingly taking place from every part of the substance of bone, in the disposition and removal of phosphate of lime, that has been tinged with madder. If too much earth be removed, the quantity of animal matter will be relatively increased, and a disposition given to softness of the bones—a state, which exists in the bones of children in the disease called the rickets, and in the bones of older people, in that denominated mollities ossium, or the rickets of grown people."

"I have already had occasion to mention the effects of the progressive absorption of bone, as manifested in the progress of aneurisms and other tumors of the skin; but the formation of pus is by no means a necessary, constant, or even frequent attendant on the progressive absorption in bone. Hydatids in the brains of sheep, tumors growing from the pia or dura mater in the human body (see DURA MATER), or aneurism seated over the cranium, or within the cavity of the chest, are often the cause of the whole substance of a bone being removed, layer after layer, by progressive absorption, without the formation of a single particle of pus. (See ANEURISM.) This state of the bone has often been confounded, but improperly, with that state of the bone which arises from ulcerative absorption, the state which is properly denominated caries, and in which one or more solutions of continuity may be produced upon the surface, or in the substance of the bones. The ulcerations, occasioned in bones by the venereal disease, afford by far the best marked examples of the effects and appearances of ulcerative absorption, or caries in bones," &c. (See *Thomson's Lectures on Inflammation*, p. 389.)

The prominent feature both of ulceration and caries, is loss of substance through absorption. But, as Mr. Mayo properly observes, "caries is something more than mere absorption. When an aneurism of the aorta presses against the sternum, or the vertebræ, the bones are gradually eaten through; they are partially absorbed; but they are not carious. When, however, the face is attacked with lupus, and the ulcer, spreading in depth and breadth, reaches the bones, and they become excavated simultaneously with the soft parts in the enlarging ulcer, the osseous tissue is not only absorbed, but truly carious. In caries, absorption is preceded by a change in the bone, which (with very few and doubtful exceptions) has a well marked inflammatory character. The same condition exists during the progress of the absorption. There is further present an imperfect restorative action, which is shown in the more or less partial growth of unwholesome granulations from the ulcerated surface. Of these changes, the inflamed condition of the bone is the primary and most important; the absorption is secondary and accidental. Absorption may be prevented by subduing the inflammation; or may, after having begun, be arrested, and the crop of unwholesome granulations converted into a healthy restorative growth, if the case is of such a nature as to allow of the suppression of the inflammatory or specific action." (See *Outlines of Human Pathology*, p. 36.)

Caries has been divided into several kinds, according to the nature of its causes: 1. Caries from external causes; 2. From constitutional disease, in which cases, besides local remedies, it is necessary to employ such medicines as are calculated to obviate the particular affection of the system, whence the diseased state of the bone has originated.

Mr. Mayo enumerates four kinds of caries: 1. *Simple*. When, in a person of sound constitution, a state of unwholesome and protracted inflammation is set up in a bone, through some accidental local cause. 2. *Syphilitic.* When a disposition to a specific periosteal inflammation is produced by lues. 3. *Strumous.* When the scrofulous diathesis gives origin to caries. 4. *Malignant.* When the bones are absorbed in the spread of malignant ulcers. (See *Outlines of Human Pathology*, p. 36.)

[To these must be added *scúrvy* as a not uncommon cause, and the *abuse* of *mercury* in the treatment of disease in scrofulous constitutions as a very common one.]

But many circumstances, in relation to the varieties of caries, yet lie in obscurity. If, as a modern writer remarks, the situation of the bones, the nature of their organisation, and the slowness of their diseases, would let an attentive observer trace the formation, development, and progress of caries, no doubt there would be noticed a diversity in its symptoms, corresponding to its different species ; and, probably, it would be found, that a venereal or scrofulous caries would vary in its origin and progress, as much from a caries arising from a purely local cause, as a venereal or scrofulous ulcer differs from the kind of ulceration that follows a common abscess. (*Dict. des Sciences Méd.* t. iv. p. 84.) The *worm-eaten* caries, as it has been termed, which penetrates the whole substance of a bone, and gives it an appearance as if it had been bored in hundreds of places, is a very different affection from some other forms of the disease, whether superficial, or extending to the deeper texture of the bone.

Around the carious part there is always a deposit of new osseous matter, in the form of tubercles, extending to a considerable distance, and greatly increasing the thickness of the bone. The new bone, on superficial inspection, appears rough and porous, the pores being for the transmission of blood-vessels.

According to Mr. Mayo, syphilitic caries begins with inflammation of the periosteum, and "does not lead to much enlargement of the bone. The bones commonly attacked are those, which, lying near the surface, are obnoxious to cold: the tibia, for instance, the ulna, the clavicle, the cranial bones. The swelling, by which syphilitic caries first manifests itself, is called a node. It is an inflammation, either confined to the periosteum, or involving at most the cortex of the bone. The periosteum becomes thickened, and is exquisitely painful. If the integuments are divided down to the bone at this period, a thick, viscid, glary matter, like honey, is often found in the cells of the periosteum, &c. The surface of the bone now gradually enlarges, or is thrown up in particles of porous bone, either furrowed by longitudinal grooves, or spongy and sieve-like, riddled with innumerable minute holes." The outer table of the skull in venereal caries, generally has the appearance of being worm eaten. Mr. Mayo adds, that, while the caries is making progress, the integuments inflame ; and matter forms below the skin, which afterwards ulcerates. The skin before breaking has a livid colour ; and afterwards the skin around the ulcer has the same hue. The edges of the sore are commonly a little raised ; its outline uneven, and the granulations irregular, and covered by a viscid ash-coloured secretion. A probe readily passes through the soft and gritty texture of the caries. The co-existence of ulcerated fauces and squamous eruption, or other disease of the skin, generally leaves no doubt of the nature of the caries. Sometimes, however, the latter exists alone. (See *Mayo's Outline of Human Pathology*, p. 40.)

Mr. Mayo is unacquainted with any essential difference in the appearance of carious bones in some forms of scrofula, and in the parallel cases dependent upon lues. "Less pain, less periosteal inflammation, and a smaller extent of surface attacked, the absence of other symptoms, and the general physical appearance of the patient (he adds), afford a strong presumption of the scrofulous origin of the disease." (Op. cit. p. 41.)

The instances of malignant caries, adduced by Mr. Mayo, are those from lupus and cancer. (p. 48.)

Mr. Syme regards the distinction of caries into the *dry*, *moist*, *worm-eaten*, &c. only as the result of the confusion of caries with other morbid states of the osseous tissue. The dry is in reality necrosis, as already noticed. A carious bone, after maceration, according to Mr. Syme, looks as if it had been burned ; being harder, whiter, and more brittle than usual, and always attended with more or less excavation, so as to expose the cellular structure. It resembles a piece of loaf sugar, that has been partially dissolved by momentary immersion in hot water. (See *Edin. Med. and Surg. Journ.* vol. xxxi. p. 257, and *Syme's Principles of Surgery*, p. 171, ed. 2, 8vo. Edinb. 1837.)

Caries from scrofula, the most frequent case, is more difficult of cure than that from syphilis and scurvy ; for some efficacious remedies against the latter diseases are known, but scrofula cannot be said to be much within the reach of medicine. The prognosis is less favourable in old than young subjects ; and much depends on the extent of the disease, the patient's strength, and the state of the soft parts.

When caries arises from constitutional disease, internal remedies are of course indicated. Thus iodide of potassium, sarsaparilla, tonics, and sudorific medicines have a tendency to cure (perhaps even more frequently than mercury) caries from syphilis ; while vegetable diet and acids cure both scurvy and the caries dependent on it.

According to writers, the indications in the treatment of caries are, either to produce a change in the action of the diseased portion of bone, whereby it may regain a healthy state, or to destroy it altogether.

In the caries from constitutional causes, the first object seems to be brought about by the operation of such remedies as remove the original disease ; and, I should much doubt whether, in these cases, any very active local treatment is necessary, or free from objection. Of course this remark is meant to apply only to examples in which we possess some medicine or plan which is known to be a tolerable sure remedy for the general disease. This is not the case in caries from scrofula, and here issues, blisters, friction, with other local means are unquestionably advantageous. (See JOINTS, and VERTEBRÆ.) But surgeons have proceeded further ; and not content with issues, blisters, fomentations, &c. as means for quickening the action of the diseased bone, they have commonly recommended applying directly to it the strongest stimulants, as the tincture of aloes or myrrh, a solution of the nitrate of silver, the acetic acid, or diluted muriatic or nitric acid. The actual and potential cauteries, and cutting instruments, have also been employed.

On the Continent, and particularly in France, the plan of touching carious parts of bones with the actual cautery, after bringing them fairly into view by the previous use of the knife, is still pursued. It is thought that the burning iron acts by changing the caries into a necrosis, irritating the subjacent sound parts, and exciting that action of the vessels, by which the dead or diseased part of the bones must be thrown off. Such is the doctrine inculcated by Boyer, and such is the practice sanctioned by other surgeons of the present day.

[The pathology of caries indicates clearly its appropriate treatment. As it is essentially a constitutional affection, so must it be met by appropriate general remedies; those forms of the affection which are produced by any of the specific causes already alluded to are the most amenable to treatment: but in every case, soothing local antiphlogistic applications, the early evacuation of abscesses, the administration of remedies calculated to sustain the powers of the patient, judiciously combined with alteratives, the free use of a nourishing diet, and above all, sea air, are the means to be relied on for the correction of the carious constitution. In the former editions of this work, much space was allotted to the description of the various modes of removing carious bones, and the different appropriate instruments. The gouge has been much extolled and much used of late years; indeed surgeons would appear to have ignored the constitutional origin of this affection altogether, and to have indulged in the idea that they could excise an ulcerating surface with benefit to a patient already reduced in health, and for whose cure the largest local supply of blood is required rather than a considerable local depletion. But it is refreshing to learn that the day for local interference is passing away, and the most experienced surgeons now admit that local interference with carious bone is not satisfactory in its results. At no time are we justified in interfering locally, save when a portion of bone is felt loose and detached, or when the improvement of the general health is sufficiently manifest to warrant the hope that the ulcerative action is arrested. For the same reason, great care should be observed in the application of blisters, and counter-irritants in the neighbourhood of diseased bones: they should always be placed at a sufficient distance to prevent their acting as immediate excitants. When placed in close contact, as on the carpus, and tarsus, where little soft parts intervene, they almost invariably increase the mischief considerably.]

Spencer Smith.

[Disease of the liver, spleen, and kidneys, consisting of "waxy degeneration," occurs consecutively to long continued caries and necrosis; and both in the diseased bone and diseased viscera, and also in the blood, those peculiar particles denominated "corpora amylacea," have been detected.] Ed. (See Heterochymensis.)

(See *J. L. Petit*, Traité des Mal. des Os. Paris, 1741. *A. Monro*, in Edin. Med. Essays, vol. 5. *Weidmann*, De Necrosi Ossium, Francof. 1793. *Callisen*, Systema Chirurgiæ Hodiernæ, vol. i. p. 493. *Boyer*, Traité des Maladies Chir. t. iii. p. 453, et seq. Paris, 1814. Dict. des Sciences Méd. t. iv. p. 78, &c. *J. Wilson*, on the Structure, Physiology, and Diseases of the Bones, &c. p. 263, 8vo. Lond. 1820. *L. Wissmann*, De Rite Cognoscendis et Curandis Nudatione, Carie et Necrosi Ossium, 8vo. *R. Liston*, Essay on Caries, in Edin. Med. and Surg. Journ. No. 78. *B. Bell*, on Diseases of the Bones, chap. 2. 12mo. Edinb. 1828. *Herbert Mayo's* Outlines of Human Pathology, sect. vii. p. 36. 8vo. Lond. 1835. [*Stanley*, Treatise on Diseases of the Bones, 8vo. London, 1849. Dictionnaire des Dictionnaires de Médecine, &c. t. ii. Paris, 1850. *Gerdy*, Chirurgie Pratique. t. iii. Paris, 1855. *Houel*, Manuel d'Anatomie Pathologique. Paris, 1857.]

CARTILAGES, ULCERATION OF. (See Joints.)

CASTRATION. The operation of removing a testicle. For an account of the cases rendering this measure necessary, see Testicle, Diseases of. The manner of operating is as follows:—The patient being laid on a table of convenient height, the first incision should begin, as nearly as possible, opposite to the abdominal ring, and be continued at least to the bottom of the scrotum.

The manner of beginning this incision is differently described by writers: some of them advising that the skin be held up by an assistant; others, that the knife be used perpendicularly in this as in other parts. The latter mode is generally preferred by English surgeons. The length of the division is a more important consideration. A small wound would indeed serve to lay bare the spermatic cord; but it will not permit the operator to do what is necessary afterwards with dexterity or facility; and as the scrotum must, either at first or at last, be divided nearly to the bottom, it had better be done at first.

Dupuytren recommends it to be carried also a little further, in the direction backwards. "In scirrhous cases (says he), not only is the testicle affected, but often a portion of the spermatic cord. It is therefore for the purpose of following up the diseased parts that the incision is extended up to the abdominal ring. It is carried down the whole length of the organ, in order that this may be removed entire from the scrotum; for, if the opening were only two or three inches long, the testis could not be easily drawn out, and the dissection would be extremely painful. The intention of prolonging the incision backwards is not less obvious; if this were not attended to, the scrotum would retract, and form a sac, in which the pus would accumulate." (See *Dupuytren*, *Clin. Chir.* t. i. p. 91.)

The spermatic cord is next to be laid bare by another incision. If the external pudendal artery is divided, the bleeding from it may be checked by an assistant putting his finger on it. The spermatic cord having been detached from its surrounding connections, the operator, instead of putting a ligature round it, which is an excessively painful proceeding, should first transfix it with a tenaculum or vulsellum, so as to hinder its retraction within the abdominal ring; then divide it just below the tenaculum with the scalpel; and next tie the arteries of the cord as separately as possible from the rest of it. This plan, which has long been adopted by the best surgeons in London, was also preferred by Dupuytren. (See *Clin. Chir.* t. i. p. 94.) Then the testicle is to be dissected out from its connection with the scrotum: the loose texture of the connecting cellular substance, the previous separation of the testicle from the spermatic cord, and the help of an assistant to hold up the lips of the wound, will enable the surgeon to do this with great facility, particularly if he takes hold of the cord, and draws the testicle outward by means of it. As Dupuytren directs, all the cellular tissue around the testicle and cord, the tunica vaginalis, and even the cremaster, should be taken away. Before the cord is cut, it should be carefully examined, lest the incision be made so low, as to leave some of the disease behind. (See *Dupuytren, Clin. Chir.* t. i. p. 92.) In dissecting out a large testis, care must be taken not to wound the urethra, corpora cavernosa, nor the testis of the opposite side.

[After the first incision has been formed, instead of dissecting the skin of the scrotum from the diseased testicle, the operator may, by grasping the tumor cause the skin of the scrotum to recede from the testicle, and the latter to protrude forwards through the external wound. Where no preternatural adhesion between the scrotum and diseased testicle exists, the method here mentioned facilitates the enucleation of the disease which will be completed by a few movements of the knife. The cord also may be divided subsequent to the isolation of the testicle from its bed, if the surgeon prefers it, adopting the precaution of using a tenaculum or vulsellum to prevent the retraction of the cord.

M. Aumont has proposed to make the first incision on the posterior aspect of the scrotum, but this plan does not appear to possess any decided advantage over the ordinary method above described. M. Rima has recommended a different procedure when the diseased testis is of moderate size. It consists in separating as far as possible the diseased from the sound testicle, and transfixing the skin of the scrotum immediately behind the cord. The knife is then to be carried downwards, close behind the testicle to be removed, and to be made to cut its way out, forming a sort of flap of the testicle covered in front by integument. This flap is raised and the operation completed by one sweep of the knife through the cord and its covering of integument. It is said that the cellular attachments prevent the cord from retracting, and that ample integument will be left for approximation. This operation may be more rapidly performed and admit of more display, but I know of no other advantage attending it.

M. Malgaigne divides the cord without caring to secure the spermatic and deferential arteries, trusting to arrest the hæmorrhage from these vessels by compression exerted on the inguinal canal through the means of a herniary bandage, kept in position for twenty-four hours. This novelty is not mentioned here for imitation. Deligation of the arteries in the usual way is, in my opinion, far preferable.]

Desault first divides the cord, and, holding its upper end between the index finger and thumb of his left hand, he then takes up the arteries with a pair of forceps, and they are immediately tied by an assistant. (*Œuvres Chir. par Bichat*, t. ii.) The spermatic artery will be found in the anterior part of the cord; and as soon as this vessel has been tied, the surgeon is to secure another, which accompanies the vas deferens, the latter part being carefully excluded from the ligature. (See *Sir A. Cooper's Lectures*, &c. vol. ii. p. 161.)

Pott used to fill the cavity of the wound with lint; but Desault and all the modern surgeons of this country bring the edges of the wound together, and endeavour to heal as much of it as possible by the first intention.

The plan of dressing, adopted by Mr. Lawrence, consists in retaining the edges of the skin together with two or three sutures, and then applying a narrow strip of simple dressing. A folded cloth, kept constantly damp, is also laid over the wound. (*Med. Chir. Trans.* vol. vi. p. 197.) Sir A. Cooper also employs two sutures: one, opposite the end of the cord; the other at the mid-point between the first suture and the termination of the incision. (*Lectures*, &c. vol. ii. p. 101.)

After castration, the edges of the scrotum separate and become inverted, so that, if brought together, only the skin covering them is in apposition. Hence, as Dupuytren has explained, one reason for sutures, with which he imitated English surgeons in endeavouring to unite as much of the wound as he could. (See *Clin. Chir.* t. i. p. 94.)

Sometimes, one or more vessels begin to bleed soon after the patient is in bed, although they effused no blood just after the removal of the testicle. Keeping the dressings and scrotum continually wet with the cold saturnine lotion very often suffices for the prevention and suppression of such hæmorrhage: if not, the wound must be opened again, and the vessels tied.

J. L. Petit made some useful remarks on this operation. The vessels of the scrotum, says he, are not the only ones which may be the source of hæmorrhage. Anatomists know that the septum which divides this part into two cavities, is furnished with an artery that is not considerable, but which becomes materially enlarged in the case of a sarcocele or other tumor. It is sometimes so considerable that it causes a bleeding, which makes a surgeon, who has had no previous opportunity of seeing the occurrence, exceedingly uneasy. Such hæmorrhage, says Petit, may be easily suppressed with a ligature; and he assures us, that he has seen a surgeon dress the patient three times, without ever suspecting that the bleeding, for which the applications were a third time removed, proceeded from this artery. (*Maladies Chir.* t. ii. p. 524, 525.)

The same experienced surgeon also acquaints us, that he has more than once extricated from trouble persons, who knew not how to stop the bleeding after the operation. He has seen some of them take off the dressings several times without discovering the wounded vessel. As they imagined that the only hæmorrhage which could follow castration must be from the spermatic artery, they contented themselves with examining the ligature of the cord, and increasing the compression, in order to stop the bleeding; but finding their attemps fail, they were compelled to seek assistance. On being sent for, M. Petit found, that the blood did not issue from the cord, but from a small artery under the skin, at the inferior angle of the wound. He easily stopped the hæmorrhage, and explained, not only that the cord had no share in the accident, but that it is generally suspected without foundation.

In general, after the removal of a diseased testis, there is more risk of bleeding from the vessels of the scrotum than those of the cord. I have never seen hæmorrhage from the spermatic artery give trouble after the operation, but have often known surgeons obliged to take off the dressings on account of bleeding in the scrotum. I believe the most likely way of avoiding this disagreeable occurrence is to imitate Mr. Tyrell, "always to allow the patient to become warm in bed before the dressing is completed;" for, until this period, it is not known what vessels in the scrotum will bleed. (See *Sir A. Cooper's Lectures*, &c. vol. ii. p. 161.)

When the diseased testicle is exceedingly large, or a part of the scrotum is diseased, the surgeon should take care to remove the redundant or morbid portion of the skin, by including the piece, which he designs to take away, within two long elliptical incisions, which are to meet at the upper and lower parts of the swelling. In this manner, as Mr. Samuel Sharp has observed, the hæmorrhage will be much less, the operation greatly shortened, the sloughing of the distended skin prevented, and the recurrence of cancerous disease rendered less likely. (See *Treatise on the Operations*, chap. x.)

Mr. Lawrence concurs with M. de la Faye in thinking it best always to remove a large piece of the scrotum with the testicle, by which means the surface of the wound is lessened. (See *Med. Chir. Trans.* vol. vi. p. 196.) Sir Astley Cooper approves of the practice when inflammation has rendered the testicle adherent to the scrotum, as being preferable to a tedious and painful dissection for the separation of the parts. (See *Lectures*, &c. vol ii. p. 160.)

If the tumor be of a pyriform figure, perfectly smooth and equal in its surface, and free from pain, notwithstanding the degree of hardness may be great, and the surgeon may, in his own opinion, be clear that the tumor is not produced by fluid, but is a true scirrhus, it is an excellent rule to make a small opening through the scrotum into the fore part of the tunica vaginalis, previously to the commencement of the operation, as recommended by Mr. Pott, so that if the case be one of serum or blood, its nature may be ascertained, and perhaps the testicle saved. "My reason for giving this advice (says Pott) is, that I was once so deceived by every apparent circumstance of a true, equal, indolent scirrhus, that I removed a testicle, which proved upon examination to be so little diseased, that, had I pierced it with a trocar previous to the operation, I could, and certainly should, have preserved it." J. Cloquet has seen castration performed in two instances of simple hydrocele, accompanied with great tension, but presenting no transparency nor manifest fluctuation. (*Pathologie Chir.* p. 45.)

The best way in cases of doubt, is to make a small opening with a lancet or knife, or to introduce a small trocar in the manner advised by Pott.

The agony of tying the cord is immensely increased by including the vas deferens; and, as no good results from so doing, the practice should be renounced in every part of the world, as it long has been in this metropolis.

Cases are recorded, in which the inclusion of the whole of the spermatic cord appears to have occasioned severe and perilous consequences, and these in so great a degree, that it was found necessary to cut and remove the ligature. Sometimes, says Petit, patients on whom castration has been performed, suffer more or less acute pain in the kidneys. The suffering often becomes insupportable and highly dangerous, the belly being swelled, tense, and painful; the patient being affected with syncopes, and affections of the heart, sometimes with vomiting, and a retention of urine: lastly, a universal inflammation of the belly, and a violent fever, accompanied with delirium, are occasionally the fatal consequences of this operation. Petit was required to visit a patient, who had been in this deplorable state for twenty-four hours, after having suffered castration, and this distinguished surgeon could impute the sudden and violent symptoms to nothing except the ligature on the spermatic cord; consequently, he advised the ligature to be removed. The patient received some slight relief from this step; and, after having been bled twice within a short space of time, he found himself a great deal better; but as the dressings became wet with blood, apprehension of bleeding began to be entertained. Petit, therefore, had recourse to moderate compression of the cord. No hæmorrhage ensued; the case afterwards went on well; and the patient recovered sooner than was expected. (*Traité des Maladies Chir.* t. ii. p. 527, 528.)

In the operation of removing a testicle, one caution seems particularly necessary, viz. if the cord should be at all enlarged, the surgeon ought carefully to examine, whether the augmentation of its size may not be owing to a portion of intestine, or omentum, that is contained within it. (*Sabatier, Médicine Opératoire*, t. i. p. 533, édit. 1.) In one case of extirpation of the testicle, "after the operation was completed, and the wound dressed, the patient being seized with a fit of coughing, to the astonishment and dismay of the surgeon, the dressings were forced off by a protrusion of several convolutions of small intestines: from this, it was proved that the patient had had a hernia; but, the diseased enlargement of the testicle had acted as a truss, and prevented the rupture from coming down." (See *Operative Surgery*, by *Sir C. Bell*, vol. i. p. 226; also p. 224.)

Another circumstance merits attention: when there are reasons which oblige us to divide the cord high up, and this part has not been tied before such division is made, it may be drawn up by the cremaster within the abdominal ring, and some difficulty may be experienced in securing the spermatic arteries. Sir C. Bell saw this happen twice, and the patients lost their lives from hæmorrhage. Hence, when it is necessary to cut through the cord near the ring, it is best always to transfix it with a tenaculum first, as above recommended. However, were the cord to happen in any instance to be drawn up within the ring, a surgeon would be guilty of most supine neglect to let the patient die of bleeding; for, as Sir C. Bell has remarked, we may follow the cord with perfect safety, even to the origin of the cremaster, which pulls it up, if attention be paid to the course of the cord, obliquely upward and outward, within the inguinal canal. Mr. Cline was present at the removal of a testicle, after which the cord could not be found; he therefore slit up the inguinal canal, and brought it into view again. In order to avoid this inconvenience, Sir Astley Cooper approves of the practice of passing a temporary ligature through the cord, as soon as it has been exposed. (See *Lectures*, &c. vol. ii.

p. 61.) Either this expedient, or that of the tenaculum, is unquestionably prudent.

A few years ago, the operation for a bubonocele was performed, and as the testicle was found diseased, the surgeon made a complete division of the spermatic cord, tied the spermatic arteries, and then left the testicle in its natural situation. After a time, the absorbents had diminished the part to a very small inconsiderable tumor. (*H. Weinhold*, in *Journ. der Pract. Heilkunde von C. W, Hufeland und K. Himly*, 1812, *zehntes stück*, p. 112.) This case merits attention, because it is the first instance, I believe, in which such practice was ever tried. Subsequently, the following work was published: — *Nouvelle Méthode de traiter le Sarcocele, sans avoir recours à l'Extirpation du Testicule; par C. Th. Maunoir*, 8vo. Génève, 1820. The new plan consists in dividing and tying the spermatic arteries, and leaving the rest of the cord and the testis undisturbed. Instead of this plan, another has been proposed, which consists in merely removing an inch or two of the vas deferens from the cord. I do not find that these methods have yet been established.

When disease, not merely an œdematous swelling, extends far up the cord, Pott considered castration as too late. In such cases Lisfranc has seen Dubois pull down the cord and then divide it, and Baron Dupuytren cut up the inguinal canal to the internal ring; but all the patients died. (*C. Averil, Operative Surgery*, p. 103. Lond. 1823.)

In one instance, I removed a testis for medullary disease, and observed in the part of the cord removed little white bodies, like millet seeds in size and shape. This led me to apprehend a relapse, but the patient has continued well for some years. In University College Hospital, I removed another testis, for the same kind of disease; but I fear that the patient will ultimately die of another medullary tumor in the abdomen.

See *Sharp*'s Operations of Surgery, chap. x. *Pott*, On the Hydrocele, &c. *Sabatier*, De la Méd. Opér. tom. i. *Bertrandi*, Traité des Opér. de Chirurgie, chap. xi. Œuvres Chir. de Desault, par *Bichat*, tom. ii. p. 449. *Larrey*, Mém. de Chirurgie Militaire, tom. iii. p. 423, &c. *John Pearson*, On Cancerous Complaints. *J. L. Petit*, Traités des Maladies Chir. tom. ii. p. 519, &c. *Sir C. Bell*'s Operative Surgery, vol. i. *Roux*, Parallèle de la Chirurgie Angloise avec la Chirurgie Françoise, p. 119, &c. *Lawrence*, in Med. Chir. Trans. vol. vi. p. 196, 197. Sketches of the Medical Schools of Paris, by *J. Green Crosse*, p. 139, &c. *Sir A. Cooper*'s Lectures on the Principles and Practice of Surgery, vol. ii. p. 159. 8vo. Lond. 1825. *Baron Dupuytren*, Leçons Orales de Clinique Chir. t. iv. p. 109, &c. 8vo. Paris, 1834. *A. L. M. Velpeau*, Nouveaux Elém. de Méd. Opérat. t. iii. p. 537. 8vo. Paris, 1832. *J. F. Malgaigne*, Manuel de Méd. Opérat. p. 624.

CATAPLASMA ACETI. Made by mixing a sufficient quantity of vinegar with either oatmeal, linseed meal, or bread crumb. When linseed is employed, it is best to add a little oatmeal or bread crumb, in order to keep the poultice from becoming hard. The vinegar poultice is generally applied cold, and is principally used in cases of bruises and sprains.

CATAPLASMA ALUMINIS. Made by stirring the whites of two eggs with a bit of alum, till they are coagulated. In cases of chronic and purulent ophthalmia it has been applied to the eye, between two bits of rag; and it has been praised as a good application to chilblains which are not broken.

CATAPLASMA CARBONIS. Made by mixing powdered charcoal and linseed meal with warm water, and applied as an antiseptic, to destroy the fœtor of unhealthy and gangrenous ulcers. One part of powdered charcoal should be mixed with three or four parts of linseed meal.

CATAPLASMA CEREVISIÆ. Made by stirring some oatmeal, or linseed meal, in strong beer grounds. It is used in the same cases as the Cataplasma Fermenti.

CATAPLASMA CONII. ℞ *Herbæ cicutæ exfoliatæ*, ℥ ij. *Aquæ*, ℔ ij. To be boiled till only a pint remains, when as much linseed meal as necessary is to be added. Hemlock poultice is an application for cancerous, scrofulous, and other ill-conditioned ulcers, frequently producing a great diminution of the pain of such diseases, and improving their appearance. Justamond preferred the fresh herb bruised. A solution of the extract is sometimes added to an ordinary linseed poultice. [It is in this way that the Cataplasma Conii is ordered to be made in the present Pharmacopœia. 1851.]

CATAPLASMA DAUCI. *Carrot poultice.* Some bruise the carrots in a mortar into a pulp; while others first boil them. This poultice is employed as an application to ulcerated cancers, scrofulous sores, and various inveterate ulcers.

CATAPLASMA FARINACEUM. The bread and milk poultice, made by putting some slices of bread-crumb in milk, and letting them gently simmer over the fire in a saucepan, till they are properly softened. The mass is then to be mixed and stirred about with a spoon, and spread on linen.

CATAPLASMA FERMENTI CEREVISIÆ. *Yeast Poultice.* ℞ *Farinæ Tritici*, ℔ j. *Fermenti cerevisiæ, Yeast dictæ*, ℔ ss. These are to be mixed together and exposed to a moderate heat till effervescence begins. In cases of sloughing and many ill-conditioned ulcers, this is an application of great repute. [It operates as a gentle stimulus and as a corrector of fetid effluvia. The carbonic acid which it gives off is considered to be its active ingredient. The Cataplasma Fæculæ Cerevisiæ, or beer ground poultice, is sometimes used in similar cases.]

CATAPLASMA LINI. *Linseed Poultice.* ℞ *Farinæ Lini*, ℔ ss. *Aq. Ferventis*, ℔ jss. The powder is to be gradually sprinkled into the hot water, while they are quickly blended together with a spoon.

This is one of the best and most convenient of all the emollient poultices for common cases, and it has nearly superseded that of bread and milk, which was formerly much more frequently employed.

Mr. Hunter speaks in the following terms, of the linseed poultice, and its uses. —

"Poultices are commonly made *too thin*; by which means the least pressure, or their own gravity, removes them from the part: they should be thick enough to support a certain form when applied.

"They are generally made of *stale* bread and milk. This composition, in general, makes too *brittle* an application; it breaks easily into different portions from the least motion, and often leaves some part of the wound uncovered, which is frustrating the first intention.

"The poultice, which makes the best application, and continues most nearly the same between each dressing, is that formed of the meal of linseed; it is made at once, and when applied it keeps always in one mass.

"The kind of wound to which the above application is best adapted, is one made in a sound part, which we intend shall heal by granulation. The same application is equally proper when parts are deprived of life, and consequently will slough. It is therefore the very best dressing for a *gunshot* wound, and probably for most *lacerated wounds;* for *lint,* applied to a part that is to throw off a *slough,* will often be retained till that slough is separated, which will be for eight, ten, or more days."

CATAPLASMA PLUMBI DIACETATIS. ℞ *Liquoris Plumbi Diacetatis,* ʒ j. *Aquæ destillatæ,* ℥ xvj. *Micæ panis q. s.* — *Misce.* Practitioners, who place much confidence in the virtues of lead, externally applied, often use this poultice either in a warm or cold state.

[CATAPLASMA SODÆ CHLORINATÆ. This is an excellent stimulant and antiseptic poultice for sloughing sores. It is ordered in the Ph. Lond. 1851, to be made as follows: ℞. *Aquæ ferventis* f. ℥ vj., *Pulv. Lini,* ℥ ivss. *Liquoris Sodæ chlorinatæ* f. ℥ ij. Add the linseed gradually to the water, then mix in the chlorinated soda.]

CATARACT. (From *καταράσσω,* to confound or disturb; because the disease confounds or destroys vision. Γλαύκωμα·ὑπόχυμα. *Gutta opaca. Suffusio. Der Graue Staar.*) Is usually defined to be a dulness or impediment of sight, produced by opacity of the crystalline lens or its capsule.

A cataract is also described as a partial or general opacity of the crystalline lens, or of its capsule, with a corresponding diminution of sight. "The most striking circumstances observable in cataract (says Mr. Lawrence), are an opaque body placed behind, or even filling up the pupil, and the impaired state of vision which is the result of that change. In both these respects it agrees, in its incipient stage, with glaucoma and some forms of amaurosis; but as the treatment is essentially different in these several affections, it is necessary to discriminate them accurately. In incipient cataract, we can do little or nothing; we must wait until the opacity has become complete before we perform an operation; but active measures must be resorted to in the earliest stage of amaurosis: if we should leave the case to itself under the supposition of its being cataract, loss of sight would be inevitable and irremediable." (See *Lawrence, On Dis. of the Eye,* p. 397.)

Hippocrates and the ancient Greeks described cataract as a disease of the crystalline lens, under the name of *γλαύκωμα*; but no sooner had Galen promulgated the doctrine of the lens being the immediate organ of sight, than the correct opinion of the ancient founder of medicine began to decline, and, for many years afterwards, had no influence in practice. In fact, the seat of cataract was entirely forgotten till about 1656, when first Lasnier, and, afterwards Borel, Bonetus, Blegny, Geoffroi, &c. revived the truth, which had been so long extinct; and they and a few others believed that the disease was situated in the crystalline lens. The bulk of practitioners, however, remained ignorant of this fact even as late as the beginning of the eighteenth century, when the several publications of Maître-Jan, Brisseau, St. Ives, and Heister, combined to render the truth universally known.

In 1708, M. Méry, who had hitherto joined in the belief that cataract was not a disease of the lens, communicated to the Academy of Sciences a memoir, in which he acknowledges the correctness of the statement made by Brisseau and Maître-Jan, that vision can take place without the assistance of the crystalline lens; and he recommended a clergyman who had a cataract to have the lens extracted, which was successfully done by M. Petit.

A cataract, even in its highest degree, does not produce complete blindness. For the most part, its formation takes place slowly; the cases in which it originates quickly being but few, and those in which it is suddenly produced in a complete form still more unusual. A well-marked case is, however, related by Dr. Wendelstrom, in the *American Journal of Medical Science,* August 1829, p. 502.

When a cataract is slowly formed: 1. All objects, especially white ones, seem to the patient to be covered by a haze or cloud, which is generally perceived before any opacity is visible in the pupil. 2. The decline of vision bears an exact proportion to the increasing opacity distinguishable behind the pupil. 3. In most cases, the opacity is first discerned behind the pupil, most plainly also at the central point; the instances in which it first presents itself at the edge of the pupil being less frequent. 4. In eyes with a light-coloured iris, the greater progress a cataract makes the more clearly can one perceive at the edge of the pupil a blackish ring, which partly arises from the shadow of the iris falling on the cataract, but chiefly from the dark-coloured pupillary edge of the iris, which, in a clear pupil, cannot be seen, but now that a greyish surface lies behind it, is rendered very manifest. This blackish ring is perfectly evident in cases of soft cataracts, and arises from the back of the pupillary edge of the iris being pushed forward by the size of the lens. But if the dilatation be increased to its full extent by the application of belladonna, an internal blacker circle will be seen to surround the turbid part behind the iris, and the patient sees better for a short time. (*Guthrie's Operative Surgery of the Eye,* p. 197.) 5. As a cataract generally begins at the central point behind the pupil, such objects as are placed directly in front of the eye are worst seen, even in the early stage of the disease; but those which are laterally placed, especially when the light is not too strong, and of course the pupil a good deal dilated, can yet be seen tolerably well. 6. Hence, when the opacity, at the central point behind the pupil, is at all considerable, the patient is completely blind in a strong light, while, on the contrary, in a moderately dark room, a degree of vision is yet enjoyed. When the opacity is not far advanced, the eyesight may be improved by the patient's turning his back to the light. Belladonna, by increasing the size of the pupil, is of service, and by means of it, "the patient may be conducted, with comparative comfort, through that stage of the disease which intervenes between a moderate defect of vision and the period of the operation. I know (continues Mr. Middlemore) that some surgeons object to its continued use: they say, that its prolonged employment induces a torpid state of the retina, the susceptibility of which becomes permanently diminished under its influence; but although it has been used under my observation in these and other cases very extensively and for a long period, I do not remember to have witnessed a single instance tending in the slightest degree to confirm this opinion." (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 77.) 7. Persons with incipient cataracts derive palliative aid from the use of convex glasses, because objects are magnified by them ; but they only answer while the opacity is inconsiderable. 8. To such patients the flame of a candle seems to be enveloped in a whitish misty halo, which always becomes broader, the further the patient is from the light. "A candle or street lamp seems expanded into a large globe of weaker light ; it looks, to use the phrase of a countryman at the Glasgow Eye Infirmary, as if every lamp was as big as a corn-sieve." (See *Mackenzie, On Dis. of the Eye*, p. 673.) When the cataract is far advanced, the flame of the candle cannot be seen, and the patient can only indicate the place near which the light is, or say whether it is close, or at a distance. 9. A cataract which forms slowly, produces, in the course of its progress, no change in the mobility of the iris ; and if this effect sometimes takes place when the disease is completely developed, the nature of the case is now so manifest, that no surgeon is in any danger of mistaking the complaint for amaurosis.

The characteristic appearances of amaurosis are entirely different. 1. The change of colour occasionally perceptible behind the pupil, is at a considerable distance from this opening, as may be best seen when the eye is viewed sideways. 2. The opacity is somewhat concave. 3. Its colour inclines rather to a greenish or reddish cast. 4. The decline of the eyesight is not at all in a ratio to the degree of opacity, for the patient may be almost blind, though there may be only a slight greenish discoloration of the pupil, very inadequate to account for the defect of vision. 5. The pupil is more or less dilated ; the iris sluggish or motionless, its pupillary edge not exactly circular, sometimes angular. 6. Even the cornea itself, is not quite so clear and transparent as in the natural state. 7. The temporary increase or diminution of blindness, so common in patients with incomplete amaurosis, never depends, as in those with cataracts, upon the degree of dilatation of the pupil, but upon causes which tend either to depress or excite the system, or upon the degree of light. In general, where vision begins to fail from diminished sensibility of the retina, the patient courts a strong light, and when he attempts to read by candlelight, he brings the book as close as he can to the candle. His period of most distinct vision is noonday, when objects are most brilliantly illuminated by the sun. This is the very time when the cataract patient sees worst. (See *Mackenzie, On Dis. of the Eye*, p. 673.) 8. The halo which amaurotic patients perceive around the flame of a candle is not like a whitish cloud, but has all the hues of the rainbow: indeed, the flame itself presents these colours, and when the patient goes to some distance from it, it generally seems split, or the rays are scattered like those of a star. 9. At no period of the complaint are spectacles of any service in enabling the patient to see better. In many cases, objects situated to one side cannot be seen more plainly than those which are directly in front of the eye. But in some instances, where the sensibility of the retina is beginning to diminish, or even where amaurosis is advanced, the patients see objects placed to one side better than such as are directly before the eye. 10. The sight is not temporarily improved by the application of belladonna. [In doubtful cases, recourse may be had to the catoptric test of Purkinje, in the following manner : The pupil of the diseased eye being dilated, the patient should be seated in a dark room in front of and somewhat lower than the observer, who holds a lighted taper in one hand, shading the light from his own eyes with the other.

When a healthy eye has a candle thus held before it at the distance of a few inches, three reflected images of the flame are seen, one behind the other, the anterior and posterior being erect, the middle image inverted, and much smaller than the others. The anterior image is formed by the cornea, and is much the brightest. The middle image is formed by the posterior surface of the crystalline, the posterior image by the anterior surface. The posterior surface of the crystalline thus viewed, acts as a concave mirror giving rise to an inverted image, the focus of which is positive, and is situated within the crystalline. When the candle is moved, the erect images move in the same direction, the inverted in the opposite direction.

In the diagnosis of incipient cataract and incipient amaurosis, this test is decisive ; for in simple amaurosis the three images are quite distinct, while, in even the early stage of cataract, the inverted image is obscure, or even extinct.

Our diagnosis may be still more assisted by the ophthalmoscope ; with its aid we are enabled to detect with certainty opacities, great or small, of the lens and capsule, and thus to decide very confidently upon the nature of the case. (See *Jaeger Beitrage Pathol. des Auges*, taf. ii. and iii.)]

For the difference between cataract and glaucoma, see GLAUCOMA.

The nature of the affection is sometimes elucidated by its history. Cataract forms without any uneasiness in the eye or head, or any disturbance of the health. Glaucoma and amaurosis are preceded and accompanied by various uneasy sensations, and functional disorder. (See *Lawrence, On Dis. of the Eye*, p. 399.)

Unless the disease be well marked, a positive opinion on the existence of cataract should not be given without dilating the pupil with belladonna, so as to bring the whole field of disease into view. "It is important also to observe the degree of celerity with which the pupil yields to the influence of belladonna. If the retina is sound, in half an hour the pupil is generally widely dilated ; in an amaurotic eye there is often very little dilatation at the end of twenty-four hours." (See *Mackenzie, On Dis. of the Eye*, p. 677.) The extract of belladonna, dissolved in water to the consistence of cream, may be rubbed on the forehead and eyebrow ; or, a little more diluted, may be dropped into the eye. A still more elegant application is the solution of sulphate of atropine, two grains to an ounce of water. In speaking of the advantages of dilating the pupil with belladonna, a writer remarks :—"This will enable us to detect the characters of the opaque lens, as regards its colour, its consistence, and the seat and extent of the opacity, much better than where we have not this advantage ; and it will also assist us in ascertaining the true state of the retina ; and as regards the iris, whether or not it has acquired any morbid adhesions, and, if any, their nature, their seat, and extent, and also (what is of great moment) how far the pupil retains the capacity of being dilated by artificial means. (See *Middlemore*, *On Dis. of the Eye*, vol. ii. p. 73.)

The obstacle to vision, situated in the posterior chamber, between the vitreous humour and the uvea, and making what is termed a cataract, may be either within the limit of the capsule of the lens, or between the anterior layer of that capsule and the uvea. The first case is the *genuine*, the second, the *spurious* cataract.

A genuine cataract, when a primary disease, and unattended from the first with other morbid effects in the eye, is mostly a single independent affection; on the contrary, as the spurious cataract is generally the consequence of internal ophthalmy, it is generally combined with a partial opacity of the anterior layer of the capsule, and, of course, with a genuine cataract.

The first variety of genuine cataract noticed by Beer, is the *lenticular;* it usually begins in the centre or nucleus of the lens, mostly presenting a dull yellowish grey colour, which is somewhat deeper at the centre than at the margin of the pupil; a character retained even when the disease is in its most complete stage. If the lenticular cataract is hard or firm, "the opacity has a greyish appearance, with more or less of the yellowish brown or amber tint towards the centre. In the firm and darker coloured portion, it resembles wax slightly softened by heat; the circumference is lighter-coloured and softer, being about the consistence of soft jelly. The more we see of the amber colour, and the deeper the tint, the harder is the cataract; the greyer its appearance, the softer is the consistence." The central portion is firmer than the rest. In a few instances, the lens has been of a dark brown, or mahogany colour, and hard throughout. An ordinary firm cataract presents the consistence of wax. The firm cataract, with the amber tint in the middle, gradually shaded off into grey, is the ordinary form of the complaint in advancing age. (*Lawrence*, op. cit. p. 399.) It always forms slowly; and except when the iris is too dark coloured, it is more or less attended with a blackish ring at the edge of the pupil, which ring becomes plainer as the disease advances. It never causes any alteration in the expansion or contraction of the iris; nor does it even in its highest degree deprive the patient of all power of vision, who in shady places, or when the pupil is artificially dilated, is often capable of distinguishing pretty well many objects which are placed laterally with respect to the eye. A lenticular cataract is usually at some distance from the uvea, so that the extent of the posterior chamber is manifest, while the opacity presents more or less of a convex appearance, and never that of very white cloudy specks. Frequently the lenticular cataract is unattended with any change in the capsule.

The second species of genuine cataract noticed by Beer is the *capsular.* The disease seldom commences in the centre of the pupil, and usually arises at its margin in the form of distinct white shining points, streaks, or specks; its colour, therefore, is always very light and never altogether uniform, even when the disease is completely formed. The disease has some effect on the motions of the iris, at least their quickness. A capsular cataract seldom remains long the only affection, but is followed by disease of the lens itself; a fact which cannot surprise us, when we consider that it is through the medium of the capsules that the particles of the lens are incessantly undergoing the changes of removal and reproduction.

The *capsular cataract* is subdivided by Beer into the *anterior;* the *posterior;* and the *capsular cataract*, in which both the front and back portions of the capsule are opaque.

The *anterior capsular cataract* may be known by its light grey, and in some places, completely chalk-white colour, intersected by shining mother-of-pearl-like streaks and spots. As the capsule is at the same time thicker than natural, the posterior chamber is lessened, and the cataract is not unfrequently close to the uvea, especially when the lens has also completely lost its transparency. In this stage, the movements of the iris are likewise rendered less quick, and the shadow at the margin of the pupil is entirely absent. Hence, vision is not only hurt, but quite impeded, in regard to any correct sensation of light, whether the patient be in a light, or shady situation; and frequently a faint light is completely invisible to him.

The *posterior capsular cataract* belongs to the rarer forms of the disease of the eye. Like the anterior capsular cataract, it is denoted by a whitish-grey unequal, variegated colour; but no light coloured, chalk-white spots and streaks are ever discernible, which, while the lens retains its transparency, may be owing to the distance of the cataract from the pupil. However, the opacity situated behind the pupil always seems concave when the eye is inspected, not from before, but from every side of it. While the posterior half of the capsule is not completely opaque, the lens is not materially affected; the eyesight is only more or less weakened; and sometimes, especially with the aid of a magnifying glass, a tolerable degree of vision is enjoyed, notwithstanding the considerable opacity behind the pupil. This species of cataract has not itself any influence over the motions of the iris, and after the lens becomes opaque it is not softened.

Though the *perfect* or *antero-posterior capsular cataract* is not the rarest species of genuine cataract, it cannot be said to be very common. In addition to the symptoms of the anterior capsular cataract, the iris is occasionally nearly motionless, the cataract lying close to that membrane; the posterior chamber for the same reason is effaced; and an inexperienced surgeon might suppose the anterior portion of the capsule were adherent to the uvea, unless he convinced himself of the contrary by producing an artificial dilatation of the pupil.

The existence of *perfect capsular cataract* cannot be easily ascertained; for if the anterior portion of the membrane be opaque it will prevent us from knowing whether the posterior be so or not. (See *Lawrence*, *On Diseases of the Eye*, p. 494.)

When any portion of the capsule is left behind after operations with the needle, and becomes opaque, the case is termed a *secondary membranous*, or *capsular cataract.*

The third species of genuine cataract is the *cataracta Morgagniana.* It is one of the rarest forms of the disease; so rare, indeed, that it has been regarded as purely hypothetical. [The most remarkable character of the Morgagnian cataract is the difference of colour which it presents according as the patient is in the erect or in the horizontal posture. In the former, the cataract presents a dark brownish colour, owing to the kernel of the lens gravitating forwards towards the pupil; but the instant the patient lies down, the cataract assumes a white colour, the kernel falling back towards the vitreous humour. On puncturing the capsule the fluid part of the cataract escapes, and mixes with the aqueous humour. Severe vomiting is apt to follow, if this turbid fluid is allowed to remain in the anterior chamber. Mr. W. R. Wilde has published a valuable paper on this disease. (*Observations on Morgagnian Cataract. Medical Times and Gazette*, Oct. 2, 1852.)]

The fourth species of genuine cataract described by Beer is the *capsulo-lenticular cataract.* It is by no means uncommon, and attended with the following characteristic symptoms:—The colour of the opacity, close to the uvea, is partly chalk-white, partly like that of mother-of-pearl, and in many places both these colours can be evidently seen disposed one over the other, that of mother-of-pearl, however, being always most superficial. After the application of the extract of belladonna, the iris contracts, and the pupil is long in returning to its former diameter. Besides the obliteration of the posterior chamber, the anterior one itself is mostly diminished, in consequence of the iris being pushed towards the cornea by the very large size of the cataract.

The capsulo-lenticular cataract is not unfrequently the consequence of a slow inflammatory process in the iris, the lens and its capsule; and hence several varieties of this case, and its not unfrequent combination with a spurious cataract; which modifications should be correctly understood previously to an operation, in order to form a just prognosis of its event, and to know what method of operating ought to be adopted.

Of these varieties, the first is the *capsulo-lenticular cataract, conjoined with slight depositions of new matter upon the anterior capsule of the lens.* These after-formations upon the front layers of the capsule, as Beer calls them, put on very different appearances, and accordingly receive various appellations. For instance, the *marbled capsulo-lenticular cataract,* when the chalk-white new-formed substances upon the anterior layer of the capsule are so arranged as to resemble the variegated appearance of marble. The *window* or *lattice capsulo-lenticular cataract,* when the new-deposited substances cross each other, leaving darker coloured interspaces. The *stellated capsulo-lenticular cataract,* when the new matter runs in concentric streaks towards the middle of the pupil. The *central capsulo-lenticular cataract,* when a single, elevated, white, shining point is formed on the anterior capsule, while the rest of this membrane is tolerably clear, and the lens not completely opaque. The *dotted capsulo-lenticular cataract,* when the front layer of the capsule presents several distinct unconnected depositions on its surface. The *half-cataract,* or *cataracta capsulo-lenticularis dimidiata,* when one half of the front of the capsule is covered with a white deposit.

Another variety of the capsulo-lenticular cataract is the *siliquose.* Though principally met with in young children, it is not one of the most uncommon affections in adults, and, in the former, it is often falsely regarded as a congenital complaint. When this cataract is extracted either from children or grown-up persons, Beer says that the dried shrivelled capsule is always found round the equally dry nucleus of the lens, like a husk or shell. In children, however, he says, that the nucleus of the lens is often scarcely perceptible, while in adults it is always of considerable size; and this may be the reason why this cataract in children does not present so bright a yellow-white colour as it does in grown-up persons. In infants, in which it is frequently seen in the first weeks of their existence, it is manifestly produced by a slow and neglected inflammation of the lens and its capsule, arising from too strong light. In adults, the inflammation exciting this form of cataract is always owing to external violence; yet Beer supposes that a considerable diminution of cohesion between the capsule and the adjacent textures must likewise have a principal share in bringing on the disease, which, in grown-up persons, is constantly preceded by a concussion of the eyeball, from the cut of a whip, the lash of a horse's tail, &c. In children, says Beer, this form of cataract may be known by its light-grey, whitish, though seldom very white, colour; its diminutive size, and considerable distance from the uvea; and by the freedom with which the iris moves when no adhesions exist at any points between this organ and the cataract, as occasionally happens; a proof of the previous inflammation of the capsule, lens, and neighbouring textures. The eyesight is never quite impeded, but only much diminished. On the contrary, in adults, this cataract invariably presents a dazzling white hue, and only a few points of it are of a smutty yellowish-white colour, whence the case has been sometimes termed the *gypsum-cataract.* It is not convex, but rather flat; it does not approach the iris; and when free from adhesions to the uvea, which are more likely to happen in adults, it has no effect on the motion of the iris. Vision is generally entirely lost, with the exception of the power of discerning the light, and even this faculty is sometimes destroyed, in consequence of the previous violence done to the eye, whereby not merely the lens and its capsule but also the retina have suffered.

A rare variety of the capsulo-lenticular cataract, mentioned by Beer, is that described by the French under the name of *cataracte barrée*, the *bar cataract*, and by Schmidt under the appellation of the *cataract with a girth* or *zone.* The diagnosis is easy; for behind the diminished, more or less angular pupil, the cataract can be plainly seen, to which is attached, either in a more or less perpendicular, or horizontal direction, a chalk-white, generally very shining and thickish kind of bar, or girth, which is closely adherent at both its extremities to the pupillary margin of the uvea, and sometimes reaches, but often only on one side, more or less towards the ciliary processes. The iris is therefore completely motionless, the uvea not being merely adherent to the substance forming what is termed the *bar* or *girth*, but, also closely connected with the whole front portion of the capsule. The perception of light is either very indistinct, or quite lost, and, not unfrequently, the globe of the eye is somewhat smaller than natural. Beer says that he has never met with this variety of cataract, except after violent internal inflammation of the eye.

OF SPURIOUS CATARACTS.

The most frequent, according to Beer, is what he names the *lymph-cataract.* It is, without exception, the effect of an inflammation, which is chiefly situated in the iris, the lens and its capsule. Hence, it is frequently combined with a genuine cataract. The nature of the disease may be known from the patient's account that the present blindness has been preceded by a painful tedious affection of his eye and head; and from an examination of the eye itself, in which the pupil will be found more or less diminished and angular; the iris either perfectly motionless, or nearly so; the eyesight and even sometimes the perception of light more or less impeded, or lost, and this not merely in proportion to the quantity of lymph observable immediately behind the pupil, but also in proportion to other morbid effects produced in the organ by inflammation. Lastly, the surgeon may notice, directly behind the pupil, a plastic lymph, either in the form of a delicate kind of network, or of a thick web of a snow-white colour. Sometimes, in this variety of spurious cataract, though very little coagulating lymph appears upon the anterior portion of the capsule of the lens, and what is effused, as well as the lens itself, is almost clear and transparent, yet the eyesight is considerably impaired, and, on more careful examination of the pupil, something of a dark-brown colour is perceived, which often projects, at several points behind the pupillary edge of the iris, a good way towards the centre of the pupil. In this substance one may discern, with a good magnifying glass, new vessels extending from those of the uvea, and formed by the previous inflammation; by means of which vessels, this mass, and the delicate layer of lymph are connected with the capsule of the lens.

A rare variety of spurious cataract described by Beer is the *blood-cataract.* Either from some considerable injury of the eye, a large quantity of blood is extravasated in the chambers, and slowly absorbed, a part of it, however, remaining in the posterior chamber in the form of small clots, encysted in the lymph which was effused during the inflammation; or else, in the course of a more tedious and neglected case of hypopium, blood is effused in the chambers of the eye, and still continues in the same form behind the pupil, after the matter has been absorbed. In the first example this cataract looks like a reddish web, interwoven with silvery streaks or threads; the pupil, though angular, is seldom contracted; the iris nearly or quite motionless; and not only is the light clearly distinguished, but a partial degree of vision sometimes retained. On the contrary, in the second instance, the opacity behind the pupil is very dense, white, studded with reddish or brownish points or specks, having a clustered appearance, and frequently projecting through the pupil into the anterior chamber; while the pupil itself is very small and angular, the iris quite incapable of motion, and generally either no perception of light remains, or only a very confined, indeterminate sensation of it.

Another classification of cataracts, which is of great importance to an operator, is founded upon their consistence; for this makes not only a great difference in the prognosis, but also in the choice of a method of operating.

When the opaque lens is either more indurated than in the natural state, or retains a tolerable degree of firmness, the case is termed a *firm* or *hard cataract.* When the substance of the lens seems to be converted into a whitish or other kind of fluid lodged in the capsule, the case is denominated a *milky* or *fluid cataract.* When the opaque lens is of a middling consistence, neither hard nor fluid, but about as consistent as a thick jelly or curds, the case is named a *soft* or *caseous cataract.* When the anterior, or posterior, layer of the crystalline capsule becomes opaque, after the lens itself has been removed from this little membranous sac, by a previous operation, the affection is named a *secondary cataract.*

The harder the cataract is, the thinner and smaller it becomes. In this case the disease represents either an ash-coloured, a yellow, or a brownish appearance. The interspace betwixt the cataract and pupil is considerable. The patient distinctly discerns light from darkness, and when the pupil is dilated, can even plainly perceive large bright objects. In the dilated state of the pupil, a black circle surrounding the lens is very perceptible. The motions of the iris are free and prompt; and the anterior surface of the cataract appears flat, without any degree of convexity.

Beer says that it is only the genuine lenticular cataract which can be hard, and it is chiefly met with in thin elderly persons; but the opinion that all cataracts in old persons are firm is contradicted by experience. In cataracts extracted from thin aged individuals, the lens is sometimes found dwindled, as hard as wood, nearly of a chestnut-brown colour, and with its two surfaces as flat as if they had been compressed. This case has sometimes been denominated the *dark-grey cataract,* and is very difficult to make out previously to an operation, being liable to be mistaken for an incipient amaurosis. Hence, in order to judge of it effectually, the pupil should always be dilated.

The fluid or milky cataract has usually a white appearance, and irregular spots and streaks, different in colour from the rest of the cataract, are often observable on it. These are apt to change their figure and situation when frequent and sudden motions of the eyes occur, or when the eyes are rubbed and pressed; sometimes also these spots and streaks vanish, and then re-appear. The lower portion of the pupil seems more opaque than the upper, probably because the untransparent and heavy parts of the milky fluid sink downward to the bottom of the capsule. The crystalline lens, as it loses its firmness, commonly acquires an augmented size. Hence, the fluid cataract is thick, and the opacity close behind the pupil. Sometimes one can perceive no space between the cataract and margin of the pupil. In advanced cases, this aperture is usually very much dilated, and the iris moves slowly and inertly. This happens because the cataract touches the iris and impedes its action. The fluid cataract is sometimes of such a thickness that it protrudes into the pupil, and presses the iris so much forward as to make it assume a convex appearance. Patients who have milky cataracts may distinguish light from darkness very indistinctly.

According to Beer, a fluid cataract is mostly conjoined with a complete opacity of the capsule: its diagnosis, therefore, is commonly difficult, and sometimes its nature cannot be known with certainty until an operation is undertaken. When the capsule is opaque only in some places, he states that the following circumstances may be noticed: — The cataract lies close to the uvea, and when the patient inclines his head forwards the cataract presses the iris towards the cornea, and the anterior chamber becomes evidently smaller; but when he lies upon his back, the cataract recedes in some degree from the uvea. The power of distinguishing the light is unequivocal. When the head is kept quiet for a long time, a thick sediment and a thinner part can be plainly remarked in the cataract; during which state, that is, while the two substances are undisturbed, the patient can sometimes distinguish large well-lighted objects as through a dense mist; but when the head or eye is quickly moved, these two substances become confused together again, and the cataract again presents an uniform white colour.

Sometimes the opaque lens is of a middling consistence, neither hard nor fluid, but about as consistent as thick jelly, curds, or new cheese. Cases of this description are termed soft or caseous cataracts. The consistence here spoken of may be confined to the two surfaces of the lens, or may exist in its very centre. The first case is the most frequent. The diagnosis is not difficult; for it always has a light grey, greyish-white, or sea-green colour. When it is far advanced, it quite impedes the eyesight, and sometimes considerably interferes with the perception of light. As the lens softens in this manner it commonly grows thicker and larger, even acquiring a much greater size than the fluid. The motions of the iris are very sluggish. Indeed, it is sometimes requisite to use belladonna, in order to ascertain that no adhesions exist between the uvea and the cataract, for in such cases the posterior chamber is very often completely abolished, and the black ring at the edge of the pupil is not at all owing to the shadow of the iris, but entirely to the dark border of the iris at the margin of that opening. According to Mr. Travers, the caseous cataract has a heavy dense appearance, uniformly opaque, a clouded, not a fleecy, whiteness, and sometimes a greenish or dirty white tinge. (*Med. Chir. Trans.* vol. iv. p. 285.) It is observed that cataracts are never hard in the young, and that a hard lens is never met with below the age of puberty. Cataracts are not always hard in old persons: we may have soft cataracts in the old, and hard ones in the middle period of life. (See *Lawrence*, op. cit. p. 410.) I lately attended, with Mr. Alexander, and Mr. Bainbridge of Tooting, a young woman eighteen years of age, from whom Mr. Alexander extracted a lens which was as firm as cartilage. The case was one of congenital cataract.

In estimating the consistence of cataracts, perhaps their size is a better criterion of it than their colour; and "the larger and more protuberant the lens, pressing forwards into the pupil and against the iris, the greater is the certainty of its being soft." (See *Guthrie's Operative Surgery of the Eye*, p. 209.) In simple cataract, the colour of the opacity is grey, yellowish-grey, greyish or darkish-brown, milky, or chalky-white, and sometimes pearly, or silvery. In young persons, the cataract is almost invariably white or grey, or of a milky, or bluish white tint. When a brownish, or yellowish state of the lens is seen in a young person, it may almost certainly be ascribed to internal disease of the eye (p. 407). The investigations of Dr. Mackenzie have taught him that "whiteness denotes either a dissolved lens, or a capsular cataract; greyness, a lenticular cataract; amber, or dark grey, that the cataract is hard; light grey, that it is soft. If the whole extent of the pupil is uniformly opaque, the cataract is probably lenticular; if the opacity is streaked or speckled, it is probably capsular. If the opaque streaks radiate from a centre, the posterior hemisphere of the capsule is probably the seat of the disease. If the form of the opacity is convex, the anterior hemisphere of the capsule is the part affected; if concave, the posterior hemisphere. With the light concentrated on the pupil by means of a double convex glass, all these particulars are to be carefully investigated." (*On Dis. of the Eye*, p. 675, ed. 2.)

[For a clear and concise account of the true mature cataract, see *Dixon's Guide to Dis. of the Eye*, p. 197.]

A cataract, which is recent, and has originated suddenly, especially in young subjects, requires much more circumspection ere an operation is determined upon than a cataract which has already existed a long while, and the formation of which has been only gradual, particularly in an old subject; for the first case is more frequently owing to a concealed slow kind of inflammation than is generally supposed. (*Beer*, vol. cit. p. 314.)

Formerly cataracts were denominated *mature*, and *immature;* terms which, previously to the time of Mr. Pott, who fully exposed their impropriety, often led to the erroneous supposition that every cataract must acquire an increase of consistence with time, a hardness indicated by a pearly colour, and be thereby rendered more fit to be depressed or extracted. "This opinion (as Mr. Guthrie has observed) founded on the hardness or softness of the cataract, as dependent upon its duration, is contradicted by experience; for cataracts of fifteen or twenty years' duration, and of a pearly colour, have been extracted perfectly soft, whilst others of one year's standing, and of a milky colour, have been found hard. Neither is the relative state of blindness, under these particular circumstances, a more just criterion; patients having been found almost entirely blind with a soft cataract, whilst, through a hard one, they could still distinguish objects and colours." (*Operative Surgery of the Eye*, p. 190.) If, however, the term *mature* be used, as denoting the full development of the cataract, previously to which stage an operation should not be undertaken, the phrase is not destitute of foundation. (See *Lawrence*, op. cit. p. 408.)

Another division of cataracts is into *simple local* and *complicated*. A *simple local* cataract is so denominated by Beer when the patient is in every other respect perfectly healthy, and no disease prevails in any other part, however distant from the eye.

Amongst the *locally complicated* cases is the *adherent cataract*. The preternatural cohesion may be of the anterior layer of the capsule with the uvea, produced by effused lymph; it may consist in a very firm connection of the posterior layer of the capsule with the membrana hyaloidea; or it may be an unusually close cohesion of the whole of the capsule with the lens; or, says Beer, all the three species of adhesion may exist together (p. 318).

The adhesion of the capsule of the lens to the uvea (synechia posterior) is generally obvious enough; for the pupillary margin of the iris is not completely circular, and is more angular the stronger the light is. The cataract lies close to the uvea, and is very white. The motions of the iris are more or less obstructed, and when the adhesion is extensive are quite prevented. The perception of light is indistinct, often very faint, and sometimes entirely lost, for the preternatural adhesion is always the consequence of previous internal ophthalmy, which, besides occasioning opacity of the lens and its capsule, readily produces other serious effects upon the retina, the choroid coat, and vitreous humour, perfectly adequate to account for the loss of sight, and the incapacity of distinguishing the rays of light. When the anterior layer of the capsule is adherent only at a single point to the uvea, the extent of the adhesion may be readily ascertained by artificially dilating the pupil, and the information thus obtained will have great weight in the selection of a method of operating.

Some other local complications of cataract are so obvious that they cannot fail to be understood; as, for instance, its combination with an adhesion of the iris to the cornea (*synechia anterior*), with closure of the pupil, unattended by any adhesion of the uvea to the anterior capsule of the lens (*synechia posterior*); the complications with atrophy, hydrophthalmia, cirsophthalmia specks and scars upon the cornea, pterygium, and various forms of ophthalmy.

According to Beer, the combination of cataract with glaucoma is also readily made out by any body who has once seen the case; for the cataract always presents a greenish and sometimes quite a sea-green colour; it is of a prodigious size, so as to project through the pupil towards the cornea; the colour of the iris is more or less changed, in the same manner as after iritis; the iris is perfectly motionless; the pupil very much expanded and drawn into angles, for the most part towards the canthi; the lesser circle of the iris is nowhere visible, the light cannot be perceived, though the blinded patient is frequently conscious of false luminous appearances within the eye (*photopsia*); and lastly, the case is invariably accompanied with more or less of a varicose state of the blood-vessels of the eye. The origin of this sort of cataract is constantly attended with severe obstinate neuralgia of the brow and head.

There are two other local complications which are much more difficult to learn before an operation. The first is a cataract combined with a dissolution of the vitreous humour (*synchysis*), the diagnosis of which, indeed, when the affection prevails in a considerable degree, is tolerably easy, as the cataract trembles, and the iris always swings backwards and forwards upon the slightest motion of the eyeball; the globe itself is somewhat affected with atrophy; the eye is quite spoiled, and feels flaccid and unresisting; the sclerotica, immediately around the cornea, is bluish as in infants, and the perception of light is uncertain. On the other hand, when the synchysis is not far advanced, the only symptoms are a suspicious softness of the eyeball, and a vibration of the iris when the eye is suddenly or violently moved.

The other complication of cataract, sometimes very difficult to detect previously to an operation, is amaurosis. When, indeed, the pupil is extraordinarily large, the iris nearly or quite motionless, and the patient cannot distinguish day from night, and of course, not the least glimmer of light, no great powers of divination are required to predict with certainty that no operation will restore the eyesight, which is abolished not by the cataract, but by the existing amaurosis. On the other hand, when the motions of the iris are nearly as free as in the natural state, the pupil as small as it usually is in a given degree of light, the patient capable of judging accurately of the strength of the light, and yet the cataract conjoined with amaurosis, which, with the exception of the faculty of perceiving the light, completely impedes vision, it is then only by a careful inquiry into the history of disease that certain circumstances attending the origin of the cataract, and indicating in some measure the prevalence of amaurosis, can be traced. Sometimes, in consequence of one eye being affected with amaurosis, and not with cataract, a reasonable suspicion may be entertained that the eye with cataract is also amaurotic; yet, says Beer, in such a case, nothing certain can be known before an operation is done.

Causes, Prognosis, &c.

Old age may be regarded as one of the predisposing causes of cataract, inasmuch as the disease is most frequent in advanced life. Of 500 cataract patients treated by Dr. Fabini, 268 were males and 232 females. The ages of these individuals were as follows:—

From 1 to 10	years	14
11 to 20		16
21 to 30		18
31 to 40		18
41 to 50		51
51 to 60		102
61 to 70		172
71 and upwards.		109
		500

(See *Mackenzie*, *On Dis. of the Eye*, p. 679, and *Gräfe und Walther's Journ.* vol. xiv. p. 445. Berlin, 1830.) This table may afford a tolerably correct view of the comparative frequency of cataract at different ages.

It was the doctrine of Wenzel that persons, much exposed to strong fires, and above the age of forty, were more liable to cataracts than other individuals.

Beer assents to the general correctness of the opinion that old age is conducive to cataracts, since the disease is most frequently observed in old persons. Yet, says he, that age, nay, a very great age, cannot be deemed a regular cause of cataract, is clear from the circumstance of many very old, and even decrepit, individuals being able, with the aid of spectacles, to read the smallest print; and it would seem that other causes besides old age are essential to the production of cataracts; as, for instance, immoderate exertion of the eye during youth, particularly in such employments as expose the organ to a strong reflected light. (*Lehre von den Augenkr.* b. ii. p. 325.) And, according to the same author, one of the most important, though least noticed, causes promoting the formation of cataract, is allowing a strong light suddenly to enter the eyes of a new-born or very young delicate infant, the consequence of which is that cataracts form more or less quickly with inflammation of the capsule and lens, or remain for life incomplete, as is the case in the central capsulo-lenticular cataract.

Frequently (says a modern writer) the cataract "proceeds from an hereditary disposition, which has existed for several successive generations; while, in other cases, it attacks several members of the same family, without any disposition of this kind being recognisable in their progenitors. Among others, Janin mentions a whole family of six persons who laboured under this disease." (*Obs. sur l'Œil*, p. 149.) Richter extracted the cataract from a patient whose father and grandfather had been affected with the same malady, and in whose son, at that period, it had begun to manifest itself. He adds that he had seen three children, all born of the same parents, who acquired cataracts at the age of three years. (*On the different Kinds of Cataract*, p. 3.) "During my apprenticeship with the late Mr. Hill, of Barnstaple, I was present when he operated on two brothers and a sister, all of whom were adults, and who stated that three of four others of their family were affected with symptoms not unlike those which they had experienced at the commencement of the complaint. I myself recently operated on two gentlemen advanced in years, who informed me that they had a brother on his return from India, who was similarly affected." (See *Adams's Pract. Obs. on Ectropium*, *Artificial Pupil, and Cataract*, p. 101. London, 1812.)

The dust of lime is supposed to be conducive to the disease, cataracts being said to be frequent amongst the workmen in lime-pits and kilns. In such cases, I conceive that the cataract has mostly been the result of inflammation.

Wounds of the eye, where the weapon has pierced the capsule and the lens, and violent concussions of the fore part of the globe of the eye, though no wound may exist, are in general followed by a cataract, as an immediate consequence.

"Inflammation is in some cases the proximate cause of cataract. Indeed, anterior and posterior capsular cataracts may be compared to specks of the cornea; while, in some instances, the lens also from long continued inflammation, becomes opaque, dissolves into a milk-like fluid, or even suppurates. Ossification of the lens and its capsule is another termination of inflammation of these parts." Iritis is sometimes followed by opacity of the capsule and lens. (See *Mackenzie, On Dis. of the Eye*, p. 677.)

Dr. Mackenzie has met with a greater number of stocking-weavers affected with cataract than of any other trade. The disease in them was often attended with amaurosis. "Looking intensely at an object in motion, which their occupation requires, is probably the cause of their eyes becoming diseased." According to the same authority, the inhabitants of volcanic countries, as Naples and Sicily, are very subject to cataract. Respecting his statement that wine and spirituous liquors promote its occurrence, I may observe, that the disease does not appear to be particularly frequent among the drunken classes of society in London.

[It has been the opinion of many writers that the opacity of the lens termed cataract is equivalent to its death, and it is pretty generally supposed that the cataract of age is marasmus of the lens. The true nature of the changes taking place in cataract have of late been carefully investigated by Dr. Robert Taylor, Stellwag, Robin, Testelin, and Lohmeyer, and their observations have thrown considerable light upon the subject.

Dr. Taylor has published his researches in the seventh vol. of the Transactions of the Pathological Society of London. The cataracts examined were from patients varying from forty to seventy-seven years of age, the majority being of the variety called "cortical," in which the opacity commences in the superficies of the lens: a few being nuclear—in which the opacity begins in the nucleus.

It is stated by Dr. Taylor that in cortical cataract, the superficial layers of the lens are converted into a soft grey semi-fluid pulp; the tubes that have escaped disintegration separate from each other, and break into short fragments with the slightest touch of the needle, thus contrasting strongly with the tubes of the healthy lens which are tough and elastic, and cohere firmly. Indications of a similar change were found in the superficial layers of nuclear cataracts.

A still more remarkable change of consistence takes place in the nucleus of both varieties. In the healthy lens it is known to increase in density with advancing years, but does not exceed the consistence of strong jelly, and however highly coloured it may be, is clear, sparkling, and transparent.

In cataract, when fully developed, the nucleus becomes exceedingly hard and dry, the divided surfaces being rough, dry, and crumbling, and this change does not seem to have reference to the age of the patient.

The soft grey pulp of which the outer part of a cataract is composed, presents a quantity of fine molecular matter, partly floating free, partly aggregated in masses, and partly adhering to the exterior of the tubes, so as to render them more or less opaque. This appears to be the result of the coagulation of the albuminous fluid in which all the lens tissues are immersed.

More or less change is also found in the large cells of the superficies of the lens; many are rendered opaque by fine granular matter in their interior; others are bent, twisted, and crumpled. They are generally yellow in colour, and the tinge is deepest in those which are most altered. Dr. Taylor also found a number of irregular cells, thick, hard, and highly refractive, in every specimen of cataract which he examined. The tubes of the cortex were softened and studded with minute granules. The tubes of the nucleus were hard and brittle, without cohesion, and loaded with fine granular deposit. Their outline irregular, and displaying sometimes fissures, at other times tubercles and nodules; many of the tubes were shrivelled as if atrophied.

In none of these cataracts were oil-globules, crystals of cholesterine, nor other evidence of fatty degeneration discovered, though these are common in fluid cataracts. Dr. Taylor remarks that the healthy lens contains a considerable quantity of fatty matter, the cholesterine of which has a strong tendency to separate by crystallisation after death. Its appearance in old disorganised lenses, may, therefore, be regarded rather as a physical than a pathological phenomenon.

M. Kletzinsky has pointed out some interesting facts connected with the combustion of the dried crystalline and the dried cataract. The combustion of the crystalline yielded 1·5625 per cent. of ashes, that of the cataract 2·9000 per cent. In each case the ash was composed of chloride of sodium, with traces of sulphate and phosphate of soda, of lime, and of oxide of iron. Treated by steam the crystalline took up 88·437 per cent., the cataracts only 64·927 per cent. Alcohol displayed in each, chloresterine, fatty fluid, crystals of fatty acid, and traces of urea. (See *Heller's Archiv f. physiol. u. pathol. Chemie*, 1853. For full information on the histology of cataract, the reader is referred to the researches of *C. Robin ; Sichel, Iconographiæ Ophthalmologique; Desmarres, Traité des Maladies des Yeux*, t. iii. 2ᵉ éd.; and *Archives d'Ophthalmologie*, t. v.; *Testelin, Ann. d'Oculistique*, 1855 and 1856, and *Lohmeyer, Zeitschrift für rationelle Medecin, nouv. sér.* t. v. 1854. Valuable statistical notes are given by *Stellwag Von Carion, Zft. der Wien. Aerzte*, 1852.)

Cataracts are said to have been cured in venereal patients while under a course of mercury. Probably, however, many such cases might have been mere opacities of the cornea, or, at most, only transient opacities of the capsule, or depositions of lymph in the posterior chamber, the consequence of existing or previous inflammation. Wenzel placed no reliance whatever on the power of any remedies to dissipate a cataract, and as he had remarked their inefficiency in numerous instances, he felt authorised in declaring that internal remedies, either of the mercurial or any other kind, are inadequate to the cure of this disorder ; and equally so whether the opacity be in the crystalline lens or in the capsule, whether incipient or advanced.

Ware, who at one time supposed that incipient cataracts might be cured by spirituous applications, and particularly the sulphuric æther, latterly abandoned the opinion. In short, the operation is now regarded as the only means affording any rational hope of restoring the eyesight of patients afflicted with cataracts. Speaking of genuine cataracts, Mr. Lawrence delivers his belief that no external nor internal medicines with which we are at present acquainted can alter the condition of the opaque lens and capsule. General or local measures may occasionally alleviate particular symptoms, or remove concomitant affections ; but they have absolutely no influence on the cataract. (*On Dis. of the Eye*, p. 411.) Another experienced and well-informed writer on this subject joins in the belief that most of the alleged cures have in all probability been either instances of mere fibrinous effusions on the surface of the capsule, or else cases of ruptured capsule, in which the removal of the opaque lens has been effected by the solvent power of the aqueous humour ; while, on other occasions, it is scarcely to be doubted that no affection of the lens or its capsule existed; but, that glaucoma, with incipient amaurosis, was mistaken for cataract, and submitted to certain modes of treatment, which not unfrequently prove efficacious in restoring to a certain degree the sensibility of the retina. (See *Mackenzie, On Dis. of the Eye*, p. 698, ed. 2.) The late Mr. Ware has been the only practitioner who has attempted the cure of cataract by local stimulants. M. Gondret employs electricity, galvanism, and ammoniacal collyria, and cauterisation of the forehead either with the actual cautery, or an ointment composed of a highly-concentrated solution of ammonia. M. Magendie regards the utility of this practice as depending upon its stimulating the fifth nerve, the influence of which is so essentially concerned in the nutrition of the eye, that, when divided, the cornea becomes opaque, and the humours are transformed into a substance resembling curd. Cataract being often suspected to arise from defective nutrition of the lens, some imperfection of the nerve, it is conceived, may be concerned. Here the question arises, were M. Gondret's cases true or spurious cataracts? Dr. Mackenzie expresses his suspicion, that most of them were of the latter kind. (Op. cit. p. 699.)

Notwithstanding the perfection to which the operation, with all its different modifications, really has been brought, its performance will not always re-establish vision ; and even in favourable cases, the result is exposed to many contingencies.

A surgeon should be able to distinguish, first, the cases of cataract in which an operation may be done with the best chance of success ; secondly, the examples in which the prognosis is more or less doubtful ; and lastly, the cases in which there is a great probability, or an absolute certainty, of the operation failing, in which last circumstance the practice is prohibited.

According to Beer, the result of an operation will probably be favourable :—1. When the cataract is a genuine local complaint, perfectly free from every species of complication. 2. When the conformation of the eye and surrounding parts is such, as to allow whatever method of operating may be most advantageous for the particular case, to be done without difficulty. 3. When the patient is intelligent enough to behave himself in a manner which will not disturb the precision and safety of the requisite proceedings in the operation or the subsequent treatment. 4. When the operator not only possesses all requisite medical and surgical knowledge in general, but is capable of judging correctly what method of operating suits the particular case ; and when besides he has derived from nature and acquirement such mental and corporeal qualities as are essential to a skilful operator on the eye; viz. an acute eyesight, a steady, but light, skilful hand, excellently qualified for mechanical artifice in general ; long pliant fingers ; a delicate touch ; a certain tenderness in the scientific treatment of this particular organ ; complete fearlessness; invincible presence of mind; and proper circumspection. 5. When the requisite instruments are not too complicated ; but well adapted to the purpose, and in right order. 6. When the domestic condition of the patient is such as not to occasion any particular disadvantages during or after the operation. Yet, says Beer, even with this fortunate combination of circumstances, uniform success must not be expected ; for a patient, whose sight is quite prevented by this disease, and who, previously to its origin, was already far-sighted, will be still more so after the removal of the diseased lens, and, in order to see distinctly the most common objects which are near, he will be obliged constantly to employ suitable glasses. An individual of this description, though the operation be done with great success, is apt not to be satisfied. But such patients as were short-sighted previously to the formation of their cataracts, are more pleased with the restoration of vision, as before the operation their eyesight was much less than what it is now, and in general they can lay aside the glasses which they formerly made use of without having occasion for any others.

Lastly, as Beer remarks, although patients who, before the origin of their cataracts, were neither far nor short-sighted are sensible of the important benefit of an operation, inasmuch as they now plainly discern all objects again, yet they are usually obliged to employ spectacles in reading, writing, or doing any kind of fine work. The reverse of the above conditions may be regarded as unfavourable to the success of the operation.

In almost every case of congenital cataract in a child, under eight years of age, where the capacity to distinguish the different degrees of light is possessed, and where the eye is, in other respects, healthy and perfectly formed, the prognosis, with reference to the probable result of an operation, will be favourable. (*Richard Middlemore, On Dis. of the Eye*, vol. ii. p. 68.)

The result of the operation may be more or less unfavourable ; — 1. When the patient is affected with gutta, or acne rosacea, not the effect of hard drinking, but rather of scurvy. 2. When evident traces of some general disease of the constitution are present. 3. When the patient has been ill, and is only yet convalescent. 4. When any other disease, though not constitutional, is present. 5. When the cataract is adherent for a considerable extent to the uvea, or an incurable, though not very severe chronic inflammatory affection of the eyelids, or eyeball, prevails, as, for instance, an habitual inflammation of the Meibomian glands ; ectropium of the lower eyelid ; the remains of a pannus ; or a strong aversion to light.

Lastly, every operation must fail when the cataract is manifestly joined with complete amaurosis, a dissolution of the vitreous humour, dropsy, or atrophy of the eye, glaucoma, or a general varicose affection of the blood-vessels of the eye.

The capacity of distinguishing light from darkness, and, in a shady place, where the pupil is not too much contracted, of perceiving bright colours and the shadows of objects, is a very important desideratum in every case selected for operation.

The power of distinguishing light from darkness is even more satisfactory than motion of the iris. I have met with several cases of complete gutta serena in both eyes, in which there was the freest contraction and dilatation of the pupils. Had such patients been also afflicted with cataract (a complication by no means unfrequent), and a surgeon, induced by the moveable state of the iris, had undertaken an operation, it must of course have proved unavailing, since the rays of light could only have been transmitted to an insensible retina. Hence, motion of the iris is not an infallible criterion, as authors have stated (*Wathen*), that the retina is endued with sensibility. Mr. Lucas attended, in conjunction with Hey and Jones, five children of a clergyman at Leaven, near Beverley, who were all born blind. He writes, "None of them can distinguish light from darkness ; and although the pupil is, in common, neither too much dilated nor contracted, and has motions, yet these do not seem to depend upon the usual causes, but are irregular." (*Med. Obs. and Inq.* vol. vi.)

The reciprocal sympathy between the two organs of sight is so active, that no one solicitous to acquire either physiological or pathological knowledge respecting them, ought for a moment to forget it. Hence, in the examination of cataracts, it is of the highest importance to keep one eye entirely secluded from the light, while the surgeon is investigating the state of the iris in the other ; for the impression of the rays of light upon one eye, sensible to this stimulus, is known to be often sufficient to produce corresponding motions of the iris in the opposite one, although in the state of perfect amaurosis. It is now well established that the action of the iris is not exclusively sympathetic with the impression of light upon the retina of the eye to which it belongs. The action of the iris may depend, indeed, first, upon the direct agency of light upon its irritable and contractile texture ; secondly, upon the stimulus of light upon the retina; or, thirdly, upon a sympathy with the iris of the opposite eye. In investigating the state of the retina in several forms of disease, these three influences over the action of the iris should be remembered. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 79.) In other examples of cataract, the pupil may be quite motionless, and yet sight shall be restored after the performance of an operation. (*Wenzel.*)

But although the power of distinguishing light from darkness is more satisfactory than motion of the iris, it is not an unequivocal test of the retina being perfectly free from disease. While amaurosis is incomplete, the patient can yet distinguish light and the shadows of objects. Dilatation of the pupil is also a deceitful criterion of the complication of this disease with the cataract. When the cataract is large, or adherent to the iris, the pupil is frequently much dilated, though the optic nerve may be natural and sound ; the pupil often continues quite undilated in a perfect gutta serena. (*Richter.*)

From all this it must be manifest, 1st, That the irregularity and inconsistency of the symptoms of amaurosis, together with the possibility of particular states of the cataract rendering the patient utterly unconscious of the stimulus of light, make it necessary for the surgeon to be particularly attentive to the appearance and to the history of the origin and progress of the disease, in order to understand the real condition of certain cases. 2ndly, That, when the patient can distinguish light from darkness, though the iris may be motionless, there is good ground for trying an operation. Possibly, in this circumstance, an incipient *amaurosis* may exist ; but the *chance* of the defect of the iris arising from other causes, the *certainty* that the opaque body *must* be removed from the axis of sight (even if the disease of the retina be cured) ere sight can be restored, and the *improbability* that an operation to cure the cataract will render the other complaint at all less remediable, fully justify the attempt. Frequently the patient has a fully formed cataract in one eye which presents the signs of amaurosis, while an incipient cataract, or one as much advanced exists in the other, which at present is free from these symptoms : in this case (says Mr. Travers), the cataract of the latter should be removed without delay. (*Synopsis, &c.* p. 314.)

The concurrent testimony of almost all writers upon the subject tends to prove that the restoration of sight has sometimes been effected in the most hopeless cases ; and I am therefore of opinion with Mr. Lucas that in all doubtful cases an operation should be tried as a remedy by no means violent or hazardous. (*Med. Obs. and Inquiries*, vol. vi. p. 257.)

I shall conclude this part of the subject with annexing the sentiment of Mr. Travers, viz. that it would be incorrect to say, that the operation is unadvisable in all cases of cataract in which the patient has no sense of light; for it is possible, that the density of the lens may be such as absolutely to exclude the light, and that the motions of the iris may be therefore suspended; or from some degree of the pressure of the lens, or adhesion of the uvea to the capsule, that the pupil may be undilated, and the circumference of the lens permanently covered. But, undoubtedly, says Mr. Travers, a case of this description is unpromising. "A strong sense of light by which at least to know the direction in which it enters the apartment, to be sensible of its falling on the eye, and of a shade, as the hand for example, intercepting it, with a corresponding freedom of motion of the pupil, is the most favourable state for the operation." (*Synopsis of the Diseases of the Eye*, p. 315.)

As it not unfrequently happens that cataracts produced by external violence spontaneously disappear, (*Pott*, *Hey*, *Ware*, &c.,) the operation should never be too hastily recommended for them.

Respecting the question whether an operation ought to be done when only one eye is affected with cataract and the other is sound, some difference of opinion prevails.

When there are cataracts in both eyes, some authors are of opinion that there is no reason why one should not be operated upon immediately after the other. As, however, the inflammation is likely to be more severe, *cæteris paribus*, when both eyes are operated upon at the same time, Scarpa, who gives the preference to the needle, disapproves of this mode of proceeding, and assures us that in patients with cataracts in both eyes, his experience had taught him that it is better to wait till one eye is well before any attempt is made upon the other. (*Saggio di Osservazioni, &c.* p. 255.)

On this point the following is Beer's sentiment:—When cataracts are completely formed in both eyes, the patient willing, and everything promises a favourable result, both eyes may be operated upon at the same time. On the contrary, when any circumstances are present which render the event of the operation very doubtful, it is most advisable to make the attempt only on one eye, even though the patient absolutely wish more to be done; so that if the first operation should fail, but the complication of this cataract afterwards change considerably to the advantage of the patient, one eye would still be left for a second more favourable attempt. (*Lehre von den Augenkr.* b. ii. p. 350.)

If division of the cataract is the operation to be performed, Dr. Mackenzie approves of operating on both eyes at the same time; if extraction, then he deems it best to await the result of the operation on one eye before touching the other. "Double extraction (says he) decidedly exposes the eyes to greater risk of inflammation." (*On Dis. of the Eye*, p. 700, ed. 2.)

The propriety of operating on the cataracts of children is now firmly fixed on the basis of experience. The needle may be successfully employed on children of the most tender age. The late Mr. Saunders, surgeon to the London Infirmary for Diseases of the Eye, had the principal share in promoting the adoption of this important improvement. His practice confirmed what reason had long ago made probable; and the judgment, tenderness, and skill with which he operated on the eyes of infants as well as those of adults were followed by a degree of success which had never been previously witnessed, and which infused quite a new spirit into this most interesting branch of surgery. Subjects from eighteen months to four years old received most benefit from Mr. Saunders's operations; and if any intermediate times be selected Dr. Farre is inclined to recommend the age of two years. "The parts have then attained a degree of resistance which enables the surgeon to operate with greater precision than at an earlier period; yet the capsule has not become so tough and flexible as it does at a later period, after the lens has been more completely absorbed.

"But this is not the greatest, although a considerable advantage, of an early operation; for, in cases in which the patient has no perception of external objects, the muscles acquire such an inveterate habit of rolling the eye, that for a very long time after the pupil has been cleared by an operation no voluntary effort can control this irregular motion nor direct the eye to objects with sufficient precision for the purpose of distinct and useful vision. The retina too, by a law common to all the structures of an animal body, for want of being exercised, fades in power. Its sensibility, in many of the cases cured at the ages of four years and under, could not be surpassed in children who had enjoyed vision from birth; but at eight years, or even earlier, the sense was evidently less active; at twelve, it was still more dull; and from the age of fifteen and upwards it was generally very imperfect, and sometimes the mere perception of light remained. But these observations do not apply to those congenital cataracts in which only the centre of the lens and capsule is opaque, the circumference being transparent; for in those the retina is exercised by a perception, although an imperfect one, of external objects, the motions of the muscles which direct the globe are associated, and an absorption of the lens does not take place: therefore in this variety of the disease, the argument in favour of an early operation is not so much a medical as a moral one — it is preferable for the purposes of education and enjoyment." (*Saunders, On Diseases of the Eye*, p. 153, 155.)

Dr. Mackenzie is also an advocate for operating in infancy, if possible, before teething commences. (*On Dis. of the Eye*, ed. 2, p. 702.) Mr. Lawrence has operated, with perfect success, on infants of six weeks, but considers the age of two months as generally early enough. He has always operated in the first year, where he has had the choice. (*On Dis. of the Eye*, p. 51.)

Mr. Guthrie considers the period of dentition an unseasonable one for the operation; but excepting the time of this process, if the child be healthy, he thinks it qualified for the attempt at any age, reckoning from that of six months: and that, "even if the operation be delayed until the end of the third or fourth year, little or no inconvenience is found to arise from it." (*Operative Surgery of the Eye*, p. 362.)

When once it is decided to operate upon a cataract, the sooner the operation is done, in general, the better; because the anxiety of the patient increases every day, nay, every hour. When the operation is deferred for a few days, the greatest caution must be used not to let him expose himself to any causes likely to bring on catarrhal or rheumatic complaints. (*Beer*, b. ii. p. 344.) The following advice, delivered by Mr. Lawrence, with respect to preparation of the patient for operation, seems judicious:—After recommending the operation not to be performed if the tongue is foul, he observes, "No fermented liquors, and generally no animal food, should be taken for a week or fortnight previously, and the bowels should be evacuated by some mild aperient every other day during this time; they should be also well cleared on the morning of the operation. These remarks will apply to all cases; and generally speaking this is the only preparation necessary. Some patients, however, require other preparatory measures; in plethoric subjects, and such as manifest great determination of blood to the head, direct depletion is necessary. In robust persons, in those about the middle period of life, it will be necessary to resort to venesection; and if the pulse were full and the patient young and strong, it might be advisable to take blood freely and repeatedly before operating. In general, it is sufficient to take some blood on the morning of the operation. In those of a plethoric habit, with symptoms of determination to the head, we must practise active depletion; and this is occasionally necessary even in old persons." (*Lawrence, On Dis. of the Eye*, p. 415.) [At the present day such active depletion as the above is not found necessary. If the bowels are disordered, tongue foul, and appetite lost, a dose of calomel, every second or third night, followed by salts and senna next morning, ought to be given, three or four times. "Even if the patient appears to be in perfect health, three or four saline purges ought to be administered at proper intervals, and a strict antiphlogistic plan of diet followed, for at least eight or ten days." (*Mackenzie*, op. cit. p. 701.)

Mr. Middlemore states that he has repeatedly operated for cataracts upon very gouty persons, with almost uniform success. His plan is to place an issue in the arm, about a week prior to the operation; to select proper weather for the operation, and to take care that no fit of gout is expected to occur about the time of its performance. In this particular case he also prefers operating upon both eyes at the same period. (*On Dis. of the Eye*, vol. ii. p. 120.) If a fit of gout is impending, or is supposed to be likely to occur, it should be allowed to pass over before the operation is performed.]

Of the various Operations for Cataract.

Four different operations are practised for the cure of cataracts, viz., one termed *couching*, or *depression*, of which the method called *reclination* is a modification: a second, named *extraction:* a third, in which the lens is neither extracted nor depressed, but after the needle has been introduced into the eye in the same manner as for depression, the lens is disturbed, or divided, and left in its place to be removed by absorption. This method is frequently termed the operation by *solution* or *absorption*, which, however, is not altogether an unobjectionable phrase, because these processes are also concerned as a means of restoring vision after keratonyxis: and a fourth, denominated *keratonyxis*, which consists in puncturing the cornea with a needle, the point of which is to be conveyed through the pupil, so as to reach the cataract, which is to be gently broken into fragments. In particular cases, as Beer observes, each of these modes has manifest advantages over the others; but no single method will ever be exclusively preferred by any man of experience and judgment.

In every operation for a cataract, the position of the patient, assistants, and surgeon, is of great importance. In order to enable the assistant who stands behind the patient, to be conveniently near the head of the latter, Beer prefers letting the patient sit on a stool which has no back. However, some surgeons have been in favour of employing a chair which is completely perpendicular. When the left eye is to be operated upon, the same assistant is to apply his right hand under the patient's chin, and press the head of the latter against his breast, at the same time that he inclines it and himself more or less forward towards the operator, who sits upon rather a high stool, in front of the patient. In this country, a music-stool is commonly preferred, the height of which can be regulated in a moment, by simply turning the seat round to the right, or left, whereby the screw with which it is connected is made to rise or descend, as may be found most desirable. The same assistant then places his left hand flat upon the left side of the patient's forehead, with the points of the fore and middle fingers somewhat under the edge of the upper eyelid; and, with the forefinger, he is now to raise the edge of this eyelid as much as possible, following that finger immediately with the middle one, so as to fix the eyelid with greater certainty. The ends of these fingers, however, must be so applied, as not to touch the globe of the eye in the slightest manner, much less make any pressure upon it; yet so that the upper part of the eyeball and cornea may be gently resisted by them when the eye rolls upwards away from the instrument about to be introduced, whereby this position, which is extremely inconvenient to the operator, may be immediately rectified. The patient should also sit opposite a clear window, so that a sufficient light may fall obliquely upon the eyes, without any rays being reflected to the cornea, and becoming a hindrance to the operator. Nor should light from any other quarter be ever allowed to fall upon the eyes. The surgeon should sit in front of the patient, whose head ought to be directly opposite the operator's breast, whereby the latter will be enabled to see from above, with the greatest correctness, every thing in the eye during the operation, and will not be under the necessity of raising his arms too considerably. Supposing it to be the left eye which is to be operated upon, he next effectually draws down the lower eyelid with the left forefinger, the end of which must be placed over the edge of the eyelid towards the globe of the eye. The middle finger is then to be applied in a similar way over the caruncula lachrymalis. The operator now takes in his right hand the requisite instrument for the operation, viz. the needle or knife, which is to be held like a pen, between the thumb and the fore and middle fingers. By this particular arrangement of the fingers of the assistant and operator, which, indeed, is partly ineffectual where the fissure of the eyelids is very narrow and the eyeball is diminutive and sunk in the orbit, the restless eye of the timid patient is fixed; for a point of the finger is disposed on every side to which the eye can possibly turn away from the instrument about to be introduced, and when the cornea is gently touched with the extremity of the finger, the wrong position which the eye is about to take is immediately prevented.

Mr. Alexander, whose great skill in operations on the eye is universally acknowledged, employs no assistant for raising the upper eyelid, or fixing the eye, which objects he accomplishes himself; and, in Germany, this independent mode of proceeding has been particularly commended by Barth. (*Etwas über die Ausziehung des grauen Staares, für den geübten Operateur.* 8vo. Wien, 1797.) Mr. Alexander, however, mostly divides the upper segment of the cornea.

OF COUCHING, OR DEPRESSION OF THE CATARACT, AND RECLINATION.

The operation of couching was once supposed to consist altogether in removing the opaque lens out of the axis of vision, by means of a needle constructed for the purpose; but it is well known to be frequently effectual on another principle, even when the nature and consistence of the cataract do not admit of the depression of the opaque body. Experience fully proves that the diseased lens when broken and disturbed with the needle, and especially when freely exposed to the contact of the aqueous humour by a proper laceration of its capsule, is gradually dissolved and removed by the action of the absorbents.

Indeed, couching now means a variety of operations; for it comprehends not merely the *depression* of the cataract, not simply its *displacement* in any direction whatsoever, not only the *breaking of it piecemeal;* but likewise the *mere disturbance of the opaque body*, whereby its absorption is sometimes effected without any kind of depression or displacement of it at all with the needle. When, therefore, the merits of couching are investigated, it is necessary to define precisely what modification of it is meant, and for what particular kind of case its application is designed; for, no surgeon of the present day would confine himself exclusively to one method of operating; and as Mr. Guthrie has remarked, "In considering the advantages or disadvantages from any or all of the different operations for cataract, it is absolutely necessary to recollect, that no individual operation is applicable to every species of the disease; that each kind requires an operation for its relief or cure, sometimes of a particular nature, and differing essentially from that which is found most advantageous in another. To collect, then, all the objections which can be urged against any of the operations, from a consideration of every case of cataract to which it is and is not applicable, is merely to confuse the subject, and has generally been done for the purpose of recommending some particular mode of proceeding, rather than to regulate these operations by the general principles of surgery." (*Operative Surgery of the Eye*, p. 365.)

Mr. Travers remarks, that the real objection to couching is the breaking up of the fine texture of the globe of the eye, by the forcible depression of the lens. "Whether it be depressed edgeways or breadthways, makes no difference in the result; it must still occupy a breach in the cells of the vitreous humour, and must derange and disorder that delicate texture and those connected with it. A slow insidious inflammation, marked by a gradual development of the symptoms of disorganisation, viz. congestion of vessels, turbid humours, flaccid tunics, and palsied iris, is too often the consequence. The sight, instead of improving when the immediate effects of the injury are passed away, remains habitually weak and dim, or declines and fades altogether. The advocates for *reclination* seem to forget that the principle which is the same in both operations is the real ground of objection. As to the position of the lens, I suspect less mischief is done by the old method of depression, as less force is required to break a space for the vertical than the horizontal lens, provided the depression be carried to no greater extent than is necessary to clear the inferior border of the pupil." (*Synopsis of the Diseases of the Eye*, p. 318.)

The cases suited to depression and reclination are those in which the lens is firm and not particularly large, and where, for various reasons, we cannot with propriety perform, or are unwilling to perform, the operation of extraction.

The form of couching-needles should vary according to the object designed to be effected in the operation.

Scarpa employed a very slender needle, possessing sufficient firmness to enter the eye without hazard of breaking, and having a point which is slightly curved. The curved extremity of the needle is flat upon its dorsum, or convexity; sharp at its edges; and has a concavity constructed with two oblique surfaces forming in the middle a gentle eminence that is continued along to the very point of the instrument; there is a mark on that side of the handle which corresponds to the convexity of the point. A couching-needle is sufficiently long when it does not exceed, at most, an inch in length: this affords the operator a greater command over the motions of the point, and enables him to judge more accurately how far it has penetrated the globe of the eye, before he has an opportunity of seeing it through the pupil. When Scarpa's needle is preferred it should therefore be of no greater length than the operation requires. The needle, here described, will penetrate the sclerotic coat as readily as any straight one of the same diameter, and by reason of its slenderness will impair the internal structure of the eye less in its movements, than common couching-needles. When cautiously pushed in a transverse direction, till its point has reached the upper part of the opaque lens, it becomes situated with its convexity towards the iris, and its point in the opposite direction; and upon the least pressure being made with its convex surface, it removes the cataract a little downward, by which a space is afforded at the upper part of the pupil between the cataract and ciliary processes, through which the instrument may be safely conveyed in front of the opaque body and its capsule, which it is prudent to lacerate in the operation. In cases of caseous, milky, and membranous cataracts, the soft pulp of the crystalline may be most readily divided and broken piecemeal by the edges of its curved extremity; and the front layer of the capsule lacerated into numerous membranous flakes which, by turning the point of the instrument towards the pupil, may be as easily pushed through this aperture into the anterior chamber, where Scarpa finds absorption takes place more quickly than behind the pupil.

Beer and many other skilful operators give the preference to a straight spear-pointed or lance-shaped needle, with cutting edges. Mr. Middlemore prefers this construction, but with the point slightly curved, the neck round, and surface broad enough to act upon the lens in depression, or reclination. (See *Middlemore*, *On Diseases of the Eye*, vol. ii. p. 158.) Scarpa's needle, made quite straight, is an eligible instrument; and Beer's small spear-pointed needle, which is sold at almost every shop for surgical instruments, deserves all the reputation which it possesses.

Full dilatation of the pupil is a point of the first importance.

Many operators apply the moistened extract of belladonna to the eyebrow on the evening before and on the morning of the operation; [but the best application is a solution of atropine to the eye itself.] The upper eyelid is to be raised and held steady against the superciliary ridge by means of the index and middle fingers of the assistant, who stands behind the patient and supports his head, while the operator draws down the lower eyelid himself with the fore and middle fingers of the hand not engaged with the needle. Supposing the eye about to be operated upon, is the left, the surgeon's fingers employed for depressing the lower lid should project a little beyond the margin of the tarsus; the index finger being situated towards the external canthus, and the middle one towards the caruncula lachrymalis, so that the movements of the eyeball upwards and inwards may be controlled.

The couching-needle (if the curved one be used) is to be held with its convexity forward, its point backward, and its handle parallel to the patient's temple. The surgeon, having directed the patient to turn the eye toward the nose, is to introduce the instrument boldly through the sclerotic coat, at the distance of one sixth of an inch from the margin of the cornea, for fear of injuring the ciliary processes.

Nor is it a matter of indifference at what height the needle is introduced, if it be desirable to avoid as much as possible effusion of blood in the operation. Anatomy reveals to us that the long ciliary artery pursues its course to the iris along the middle of the external convexity of the eyeball, between the sclerotic and chloroid coats; and hence, in order to avoid this vessel, it is prudent to introduce the instrument one line below the transverse diameter of the pupil. If the couching-needle were introduced higher than the tract of the long ciliary artery, it would be inconvenient for the depression of the cataract.

Beer divides both the operations of couching and reclination into three stages: the first is that in which the needle is introduced into the eye; the second that in which it is passed into the posterior chamber, and placed across the anterior surface of the cataract; and the third that in which the depression or reclination of the cataract is accomplished.

If a straight, slender, spear-pointed needle be used, and the second stage of the operation be completed by the introduction of the extremity of the instrument into the posterior chamber (which I particularly recommended to be done in the manner directed by Scarpa), then, according to the directions given by Professor Beer, when depression is indicated, the needle is to be immediately carried to the uppermost part of the cataract, with its point directed somewhat obliquely downwards; and with that surface, which, in the first instance, was applied to the front of the lens, now placed upon its superior edge; then the opaque body is to be pushed rather obliquely downwards and outwards, so far below the pupil that it can no longer be distinguished. After this has been done, the needle is to be gently raised, in order to see whether the cataract will continue depressed; and if it be found to do so, the needle is to be withdrawn in the same direction in which it was introduced.

On the other hand, says Beer, when reclination is to be practised, the needle after being applied to the front surface of the cataract is not to be moved further out of the position of the second stage of the operation, but its handle is merely to be raised diagonally forwards, whereby the cataract will be pressed downwards and outwards to the bottom of the vitreous humour, and turned in the manner already specified. Beer has delivered what appears to me one valuable piece of advice for operators on the eye with the needle: whether depression or reclination is to be done, says he, a surgeon can only use this instrument without injurious consequences on the principle of a lever; and every attempt to press with the whole length of the instrument is not only ineffectual with respect to the progress of the operation, but so hurtful to the eye that bad effects must follow, as may be readily conceived when it is recollected how violently the ciliary nerves must be stretched.

As for the modifications of the manœuvres rendered necessary by the varieties of cataracts, they are (says Beer) so unimportant in all cases of depression that a young operator will easily understand them himself. But things are far otherwise in the practice of reclination; for when the case is a completely formed *capsulo-lenticular cataract*, and the opaque capsule is so thin as to be torn during the turning of the lens, the latter body will indeed be placed in the intended position at the bottom of the eye, but the capsule itself, which has merely been lacerated, must form a secondary cataract, unless the surgeon, with a sharp double-edged needle, immediately divide it in every direction, and remove it as far as possible from the pupil. When, during reclination, a *softish lens*, or one which is *pulpy* to its very nucleus, breaks into several pieces, it is necessary, in order not to have afterwards a considerable secondary lenticular cataract, to put the larger fragments separately in a state of reclination, while the smaller ones may either be depressed, or (if the pupil be not too much contracted) they may be pushed into the anterior chamber, where they will soon be absorbed. *When the cataract is partially adherent to the uvea*, Beer recommends an endeavour to be first made, with the edge of the needle (which is to be introduced flat between the cataract and the uvea, above or below the adhesion) to separate the adherent parts before the attempt at reclination is made. Should it be a cataract, which always rises again as soon as the needle is taken from it, though the instrument has not pierced it at all, the case is termed the *elastic cataract*, in which the lens is not only firmly adherent to its own capsule, but this also to the membrana hyaloidea. Here Beer thinks that the best plan is first to carry the needle to the uppermost point of the posterior surface of the lens, and by means of perpendicular movements of the cutting part of the instrument, to endeavour completely to loosen this preternatural adhesion of the cataract to the vitreous humour, when reclination may be tried again, and will perhaps succeed. But, says Beer, when the continual rising of the cataract is caused by the operator's running the needle into it, the instrument must either be withdrawn far enough out of the eye to let it be again properly brought into the posterior chamber, when reclination may be effectually repeated; or if the cataract be firmly fixed on the needle at the bottom of the eye, the instrument should not be raised again, but, previously to being withdrawn, it should be rotated a couple of times on its axis, whereby the pierced lens will be more easily disengaged from the needle, and at last continue depressed. (*Lehre von den Augenkr.* b. ii. p. 356—358.)

In addition to Beer's directions for couching and reclination, the following observations seem to me to merit attention: —

When the case is a *fluid* or *milky* cataract, the operator frequently finds that on passing the point of the couching-needle through the anterior layer of the capsule, its white milky contents instantly flow out: and, spreading like a cloud over the two chambers of the aqueous humour, completely conceal the pupil, the iris, and the instrument from his view; who, however, ought never to be discouraged at this event. Although it seems to me most prudent to postpone the completion of operations with the needle, in the example of blood concealing the pupil, in the first step of couching, and not to renew any attempt before the aqueous humour has recovered its transparency, I am inclined to adopt this sentiment, chiefly because the species of cataract is, in this circumstance, generally unknown to the operator, consequently he must be absolutely incapable of employing that method of couching which the peculiarities of the case may demand. Speaking of this case, however, Beer says, "The surgeon must hasten the completion of extraction or reclination, though possibly the operation may not always admit of being continued; or if gone on with, it must be done, as it were, blindfold." (*Lehre, &c.* b. ii. p. 361.) When a milky fluid blends itself with the aqueous humour, and prevents the surgeon from seeing the iris and pupil, this event is itself a source of information to him, inasmuch as it gives him a perfect insight into the nature of the cataract which he is treating, and instructs him what method of operating it is his duty to adopt. The surgeon, guided by his anatomical knowledge of the eye, should make the curved point of the needle describe the segment of a circle from the inner towards the outer canthus, and in a direction backward, as if he had to depress a firm cataract. (*Scarpa.*) Thus he will succeed in lacerating as much as is necessary the anterior layer of the capsule, upon which, in a great measure, the perfect success of the operation depends; and not only in the milky, but almost every other species of cataract.

The extravasation of the milky fluid in the chambers of the aqueous humour, spontaneously disappears very soon after the operation, and leaves the pupil of its accustomed transparency. "In twelve cases of a dissolved lens on which I have operated," says Latta, "the dissolution was so complete, that on entering the needle into the capsule of the lens the whole was mixed with the aqueous humour, and all that could be done was to destroy the capsule as completely as possible, that all the milky matter might be evacuated. In ten of these cases vision was almost completely restored in four weeks from the operation." Mr. Pott, in treating of this circumstance, viz. the effusion of the fluid contents of the capsule into the aqueous humour, observes, that so far from being an unlucky one, and preventive of success, it proves, on the contrary, productive of all the benefit which can be derived from the most successful depression or extraction, as he has often and often seen.

When the cataract is of a *soft* or *caseous* description, the particles of which it is composed will frequently elude all efforts made with the needle to depress them, and will continue behind the pupil in the axis of vision. This has been adduced as one instance that baffles the efficacy of couching, and may really seem, to the inexperienced, an unfortunate circumstance. It often happens in the operation of extraction that fragments of opaque matter are unavoidably overlooked and left behind; yet such matter is frequently removed by the absorbents. Supposing a caseous cataract were not sufficiently broken and disturbed in the first operation, and that, consequently, the absorbents did not completely remove it, such a state might possibly require a re-application of the instrument; but this does not generally occur, and is the worst that can happen. It is quite impossible to determine *à priori*, what effect will result from the most trivial disturbance of a cataract; its entire absorption may, in some instances, follow, while in others a repetition of the operation becomes necessary for the restoration of sight. Even where the whole firm lens has reascended behind the pupil, as Latta and Hey confirm, the absorbents have superseded the necessity for couching again. The disappearance of the opaque particles of cataracts was, in all times and all ages, a fact of such conspicuousness, that, as appears from the authority of Barbette and others, it was recorded even previously to the discovery of the system of lymphatic vessels in the body. Indeed, the observation of Scarpa and others so strongly corroborate the account which I have given of the vigorous action of the absorbents in the two chambers of the aqueous humour, and particularly in the anterior one, that from the moment the case is discovered to be a soft or caseous cataract, it seems quite unnecessary to make any further attempt to depress it into the vitreous humour.

One great advantage of couching, insisted upon by Scarpa, depends upon its generally removing the capsule, at the same time with the lens, from the passage of the rays of light to the retina. Sometimes, however, this desirable event, by which the patient is extricated from the danger of a *secondary membranous cataract*, does not take place. What most frequently constitutes the secondary membranous cataract, is the anterior half of the capsule, which not having been removed, or sufficiently broken, in a previous operation, continues more or less entire in its natural situation, afterwards becomes opaque, and thus impedes the free transmission of the rays of light to the seat of vision. Sometimes the secondary membranous cataract presents itself beyond the pupil, in the form of membranous flakes, apparently floating in the aqueous humour, and shutting up the pupil: at other times, it appears in the form of triangular membranes, with their bases affixed to the *membrana hyaloidea*, and their points directed towards the centre of the pupil. When there is only a minute membranous flake suspended in the posterior chamber, Scarpa thinks it by no means necessary for the patient to submit to another operation ; vision is tolerably perfect, and in time the small particles of opaque matter will spontaneously disappear. But when the secondary membranous cataract consists of a collection of opaque fragments of the capsule, accumulated so as either in a great degree or entirely to close the pupil ; or when the disease consists of the whole anterior half of the opaque capsule, neglected in a prior operation, and continuing adherent in its natural situation, it is indispensable to operate again ; for, although, in the first case, there may be good reason to hope that the collection of membranous fragments might, in time, disappear, yet it would be unjustifiable to detain the patient for weeks and months in a state of anxiety and blindness, when a safe and simple operation would restore him, in a very short space of time, to the enjoyment of this most useful of the senses.

[Modern ingenuity has greatly improved upon the old mode of dealing with these secondary cataracts. It was customary to endeavour to remove them out of the pupil by means of a needle, but from their great toughness and the elasticity of the surrounding media it was extremely difficult to make a satisfactory impression upon them. To obviate this difficulty, Mr. Wilde of Dublin invented a beautiful instrument called capsular scissors, by which shreds of capsule may be neatly severed. The same principle has been applied to forceps, so that these portions of membrane may be drawn out of the eye through small apertures, made either in the cornea or in the sclerotica. Mr. Bowman has introduced the use of two needles, by the simultaneous working of which, each furnishing the other with a point of resistance, the capsule may be torn open or membranous shreds divided, without drag on the neighbouring structures. (See *Med. Chir. Trans.* vol. xviii. 1853.) Dr. Isaac Hays of Philadelphia has invented a fine knife-needle for the division of the lens or capsule. (*Amer. Journ. Med. Science*, July 1855.)]

No other topical application is generally requisite, after the operation, but a small compress of fine linen upon each eye ; and the patient ought to be kept in a quiet, moderately darkened room. On the following morning, a dose of some mild purgative salt, such as the sulphate of soda, or magnesia, may usually be administered with advantage. When the inflammation exceeds the ordinary bounds then the treatment applicable to iritis becomes proper.

Beer remarks, that although, after extraction, very cautious trials of the sight are indispensable, they are by no means proper after depression or reclination ; for the action of the muscles of the eye, in the inspection of objects at various distances, is very liable to make the opaque body rise again. Hence, as soon as the pupil is clear, Beer recommends covering both eyes (even when one only has been operated upon) with a plaster, and simple linen compress, which last is to be fastened on the forehead with a common bandage. The same experienced operator also enjoins perfect quietude of the body and head for some days. The patient, he says, may either lie in bed, or sit in an arm-chair, as may be most agreeable, care being taken to avoid all sudden motions. The most proper food for the patient is such as is easily digested, not too nutritious, and does not require much mastication. Everything must be avoided which has a tendency to excite inflammation in the eye. On the third or fourth day, the eye should be opened, and afterwards be merely protected by a green silk eye-screen, which should also be gradually dispensed with. The patient should be careful to do whatever is agreeable to the eye which has been operated upon, and as carefully avoid everything which irritates it or causes a disagreeable sensation in it, a difficulty of opening the eyelids, or keeping them open, a discharge of tears, or a redness of the white of the eye, &c.

Of the thrombus under the conjunctiva, sometimes caused by the prick of the needle, and of the readily bleeding granulations which occasionally shoot up at the puncture, I need not here particularly speak. For relieving the obstinate vomiting sometimes excited by injury of the ciliary nerves or that of the retina, Beer recommends castor, musk, and opium, except when the eye is in a state of inflammation, in which circumstance antiphlogistic treatment is preferable. Such vomiting, Beer joins other writers in believing, is often produced by a firm lens being depressed too far, so as to injure the retina ; a case, however, which is usually combined with a suddenly produced, complete or incomplete amaurosis. Here, unless the position of the lens can be changed by a sudden movement of the head, the above class of medicines will be of no use. This kind of amaurosis may also take place, without any vomiting, and, as Beer has had opportunities of remarking, it will not always subside, even though the cataract be made to rise again. The same amaurotic affection may also result from the surgeon hurting the retina by pushing the needle too deeply against this membrane. According to Beer, the ophthalmy liable to happen in these cases as well as after extraction and keratonyxis, is always most severe in the iris and neighbouring textures. (*Von den Augenkr.* b. ii. p. 361—363.)

I cannot help remarking how judicious it is never to attempt too much at one time in any mode of couching. It happens in this, as in most other branches of operative surgery, that celerity is too often mistaken for skill: the operator should not only be slow and deliberate in achieving his purpose ; he should be taught to consider, that the repetition of couching may, like the puncture of a vein, be safely and advantageously put in practice again and again ; and with far greater security than if, for the sake of appearing expeditious, or avoiding the temporary semblance of failure, a bolder use of the couching-needle should be made than the delicate structure of the eye warrants. We read, in Mr. Hey's *Practical Observations on Surgery*, that he couched one eye seven times, before perfect success was obtained; had he been less patient, and endeavoured to effect by one or two rough applications of the instrument what he achieved by seven efforts of a gentler description, it is highly probable that the structure of the eye would have been so impaired, as well as the consequent ophthalmy so violent, as to have utterly prevented the restoration of sight.

Beer thinks that, in general, depression and reclination are indicated only in cases in which extraction is absolutely impracticable or attended with too great difficulty, as will be better understood when this operation is considered. As examples of this kind, Beer specifies an extensive adhesion of the iris to the cornea; a very flat cornea, and of course so small an anterior chamber, that an incision of proper size in the cornea cannot be made; a broad arcus senilis; an habitually contracted pupil (incapable of being artificially dilated); an eye much sunk in the orbit, with a small fissure between the eyelids; eyes affected with incessant convulsive motions; a partial adhesion of the cataract to the uvea; unappeasable timidity in the patient; and an impossibility of managing him during and after the operation, in consequence of his childhood or stupidity. Amongst the circumstances enumerated by Mr. Middlemore as rendering the operation of depression or reclination more advantageous than extraction, is an emaciated feeble condition of the patient, which, if the latter operation were performed, might interfere with the union of the wound in the cornea, and be followed by ulceration, sloughing, and staphyloma of that texture. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 111.) The same gentleman also expresses his opinion, that in certain examples of hard cataract, where extraction cannot be performed with propriety, reclination is generally preferable to depression, because not so likely to be followed by a rising of the lens again, or to cause pressure on the retina. He adds, indeed, direct depression of the lens beneath the pupil is very seldom practised now, as it is in a great measure superseded by extraction and reclination (p. 112).

The manner of operating with the needle upon the congenital cataracts of children will be hereafter explained.

[Until recently we have not been in possession of accurate information as to the statistics of cataract in the East Indies. This want has been supplied by Mr. W. Martin, Superintendent of the Calcutta Eye Infirmary, who has published a Return of the Principal Operations on the Eye performed in that Infirmary between the years 1848 and 1851. (*Indian Annals of Medical Science*, No. 1.) From this interesting report we learn that the number of cataract operations was 586, comprising lenticular cataracts 373, capsulo-lenticular 164, capsular 49. Of these 25 were hard, 116 soft, 24 fluid, 372 mixed, and 49 capsular. The operations were, extraction 14, depression 194, solution 88, drilling 1, laceration of capsule 49. The remainder of the operations were combinations of the above.

Mr. Martin states, that extraction is not an operation suited to the Bengalee. The prominent brow, small sunken eye, with a proportionally large lens, render the performance of the operation very difficult; whilst the feeble constitution renders the union of the section uncertain and rare compared with the same in the European patient. By far the largest proportion of operations found necessary with the natives of India are depression and depression with division.]

The operation most frequently performed in the United States, is that of passing the needle of Adams, Scarpa, Saunders, or Hey, through the sclerotica, immediately behind the iris, and then lacerating the capsule, or the lens itself, and permitting the aqueous humour to act upon it, either by pressing the fragments of the lens through the pupil into the interior chamber, or, where this is impracticable, leaving them *in situ*. One of the most successful operators in the United States, is Dr. John Harper of Baltimore, and he seldom adopts any other operation than this, which he repeats, as often as necessary, on the same eye. In the case of a young lady, Dr. Reese performed it on both eyes at once, and to promote absorption gave her the blue pill; in three weeks her vision was restored, although she had been blind twelve years. Depression seems to have but few advocates in the United States; nor is extraction often preferred there even for hard cataracts. (See REESE, in Amer. ed. of this Dict.)

EXTRACTION OF THE CATARACT.

From some passages in the works of Rhazes, Haly, and Avicenna, specified by Mr. Guthrie, it is sufficiently clear that the practice of opening the cornea for the removal of cataracts was not unknown to the ancients. Rhazes says that about the end of the first century, Antyllus opened the cornea, and drew the cataract out of the eye with a fine needle, in which practice he was followed by Lathyrion. However, while doubts were entertained respecting the true seat of the cataract, it is hardly to be supposed that this mode of treatment could have been frequently adopted; but as soon as it was fully proved that the true cataract was an opacity of the crystalline lens; that the loss of sight would not be occasioned by the removal of this body; that the cornea might be divided without danger; and that the aqueous humour would be quickly regenerated; the mode of cure, by extracting the cataract out of the eye, would naturally present itself. (*Wenzel.*)

Freytag is perhaps the first in modern times who made an attempt to extract the cataract; this was about the close of the 17th century. After him, Lotterius of Turin performed the operation. But nobody has so strong a claim as M. Daviel to the honour of bringing the merits of the practice before the public; and he not only adopted it himself, but published the first good description of it. (*Sur une Nouvelle Méthode de guérir la Cataracte par l'Extraction du Cristallin*, 1747. Also *Mémoires de l'Acad. Royale de Chirurgie*, t. ii. 4to. 1753.) Two cases in which the cataract had accidentally slipped through the pupil into the anterior chamber, whence they were extracted in the years 1707 and 1708 by Mery and Petit, as related by St. Ives, seem to have had considerable influence in bringing about the regular performance of this method of removing the cataract; for they served as an encouragement to Daviel, by whom the practice was completely established. The operation was afterwards brought considerably nearer to perfection by the ingenuity and industry of Wenzel. (*Brambilla Instrumentarium Chir. Austriacum*, 1782, p. 71.)

The extraction of the cataract may now be regarded as brought to the highest state of improvement. It admits of division into three stages, the first of which, as in depression and reclination, is the most important; because, unless it be performed exactly as it ought to be, the operation would be very liable to fail, and it is exceedingly difficult to make amends for any fault committed in this early part of the proceedings. The first stage consists in making an effectual opening in the cornea with a suitable knife. The second, in dividing the anterior layer of the capsule. In the third stage, the expulsion of the cataract from the eye is effected either by the well-regulated action of the eyeball itself, or by the assistance of art.

[Various knives have been designed for the operation of extraction: Wenzel's knife has much resemblance to the ordinary bleeding lancet; Beer's knife had the form of a hay-knife; Scott and Dalrymple used a peculiar sickle-shaped knife cutting on the convex edge. But the form now generally preferred is a modification of Beer's knife; the cutting edge being placed at an angle of about 15° with the back, which is straight. The point is double edged for the space of a line, the blade is slightly convex on both sides, and in order that it should exactly fill up the wound it ought to increase gradually in thickness from point to heel: the temper should be perfect, the point firm and very sharp, and the edge extremely keen. With modifications according to particular fancy, this is the knife generally used on the Continent as well as in England.

It was formerly the custom to prepare patients for the operation by rigorous abstinence for a week or a fortnight, with purgatives every other day; and not unfrequently venesection was added. Such severe measures are generally abandoned in this country; the patient should be brought as near the standard of health as possible, the diet should be light for a day or two before the operation, and an aperient may be given the day prior to its performance. As many of the subjects for extraction are old and feeble, it may be proper to feed them well and give tonics instead of lowering them, otherwise the section will not heal kindly.

A difference of opinion exists as to the dilatation of the pupil previous to the performance of extraction. In truth it matters little whether it be dilated or not, as it generally contracts the moment the aqueous humour escapes.

In the former editions of this work, the description of the operation of extraction was culled from various sources now somewhat obsolete. It is considered better to substitute for them a concise account founded on the clear directions given by the late Frederick Tyrrell, whose skill in the performance of the operation and subsequent success could not be surpassed.

Supposing that one eye is to be subjected to operation, a light bandage is to be tied over the other eye, and the patient is to be placed on a couch near a window in such a position that the light shall fall obliquely upon the cornea, so that no dazzling from reflection may arise in any movement of the eye. If the right eye be submitted to operation, and the upper section of the cornea practised, the surgeon should be seated at the head of the patient, at a convenient height; and taking his knife in the right hand he ought to hold it as a pen or pencil. He should then raise and fix the superior lid with the fingers of the left hand in the following manner:—The point of the forefinger should be applied to the centre of the margin of the lid below the cilia, so as to touch the surface of the globe; the lid should then be pressed upwards towards the eyebrow, the point of the finger still resting on the globe; then the extremity of the middle finger should be applied upon the globe near to the inner canthus. At the same time the assistant is to depress the lower lid by stress on the integument without pressing on the globe. The operator now, resting his hand upon the temple of the patient, should gently place the blade of the knife flat upon the cornea, and ascertain if he can carry the point of the instrument to the nose without shifting his hand. He may now, having thus lightly touched the cornea, ask the patient some question requiring thought, and thus the eye generally unconsciously assumes the proper position. When it has done so, the point of the knife is to puncture the cornea near the mesial line, close to its junction with the sclerotic, the edge being directed upwards or downwards, according as the upper or lower section is intended. The blade is to be then steadily, not too hurriedly, pushed across the anterior chamber, until it again penetrates the cornea, opposite to the point at which it entered; and then slowly carried on, pausing from time time, until the flap of the cornea has been completed. As soon as the knife has penetrated the inner margin of the cornea the globe can be commanded with it; pressure from the fingers is therefore no longer necessary, but if continued might lead to escape of the humours. The points of the fingers should therefore be removed from the eye as soon as the knife has pierced the inner side of the cornea. The section must be made by the onward progress of the knife; the least retraction infallibly leads to escape of the aqueous humour, and the falling of the iris before the edge of the knife.

It is very important to allow all spasm of the muscles of the eye to subside before dividing the last few fibres of the cornea, otherwise the lens will leap out with a gush of vitreous humour to an extent which may peril the safety of the eye, and the lid should be allowed to drop the instant the section is completed.

The extent of the section should be nearly one half of the circumference of the cornea.

The patient should be permitted to rest a few moments after the section of the cornea has been made, to allow the irritability of the eye to subside.

The next step in the operation is to lacerate the anterior capsule, which is effected with the sharp extremity of the curette. The superior lid is again to be raised, but merely by the integument, which is to be pressed against the eyebrow. The curette is to be held as the knife, and as soon as the section is exposed, the sharp extremity of the instrument is to be passed beneath the flap of the cornea, taking care that the point does not become entangled in the iris. When it has reached the pupil, the point should be brought to bear on the capsule of the cataract, which is to be freely lacerated by repeated light scratches of the instrument, the lens being disturbed as little as possible. The instrument is then to be cautiously withdrawn. The surgeon should now place the concavity of the scoop of the curette against the eye, a little below the margin of the cornea, and whilst firm but not violent pressure is made with it, counter-pressure should be made with the finger on the upper part of the globe. The lens will now be seen to turn, to quit its capsule, and gradually to pass through the pupil, and then through the wound in the cornea. As soon as the large diameter of the lens has passed the pupil, the pressure should be removed, or the hyaloid membrane may be ruptured. The lens is to be removed with the curette, and the lid allowed to fall. After a few moments' pause, gentle friction with the point of the finger may be made on the upper lid, to stimulate contraction of the pupil.

It was formerly the custom to test the sight of the patient, by holding a goblet of water before his eye, and desiring him to point out the water line, but it is far safer not to risk disturbance of the section by such a proceeding.

The patient may be directed to gently open the eye, and if the flap is properly adjusted, the pupil circular, and the iris in its proper place, the eye should be finally closed. In operating on the left eye, the surgeon, if ambidextrous, will operate with his left hand, and the proceedings will in no wise differ from those already described. If, however, he prefer to use his right hand, he must place himself before the patient, who is to be seated in a low chair, and the assistant must be behind the patient, whose head he must firmly support. The assistant must also take charge of the upper lid, and must be particularly cautioned not to make undue pressure on the globe. It is a great advantage to an operator to have an assistant who thoroughly understands his work, and is acquainted with every step of the proceedings. The operator is now to support his hand upon the patient's cheek, and taking charge of the lower lid with his left hand, he proceeds to make the section, either superior or inferior, as he prefers.

The most common accident during the performance of extraction, is premature escape of the aqueous humour. This will occur if the knife be in the slightest degree retracted after the cornea has been punctured; if the eye be allowed to escape from it, or if the blade be not perfectly true; and it may be remarked that comparatively few knives possess this valuable quality. Should this accident happen when but a small aperture has been made, it is best to withdraw the instrument and defer the operation, for there will be great risk of inflicting extensive injury to the iris if the knife be pushed on; but if the anterior chamber has been crossed before the accident happens, and the iris then falls before the edge of the knife, the operator should pause, and with the point of his finger gently rub the cornea; this frequently causes the iris to contract, when the knife may be cautiously pushed on and the section completed. If a small piece of the edge of the pupil be shaved off, it is not a matter of consequence; but if the edge of the knife remain covered with the iris, it is better to withdraw the knife and complete the operation with the blunt-pointed knife. This has a small and narrow blade, which is to be passed through the wound and in front of the iris, and then the edge being brought to bear upon the cornea, that is to be divided with a gentle sawing motion in the direction previously intended.

It is better to have the incision rather too free, than so small that a good deal of force is required to press out the cataract, for not only does it then escape in a broken condition, leaving fragments behind, but there is considerable risk of the vitreous humour escaping.

A very common occurrence, especially with young operators, is for the knife to pass out before it reaches the proper point for counter-puncture, whereby the size of the section is much diminished; when this is the case, the wound may be enlarged with the blunt-pointed knife, in the manner already described: if on making pressure, the lens does not pass through the pupil, the section had better be enlarged, rather than undue force applied to squeeze it out. If the section be so small as not to admit of the passage of the lens, and too great pressure be used, the hyaloid may give way, and so much vitreous flow out as to cause the cataract to sink behind the iris; this is especially likely to happen if there be fluid vitreous humour. If the lens be out of sight, the eye should be closed, and no attempt made to fish it out, for the pupil is clear, and the case may do well. If it be only partially sunk, the section should be carefully enlarged, and then the lens may perhaps be lifted out with the sharp hook intended for the purpose; but the most gentle management is necessary.

A rare accident after extraction is hæmorrhage from the choroidal vessels. This usually takes place, either during the performance of the operation, or within a few hours afterwards. In a patient of the writer's, however, profuse hæmorrhage took place ten days after the performance of the operation. It was in a feeble old woman, and the section had not united; but with this exception, there had been nothing unusual in the progress of the case, nor anything to account for the sudden burst of blood which unexpectedly poured from the eye whilst the patient lay quietly in bed. The hæmorrhage indicates a diseased condition of the blood vessels, and is from this circumstance sometimes difficult to stop. Ice may be applied to the lid, and a compress bound on pretty firmly; the globe is of course filled with blood, and either suppurates or atrophies.

A valuable article on the accidents which may arise during or after the performance of extraction, is to be found in the fourth volume of the Archives d'Ophthalmologie (*De l'Opération de la Cataracte par Kératotomie supérieure, &c.*). It is founded on observations deduced from 780 cases operated on by Dr. Sichel, and is well worthy of perusal.

After the eyelids have been finally closed, they may be covered with strips of soft rag, kept in place by a bandage passed round the head; undue pressure upon the eye is to be avoided, and the lids are to be kept perfectly quiet.

The patient should be placed in bed on his back, and it is proper to secure the hands with tapes at night, to obviate the chance of the eye being rubbed or struck.

Oculists have differed as to the time for opening the eye after extraction, but the modern practice is not to do this before the fifth day: it is highly important that the section should be firmly united before the lid is raised, and this is not to be expected before the fifth day. It is better to be late than too early in looking at the eye. If, on examining the eye cautiously, all be well, the patient may assume a shade, but must be warned not to be too eager to use the eye: for some days very subdued light is necessary, and it is highly important to avoid flashes of light entering the room by suddenly drawing up the blind or opening the door. From ten days to a fortnight may be considered the period in which the most favourable recovery may be expected.]

Beer says the eye should seldom be opened before the fifth or sixth day. When this is first done, the light should be very moderate, and the patient placed with his back towards it, all unnecessary lateral light being kept from the eye by the linen attached to the forehead, while the daily trials of the newly-recovered powers of the eye should be made with the utmost caution. On the

8th, 9th, or, at latest, on the 10th day, Beer recommends leaving the eye open, but screened above by a green-eye shade, in a half-darkened chamber; and the patient is afterwards to be treated, until his eye is perfectly well, according to the rules already laid down as proper to be observed after couching. And especially when the patient has had cataracts in both eyes, Beer thinks it as well to apprise him, in order to prevent unnecessary alarm, that, upon first going out into the open air, particularly in the evening, he will be for some moments almost blinded, and then begin to see again, but every object will now appear covered with a white, shining circle, which at length goes off; though, in the open air, it will sometimes continue for several days. (*Beer*, b. ii. p. 380.)

[In the former editions of this work the following practice was quoted as proper to follow. "A few hours after the operation, Mr. Guthrie always bleeds the patient, whether pain comes on or not: and if it continue or afterwards takes place, he repeats the evacuation. In another few hours, if no amendment occur, he has recourse to a third bleeding. For the first twenty-four hours he does not wish the patient to be disturbed with purgative medicines, so as to produce any risk of the edges of the cornea being displaced, but after this period he exhibits saline aperients, and when much inflammation is expected, he prescribes calomel combined with opiate confection; and if the inflammation continue, he gives two grains of calomel with ¼ or ½ of a grain of opium, three or four times in the course of twenty-four hours, so as to affect the system, and prevent the bad consequences of inflammation of the iris and internal parts of the eye."

Such was the general practice thirty years ago, and it was reserved for the late Frederick Tyrrell to break through the routine, and to point out the true principles by which we should be guided.—(*Tyrrell*, *On Diseases of the Eye*, vol. ii. p. 427.) It seems to have been quite overlooked in the excessive fear of inflammation, that a certain amount of constitutional power is necessary for the healing of the extensive wound in the cornea, and that this draining away of the blood and exhausting of the patient was, in old or feeble persons, the very means to defeat that necessary object. Juster views are now entertained, and the practice in England at the present day is to watch the patient closely, depleting little, and treating each case according to its special requirements.

Mr. Dixon makes some very excellent remarks on the evils attending the lowering and depleting system after extraction, and recommends the following judicious course to be pursued: "As regards diet, patients are usually but little disposed to take much that is solid on the day of the operation, good broth or beef tea being the most acceptable form of animal food; but provided all appears to be going on well, most patients may be allowed a moderate quantity of solid animal food on the second or third day. Old and feeble persons, however, will require to have meat finely minced, or some other nutritious and light food, given in moderate quantities and at proper intervals, from the very day of the operation. With regard to stimulants, it is impossible to lay down any absolute rule. Those habitually accustomed to take wine, beer, or spirits must by no means be wholly debarred from them at a time when the nutritive powers of the body are called upon to form new material for rapidly repairing a breach of surface. In short, the surgeon's object must be carefully to regulate both food and stimulants according to the patient's previous habits; neither keeping him too high nor too low, but as near as possible up to the ordinary level of healthy vigour.—(*Dixon, On Diseases of the Eye*, p. 341.)]

The late Mr. Ware published some remarks on the bad consequences of allowing foreign bodies of any kind, after the operation, to press unequally on the globe of the eye; comprehending, under this head, the intervention of the edge of the lower eyelid between the sides of the divided cornea; the inversion of the edge of the lower eyelid; and the lodgement of one or more loose eyelashes on the globe of the eye.

To prevent the first accident, every operator, before applying the dressings, should carefully depress the lower eyelid; and before he suffers it to rise again, should take care that the flap of the cornea be accurately adjusted in its proper position; and, that the upper lid be dropped, so as completely to cover it. After this, the eyelid should not be opened again for three or four days, that is, until there is good reason to suppose the wound in the cornea closed.

The inversion of the lower eyelid is hurtful in consequence of its making the eyelashes rub against the eye. These should be extracted the day before the operation. For the mode of effecting a permanent cure, see TRICHIASIS.

Besides the danger to which the eye is exposed from the inversion of the edge of the lid, the eye may receive injury from the improper position of the eyelashes alone; one or more of which during the operation may happen to bend inwards; or, becoming loose, may afterwards insinuate themselves between the inside of the lid and the eye. An eyelash bent inward should be rectified; if broken off and loose, it should be removed.

The following observations by Beer are interesting:—When the dressings have been unskilfully applied; when the incision of the cornea has been made horizontally upon a large prominent eye; when the fissure of the eyelids is exceedingly narrow, or the patient is restless, a proper cicatrisation of the wound in the cornea may not follow. Though the aqueous humour may collect in the anterior chamber, the partially united lamellæ of the cornea may be incapable of duly resisting the pressure of that fluid, and may consequently protrude in the form of a light-grey, semi-transparent, oval vesicle, extending nearly the whole length of the wound in the cornea, and being most prominent in the centre. The patient complains of an annoying sense of pressure in the eye, as in cases of protrusion of the iris; but the discharge of the aqueous humour has completely stopped, and therefore the anterior chamber presents its natural appearance, and the pupil its regular round shape, though the edges of the wound in the cornea are whitish and swollen. This case was formerly regarded as a prolapsus of the membrane of the aqueous humour; but Beer considers it as a sort of hernia of the cornea, termed *ceratocele.* Merely puncturing, or cutting away the cyst is of no service; for, though the aqueous humour immediately flows out, the wound soon closes again and the tumor re-appears, attended also with some risk of the iris falling into the cyst, and becoming adherent to it.

Effectual relief cannot be obtained unless the tumor be removed with Daviel's scissors, as close as possible to the wound; the dressings skilfully arranged: and the eye kept closed and quiet for eight days or a fortnight. In such a case, a whitish scar is always permanently left. (*Beer*, b. ii. p. 393.)

Beer observes, that when the pupil contracts very considerably after the incision in the cornea has been made, and the cataract at the same time remains at some distance from the uvea, too small an opening has generally been formed, and it ought to be enlarged. But if the cataract cannot be forced through the pupil, without making pressure on the lower part of the eyeball, and the closure of the pupil should still continue, the circumstance proceeds from the loss of the aqueous humour, and the second stage of extraction must be deferred a little while, until the pupil dilates again, and the operation must then be finished in a very moderate light. (Also *Guthrie's Operative Surgery of the Eye*, p. 305.)

Beer notices the occasional protrusion of the iris, in the third stage of the operation, more or less between the edges of the incision in the cornea, immediately after the exit of the cataract. Here, says Beer, the iris should be reduced without the least delay; and the pupil, which is completely oval, made round again; a thing, which the operator may easily perform by applying his hand flat upon the patient's forehead, letting the latter shut his eye, rubbing the upper eyelid quickly, yet gently, with the thumb, and then suddenly opening the eye, by which means a moderate light will at once strike it, and produce an expansion of the iris.

As Beer observes, if the patient be very restless, make frequent attempts to open his eyes in the least, and partly lie upon the eye, or if in changing the compresses the greatest caution be not used, the eye will perhaps be roughly pressed upon, and the iris protrude between the displaced and half-opened edges of the incision in the cornea, to which it will become adherent during a slow and seldom very violent inflammation. From the moment when the iris thus interposes itself between the sides of the wound, the aqueous humour begins to collect, and at length pushes the iris considerably forwards. In this case, Beer recommends carefully opening the eye in a very moderate light, and adopting the expedients formerly mentioned for the purpose of making the iris recede. The dressings should be re-applied, and the eye kept closed and very quiet for at least eight or ten days, so as to hinder a recurrence of this disagreeable accident. But, if the iris should be already adherent to the edges of the wound in the cornea, the eye incapable of bearing light, and the aqueous humour more or less accumulated in the anterior chamber, Beer says everything must be left to time, while the eye is kept lightly covered for about a fortnight, and the existing inflammation properly treated. Then, if the protrusion, or staphyloma of the iris should not be diminished by the means calculated for lessening the inflammation, caustic or the knife must be employed. (*Beer*, b. ii. p. 391.) The same causes, which have been above specified, as conducive to a protrusion of the iris, may also produce a discharge of the vitreous humour.

In all patients who have been operated upon for cataracts, the edges of the eyelids become glued together with mucus on the first night after the operation: yet, according to Beer, in individuals particularly subject to copious secretions of mucus, it is not unusual for the puncta lachrymalia and lachrymal ducts to be blocked up with thickened mucus, whereby the tears are prevented from duly passing down into the nose, so that from time to time they are discharged from the inner angle of the eye, and collect under the eyelids. In this case, the patient soon begins to complain of a violent, continual, and increasing sense of pressure on the eye, and the upper eyelid swells, unattended with any redness. Irritable persons also experience a stupifying dull headach. These inconveniences may be immediately removed by clearing away the mucus with a little lukewarm milk from the inner canthus, and letting a stream of clean water fall over the cheek. Care must also be taken to hinder a recurrence of the circumstance, and to remove it, if it should happen.

After extraction, the loss of the lens must be supplied by proper spectacles, which should not however be fitted to the eyes for several weeks after the cure has been accomplished, in order to let the eye recover first as much power as possible, without artificial aid. The power of adjustment will necessarily be lost, and two pairs of spectacles be required; one for near, the other, for distant objects.

OF KERATONYXIS.

Gleize, having commenced an operation by extraction, was prevented from completing it by a sudden movement of the patient's head; instead of enlarging the opening in the cornea with scissors, he introduced a needle through it, and depressed the lens. This case led to the invention of the new method of operating by *keratonyxis*, as it is now termed, a description of which Gleize published in 1786. Gleize's method was simplified by Conradi, who merely opened the cornea and capsule of the lens with a lance-shaped knife, and left the removal of the cataract to be effected by the absorbents. Several improvements were subsequently made in this method by Dr. H. Buchhorn, who first gave it the name of *Keratonyxis*, and adopted the practice of dividing the lens, as well as the capsule, and of bringing the fragments forward into the anterior chamber. About the same time, Mr. Saunders, in England, perfected a similar operation, and applied it particularly to congenital cataracts. (See *Guthrie's Operative Surgery of the Eye*, pp. 331, 332.)

This operation requires the pupil to be first artificially dilated. The belladonna should be applied the day before, and on the morning of the operation, in order that the pupil may be completely dilated; and a few drops of a solution of belladonna, or of atropine, should be dropped into the eye, half an hour before its commencement, so as to prevent a contraction of the pupil during the operation. In the absence of chloroform the best method of keeping very young patients sufficiently steady during the performance of keratonyxis, is to bind their arms firmly to their side with a broad roller or folded sheet. They are then to be placed on a table in the recumbent position, and the head prevented from moving by an assistant pressing his hands firmly upon the temples. Keratonyxis admits of being divided into two stages: first, the introduction of the needle through the cornea and pupil as far as the cataract; and, secondly, the breaking of the lens to pieces, and the division and laceration of its capsule. For these purposes, Beer prefers a common, straight, spear-shaped, sharp-edged, couching-needle, to any curved one, however fine it may be made; first, because it pierces the cornea with greater facility; secondly, because both a soft cataract and the capsule can be more effectually cut with it, a larger opening being made, through which the aqueous humour may flow over the fragments of the lens, and the dissolution of the cataract be thus rendered more certain; whereas, with a curved needle, Beer says, the lens can only be disturbed, and the capsule torn, under which circumstances inflammation and a secondary capsular cataract are likely to be produced. He directs the instrument to be introduced either at the lower, or at the external part of the cornea, one line and a half from its margin, the point being directed obliquely towards the pupil, and the capsule is to be effectually cut by moving the extremity of the needle laterally in various ways; and, above all things, it is necessary, at the time of breaking the lens piecemeal, not to let the instrument continue always within this body; but, at every stroke, to lift it completely out of the lens and capsule, and then introduce it into them again in different directions.

Dr. Jacob prefers, for the performance of this operation, a fine sewing-needle, curved at the point. He says, that it rarely or never leaves the slightest mark in the cornea. "The capsule can be opened to any extent; a soft or friable lens can be actually broken up into a pulp, by pushing the curved extremity of the needle into its centre. and revolving the handle between the fingers; large fragments can be taken up on the point of the needle from the anterior chamber, and forced back out of the way of the iris; or, if sufficiently soft, may be divided by pressing them against the back of the cornea with the convexity of the needle," &c. (See *Dublin Hospital Reports*, vol. iv. p. 224.)

Others give the preference to an extremely fine, small, and sharp needle, slightly flattened for a short distance from its point, and with cutting edges to facilitate its passage through the cornea. It should increase in size from its point, so that its introduction may not cause the escape of the aqueous humour. (See *Middlemore*, *On Dis. of the Eye*, vol. ii. p. 155.)

It may be necessary to repeat keratonyxis two or three times, and this is more prudent than doing too much injury on any one occasion. (*Middlemore*, vol. ii. p. 156.)

After the operation, the same light mode of dressing and the same after-treatment are proper, as are adopted in cases of depression and reclination. Under the most favourable circumstances, several weeks, and sometimes as many months, elapse, before the pupil becomes quite transparent.

According to Beer, keratonyxis is not liable to many accidents. Sometimes, says he, the artificially dilated pupil contracts, as soon as the needle has pierced the cornea, and reached the cataract: in this circumstance, the operator must wait quietly, until the pupil gradually expands again, a change which may be promoted by screening the eye with the hand. If the operation were to be continued without delay, either the pupillary edge of the iris would be seriously and dangerously hurt by the needle, or the cataract could not be effectually divided. When, contrary to expectation, the nucleus of the cataract is too hard to be broken piecemeal, reclination and depression should be done through the cornea, as well as circumstances will allow, and these objects can be more easily effected with a part than with the whole of the lens. When the lens is found completely fluid, but the capsule opaque only at some points, Beer, with the view of preventing a secondary capsular cataract, recommends cutting the membrane in all directions, and annihilating it as much as possible. Keratonyxis may be followed by the same evils which occasionally take place after depression and reclination, and which will require similar treatment. But, according to Beer's experience, one of the most frequent consequences is a secondary capsular cataract, which often ensues even though the pupil was quite clear at the time of the operation; and though it may not quite blind the patient, it considerably lessens his power of vision; and renders the operation incomplete.

When the sole object of keratonyxis is to break and cut the cataract and its capsule piecemeal, and the fragments are to be left to dissolve and be absorbed, the operation can be indicated only where this division, breaking, dissolution, and absorption of the cataract can be successfully wrought. Hence, Beer sets down the method as not calculated for firm, hard, lenticular cataracts; nor for those which are softish and scabrous only upon their surface; and, he says, that it is not suited for capsulo-lenticular cataracts, nor for any cases, termed false cataracts, which are of a membranous nature. Keratonyxis, he observed, may be expected to answer only in fluid or gelatinous cataracts, when the capsule is either little or not at all opaque and thickened, and of course can be easily opened and cut to pieces, as in the case described under the name of encysted cataract. For the above reasons, the method is well adapted for children and young subjects, in whom the origin and general complications of a cataract involve the case in suspicious circumstances.

After keratonyxis, the dilatation of the pupil should be kept up by means of belladonna, until all symptoms of inflammation have subsided. (See *Guthrie's Operative Surgery of the Eye*, p. 336.)

Keratonyxis (the anterior operation of solution) and extraction seem to Mr. Middlemore to comprise all the feasible operations performed for the cure of lenticular cataract anterior to the iris; for he is unwilling to include reclination and depression, which he believes are more advantageously executed through the sclerotica. "If," says he, "we review the number and importance of the textures which have been divided or injured, we find, that, with the exception of the parts actually implicated in the disease, the cornea alone is injured. At least, they are the only parts, the texture of which is necessarily penetrated." The cornea, it is well known, is not a highly sensible part; and hence the anterior keratonyxis and extraction give less pain than other operations for cataract. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 156.)

Valuable information on keratonyxis has been published by Langenbeck in the 4th vol. of his first Bibliothek; in the 1st vol. of his new Bibl. p. 1, &c. 1815; and in a tract entitled

Prüfung der Keratonyxis, einer Methode den grauen Staar durch die Hornhaut zu recliniren, oder zuzerstuckeln nebst erläuternden Operations, geschichten. Göttingen, 1811. See also *Conradi, in Arnemann's Magazin*, b. i. p. 95, 1791. *Gleize. Nouvelles Obs. Pratiques sur les Maladies de l'Œil*, p. 118, 1812. *G. H. Buchhorn's Diss. de Keratonyxide*, Halæ, 1811.

Of Congenital Cataract.

I shall not stop here to inquire whether the expression *congenital cataract* is used with strict propriety; but the term is reprobated by Beer as being in general incorrectly applied.

So much has been already said in a preceding section of this article concerning the propriety and striking advantages of operating for the cataracts of children, that to expatiate further upon this point would be a mere waste of time.

We have noticed the case, which Scarpa terms the *primary membranous cataract*, and which is mentioned by that distinguished professor, as being met with in children, or young people, under the age of twenty, the substance of the crystalline itself being almost entirely absorbed, while the capsule is left in an opaque state, including, at most, only a small nucleus, not larger than a pin's head. This disease is described by Scarpa as being exceedingly rare, and characterised by a certain transparency and similitude to a cobweb; by a whitish opaque point, either at its centre or circumference, and by a streaked and reticulated appearance. Now, this example, which is represented by Scarpa as rare, appears from the experience of Mr. Saunders, to be by no means uncommon; since at the London Infirmary for diseases of the eye, it was found, that the majority of congenital cataracts were capsular or membranous. We learn from Mr. Saunders's publication, that, in the congenital cataract, after the crystalline lens has been converted into an opaque substance, it is gradually absorbed; and, in proportion to the progress of absorption, the anterior lamella of the capsule approaches the posterior, until they form one membrane, which is white, opaque, and very elastic. This process is commonly completed long before the eighth year, and the operator will now find a substance, which he will in vain endeavour either to extract or depress. But there is one form of the congenital cataract, in which the absorption of the lens does not proceed, viz. when the centre of the lens is opaque, and its circumference is perfectly transparent. Should the capsule and lens be penetrated, however, with any instrument, the opacity soon becomes complete, and from this moment the substance of the lens begins to be absorbed.

According to the experience of Mr. Saunders in congenital cataract, the lens may be either solid, soft, or fluid, but more frequently it is partially or completely absorbed, and the cataract is capsular.

[Mr. Dixon considers that there are four well-marked forms of congenital cataract. (Op. cit. 204.)]

The following table of forty-four cases is given in Mr. Saunders's work, for the purpose of showing in what proportion each species of cataract has been found to prevail in congenital cases: —

Solid opaque lens, with or without opacity of the capsule. Three single, two double cataracts	5
Solid lens, opaque in the centre, transparent in the circumference, with capsule in the same state. Five double - - - - -	5
Soft opaque lens, with or without opacity of the capsule. Two single, two double - - -	4
Soft opaque lens, with solid nucleus. One single, two double - - - - -	3
Soft opaque lens, with dotted capsule, the spots white, the spaces transparent. Two double -	2
Fluid cataract, with opacity of the capsule. Two single - - - - - - -	2
Fluid cataract, with opacity of the capsule, and closed pupil. Two double - - - -	2
Opaque and thickened capsule, the lens being completely absorbed, or the remains of it being thin and squamose. Six single, twelve double - - - - - - -	18
Opaque and thickened capsule, with only a very small nucleus of the lens unabsorbed in the centre. Two single - - - - -	2
Opaque and thickened capsule in the centre, remains of the lens in the circumference. One double - - - - - -	1

Here the corresponding character of congenital cataracts in the eyes of each individual is exhibited by the number of double cases, and we are informed that the same character was preserved in the cataracts of several children of the same family. (*Saunders, On Diseases of the Eye, edit. by Dr. Farre*, pp. 135, 136.)

Mr. Lawrence observes, that congenital cataract "is sometimes lenticular, but more frequently capsulo-lenticular. The lens is generally opaque throughout; generally of its natural consistence, which is gelatinous, sometimes softer, or even fluid, but *never hard*. After losing its transparency, the crystalline lens frequently undergoes absorption: hence, we often find it lessened, reduced to a small fragment, or as thin as a wafer." (*On Dis. of the Eye*, p. 443.) With reference to the statement, that a congenital cataract is *never hard*, I may mention that Mr. Alexander, this autumn (1836), in the presence of Mr. Bainbridge of Tooting and myself, extracted from the eye of a young woman, aged eighteen, who had congenital cataracts, a lens, which was as hard as that of the eye of a boiled mackerel. Another gentleman of great experience in this subject believes, that, when lenticular cataract occurs in very early life, it is *always soft*, unless the lens be the seat of cretaceous, or osseous deposition. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 94.)

Congenital cataract appears frequently to afflict several children of the same parents. In the course of the present article, I have already had occasion to advert to two striking examples of this fact. The first is related by Mr. Lucas, who attended five children of a clergyman at Leaven, near Beverley, all born with cataracts. (See *Med. Obs. and Inquiries*, vol. vi.) The second is mentioned by Mr. Gibson, who saw five or six children, the families of two sisters, who were all totally blind, and in an idiotic state, having cataracts accompanied with amaurosis. (*Edin. Med. and Surgical Journal*, vol. viii. p. 398.) Several instances occurred to the late Mr. Saunders. In one family, two brothers were thus afflicted. In a second family, two brothers, twins, became blind with cataracts at the age of twenty-one months, each within a few days of the other. It is remarkable, that the four cataracts had precisely the same character. In a third family, a brother and two sisters were born with this disease. The eldest sister was affected with it only in one eye, the brother and youngest sister in both eyes. In a fourth family, three brothers and a sister had all congenital cataracts. (*Saunders, On Diseases of the Eye*, pp. 134, 135.) One very remarkable example is recorded by Dupuytren (see *Clin. Chir.* t. i. p. 39.), where a lady, her daughter, and three grand-children, were all afflicted with cataract.

Children with congenital cataracts possess various degrees of vision; but, when they are totally blind, their eyes not being attracted by external objects, volition is not exercised over the muscles of these organs, which roll about with an irregular, rapid, and trembling motion.

I shall now proceed to speak of the manner of operating upon children. Until the time of Pott, the intention of surgeons, in couching, or depressing the cataract (as indeed the expression itself implies,) was to push the opaque crystalline downward, away from the pupil. Pott, conscious that the cataract often existed in a fluid or soft state, was aware that it could not then be depressed; and, therefore, in such cases, he recommended using the couching-needle for the express purpose of breaking down the cataract, and of making a large aperture in the capsule, so that the aqueous humour, which he believed to be a solvent for the opaque crystalline, might come into immediate contact with this body. This operation, subsequently to Pott, has been strongly and ably recommended by Hey, of Leeds, and Professor Scarpa, of Pavia. In the cases of children, it even received the approbation of Ware. (*On the Operation of Puncturing the Capsule of the Crystalline Humour*, p. 9.)

But, notwithstanding the utility and efficacy of lacerating the front layer of the crystalline capsule had been so much insisted upon by Scarpa and others, their observations were confined to the cataract in the adult subject, and, before the example set by Saunders, no one (excepting, perhaps, Gibson of Manchester) ventured to apply, as a regular and successful practice, such an operation to the eyes of infants and children.

The principle on which Saunders proceeded in his operations on the congenital cataract, was founded on the opinion, that the only obstacle to the absorption of the opaque lens is the capsule; and that, as the latter also is most generally opaque, "the business of art is to effect a permanent aperture in the centre of this membrane. This applies to every case of congenital cataract which can occur." Saunders used to overcome the difficulty of operating upon children, by fixing the eyeball with Pellier's elevator, having the patient held by four or five assistants, dilating the pupil with belladonna, and employing a very slender needle, armed with a cutting edge from its shoulder to its point, and furnished with a sharp point, calculated to penetrate with the utmost facility.

Before the operation, the extract of belladonna, diluted with water to the consistence of cream, is to be dropped into the eye, or, to avoid irritation, the extract itself may be smeared in considerable quantity over the eyelid and brow. In less than an hour, if there be no adhesions, it produces a full dilatation of the pupil, exposing to view nearly the whole anterior surface of the cataract. The application should then be washed from the appendages of the eye.

In using the needle, Saunders most carefully abstained from doing any injury to the vitreous humour, or its capsule, and it was an essential point with him to avoid displacing the lens. In directing the extremity of the instrument to the centre of the capsule, he passed it either through the cornea, near the edge of this membrane (the operation now called *keratonyxis*), or through the sclerotica, a little way behind the iris. By the first, which is called the *anterior* operation, Mr. Saunders conceived that less injury would be inflicted, and less irritation excited, than by introducing the needle behind the iris, through all the tunics of the eye. In every case, the first thing aimed at was the permanent destruction of the central portion of the capsule to an extent equal to that of the natural size of the pupil. If the capsule contained an opaque lens, Saunders used next to sink the needle gently into the body of the crystalline, and moderately open its texture, cautiously observing not to move the lens at all out of its natural situation.

When the case was a fluid cataract, Saunders was content in the first operation with simply lacerating the centre of the capsule, being desirous of avoiding to increase the irritation following the diffusion of the matter of the cataract in the aqueous humour.

When the cataract was entirely capsular, Saunders acted with rather more freedom, as he entertained in this case less fear of inflammation: but, in other respects, he proceeded with the same objects in view, which have been already related, and of which the principal consisted in effecting a permanent aperture in the centre of the capsule, without detaching this membrane at its circumference; for then the pupil would have been more or less covered by it, and the operation imperfect, "because this thickened capsule is never absorbed, and the pendulous flap is incapable of presenting a sufficient resistance to the needle to admit of being removed by a second operation." (P. 145.)

Mr. Saunders found, that the greatest success attended the operation between the ages of eighteen months and four years.

The only particularity in Saunders's treatment of the eye after the operation, was that of applying the belladonna externally, for the purpose of making the pupil remain dilated, till the inflammation had ceased, so as to keep the edge of the iris from contracting adhesions with the margin of the torn capsule. This last practice is found to be so important, that it is never neglected by any good operator of the present day. In leaving this part of the subject, I must advise every surgeon to read the interesting account of Saunders's practice, published by his friend and colleague, Dr. Farre.

[The necessity for assistants, or any measures to overcome the resistance of the children, is now entirely obviated by the introduction of chloroform: there are no patients who bear anæsthetics better than children, and none in whom their aid is more valuable. Under the influence of chloroform the operation for congenital cataract can be performed with the utmost facility, and frequently without even reddening the eye.

The anterior operation is that preferred at the present day, and is performed much after the manner recommended by Mr. Saunders. More stress, however, is laid on the advantage of doing but little at a time. For though the cure may be somewhat more tedious, the risk of inflammation is far less than when the lens is extensively cut up and disturbed. Generally speaking, three operations suffice for the removal of congenital cataract: less may be required — more are seldom needed; and if the pupil be well dilated, and the operations performed with judgment, the proceeding may almost certainly be expected to succeed. I may, however, remark, that the danger of inflammation holds a direct ratio to the age of the patient. I have never known it to arise in infants, seldom under puberty; but after that age the patient should be carefully prepared by diet, regimen, and, if necessary, by medicine; not but that a patient may be over-prepared, and brought into such a state of irritability, as to bring about the very event intended to be obviated. In like manner, he may be over-treated after the operation; and I am decidedly of opinion that success is to be obtained after all operations on the eye, just in proportion to the judgment and tact with which the patient is treated. (*Med. Times and Gazette*, July 17, 1852.)]

Great manual skill, and invariable gentleness, indeed, seem to me to have had more share in rendering Mr. Saunders's operation successful, than any particularity either in his method or his instrument. I have no hesitation in declaring my own partiality to the principles on which his practice was founded, and my belief, that they are well calculated to improve most materially this interesting branch of surgery. In conclusion, I shall mention Mr. Guthrie's general opinion respecting the kinds of operation suited for the three classes of cataracts, into which he arranges them for the consideration of this important point: the *hard* admit only of extraction, or displacement; the *soft*, seldom of displacement, or of extraction, but usually of division; the *capsular*, neither of displacement, extraction, nor division, purely considered as such, but by laceration, and removal of the opaque body from the axis of vision by different operations, which although they may partake of the nature of all, are yet not precisely either. All intermediate states of disease, such, for instance, as the caseous and fluid cataracts, admit of some slight deviations from these rules, but are still regulated by the same principles. (*Operative Surgery of the Eye*, p. 365.)

With respect to extraction, also, it deserves careful recollection, that it is a method, which, though the cataract may be of a hard consistency, is often prohibited by various unfavourable circumstances, which I have taken notice of in the foregoing pages. When cataract takes place in an extremely old, or in a very feeble individual, reclination, or depression, is preferred by Mr. Middlemore to extraction, unless there be reason to believe that the lens is unusually large. The ground for this preference is the tendency of the cornea to slough in such persons, and the hazard of there being an insufficient degree of reparative power to effect the union of the divided cornea. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 111.) Yet, I have known incisions in the cornea heal as favourably in extremely old persons, as in young. The case of the late Sir William Blizard, who had a cataract extracted by Mr. Lawrence at the age of ninety, was a memorable example of it.

When the crystalline lens is extracted, depressed, or destroyed, vision can never be restored to its original power. Some near-sighted persons, in whom the power of refraction is too great, regain ordinary vision; but far-sighted individuals see worse than they did previously to the formation of the cataract. These will require convex glasses, which, however, they should not begin to employ till long after the operation, lest the intensity of the impression produced by them should bring on inflammation of the eye, and deprive the patient of the benefit already derived from the operation. (See *Dupuytren*, *Clin. Chir.* t. i. p. 77.) Some weeks, says another experienced surgeon, should elapse, before the patient begins to use his glasses, and he will act prudently in employing spectacles at all times sparingly. (See *Lawrence, On Dis. of the Eye*, p. 427.) *W. White Cooper.*

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CATHETER (from καθίημι, to thrust into). A tube which is introduced through the urethra into the bladder, for the purpose of drawing off the urine when it has accumulated in this organ, and cannot be discharged in the natural way (see URINE, RETENTION OF); or sometimes for promoting its quick evacuation as soon as it has descended from the kidneys, as where the bladder or urethra has given way, or been wounded, and it is a matter of urgent importance to prevent any further effusion of urine. Here the patient's chance of preservation will depend partly upon free incisions for the discharge of the urine already effused, and partly upon the prompt use of the catheter, to hinder fresh quantities of this fluid from getting into the cellular tissue, or even sometimes into the cavity of the peritoneum, as in a wound or rupture of the bladder. (See BLADDER, GUNSHOT WOUNDS, and WOUNDS.) Catheters are also very important means in the treatment of strictures of the urethra, and fistulæ in perinæo. (See FISTULA IN PERINÆO; URETHRA, STRICTURES OF; and URINARY ABSCESSES.) Occasionally, they are employed for the injection of fluid into the bladder, as where coagula are lodged in this viscus, or where it is advantageous to have it in a distended state during the performance of an operation, as that of *Litholrity.* (See this word.) Of course, there are two kinds of catheters; one intended for the male; the other, for the female urethra. With respect to catheters, three things are to be considered: — 1st, the instrument itself; 2nd, the manner of introducing it; and 3rd, the conduct to be pursued after its introduction.

[Catheters are either inelastic, and made of metal, rendering them firm, and resisting; or elastic and flexible, made of elastic gum, and usually called gum catheters.] Metal catheters were anciently composed of copper; Celsus knew of no other kind. As these, however, had the inconvenience of becoming incrusted with verdigris, they at length fell into disuse, and others, made of silver, were substituted for them. This change, which was made as early as the time of the Arabian practitioners, still receives the approbation of the best modern surgeons. A common silver catheter is a tube, of such a diameter as will allow it to be introduced with ease into the urethra, and of various figures and lengths, according as it is intended for the young or adult, the male or female, subject. For an adult female it should be about six inches long; and, for young girls, four or five. For men, the length ought to be from ten inches and a half to eleven inches. But, as the instrument need not enter far into the bladder, Mr. John Bell's advice to avoid too great a length merits observance. (*Principles of Surgery,* vol. ii. p. 193.) In cases of diseased prostate gland, the catheter should be much longer than in others. (See PROSTATE GLAND.) As the urethra in some instances is narrow, and in others wide, surgeons should be furnished with catheters of different diameters. The choice of the instrument, with respect to its width, is likewise determined very much by the nature of the disease of the urethra. (*Langenbeck, Bibl.* b. i. p. 1177.) For a woman, the diameter ought to be at least two lines; and for girls, a line and a half. For male adult subjects, Desault recommends the thickness of two lines and one-third; and for boys, that of a line and a half. In general, whenever the urethra is pervious, it is better to follow the advice of Desault, and employ a largish catheter, which will enter the passage more easily, and not be entangled in the folds of the membranous lining of the canal, while it will afford a more ready outlet for the urine. On the other hand, a small catheter should be preferred, when there are obstructions in the passage. Catheters also differ in shape: those which Desault used for male subjects had only a slight curvature of one-third of their length; a curvature which began insensibly from their straight part, and was continued to the very end of their beaks. The curvature was also regular, so as to form the segment of a circle of six French inches in diameter. Amussat recommends the use of straight catheters, which are passed as far as the pubes, while the penis is drawn upwards, which is then brought down between the thighs so as to lessen the bend of the urethra. One advantage imputed to a straight catheter is, that it may be rotated between the surgeon's fingers, whereby the chance of its surmounting every obstacle will be increased. (*Archives Gén. de Méd.* t. iv. Also *P. Ecot, Diss. du Catharisme exercée avec la Sonde droite,* Strasb., 1825, 4to.) As the course of the healthy urethra in the male subject is regular, the caprice evinced by surgeons in the different curvatures of their catheters cannot be founded on any correct anatomical principles, and the bend of the instrument (at least for subjects of the same age and stature) should generally not vary at all, but be strictly adapted, as Langenbeck remarks, to the natural track of the urethra. (*Bibl.* i. p. 1177.) The female catheter, however, has only a slight curvature towards its beak; a shape adapted to the direction of the meatus urinarius. Desault improved silver catheters, by causing them to be made with elliptical openings, or eyes, at the sides of the beak, with rounded edges, instead of the longitudinal slits previously in use, in which the lining of the urethra was frequently entangled, pinched, and lacerated, so that acute pain and profuse hæmorrhage were the consequences. With the view of preventing these evils, he also filled up the openings with lard. (See *Œuvres Chir. de Desault,* t. iii. p. 118.) On each side of the external end of the catheter is a small ring, by means of which, and some tape, it can be fixed.

[Mr. Briggs, my late colleague at the Lock Hospital, devoted much time and care in ascertaining the natural curve of the urethra in the adult male. He relied principally on casts of the urethra made by injecting melted wax into the urethra and bladder of the dead subject. His investigations led him to the conclusion that the curve of the adult urethra corresponded to a segment of a circle of 3¼ to 3⅛ inches in diameter. "In a plaster cast," he says, "taken from a lateral vertical section of the pelvis of an adult after the urethra had been injected with wax, the curve was found to commence at 1¼ inch anterior to the bulb, and from this point to its termination in the bladder to form an arc of a circle of 3¼ inches in diameter, the chord of the arc being 2¾ inches, or rather less than one third of the circumference. In another cast the chord of the segment was found to measure $2\frac{8}{10}$ inches of a circle of 3⅛ inches in diameter." Mr. Henry Thompson, in his lately published work on the pathology and treatment of stricture, adopts Mr. Briggs's conclusion, and recommends that the curve given to metallic catheters should form about $\frac{3}{10}$ths of a circle of 3¼ inches in diameter. He observes, the curves of the catheters usually found at the instrument makers' describe arcs of circles varying from 4 to 4½ inches in diameter, and that the arcs comprise rather less than ¼th of the circumference. Mr. Briggs also points out the advantage of having the catheter graduated, so that the surgeon may read off in inches or in fractions of inches the extent to which the instrument has passed into the urethra during its introduction, by which means more precise knowledge may be obtained of the normal length of the whole or of separate parts of the canal, and the position of any obstruction in it more exactly defined. Mr. Briggs estimates the average length of the adult male urethra, as thus measured by the graduated catheter, to be about 7½ or 7¾ inches, of which 5½ inches belong to the spongy portion, and the remainder to the membranous and prostatic. He found the same relative measurements to hold good when taken from post mortem casts of the urethra. In a plaster cast of a vertical section of the male pelvis, where the entire urethra measured 8¼ inches, he found that 6½ inches belonged to the spongy, and the remaining 1¾ inches to the membranous and prostatic portions. (*Briggs, On Stricture of the Urethra*, pp. 12, 17, 20.) In the length and form of the curve of the catheter just advocated it will be as well to observe that the point of the instrument will form a right angle to the stem or straight part. The operator, therefore, while introducing it is enabled to judge exactly of the direction of the point when concealed in the passage by observing the inclination of the stem or straight part, which is always more or less in view. It is obvious that if the length of the arc of the curve be either increased or diminished, the point will form either a greater or less than a right angle with the stem. The surgeon should on all occasions note carefully the degree of the curve as well as its length in the instrument he may be about to use, otherwise he may be deceived as to the exact position of the point during its introduction.]

Besides silver catheters, surgeons now frequently employ flexible ones made of elastic gum. These last, indeed, are of so much importance, that they may be said to constitute one of the greatest improvements in surgery. I shall not here inquire, whether they were first invented by Theden, Pickel of Wurzburg, or Bernard of Paris; this is a point which the Germans and French must settle themselves. Imperfect attempts had been made by others at earlier periods to invent catheters possessing the property of flexibility. Van Helmont proposed the use of catheters made of horn; but this substance was found to be too stiff, and to be very quickly coated with depositions from the urine. Fabricius ab Aquapendente employed leather catheters, which were objectionable, inasmuch as they were soon softened by the urine and mucus of the urethra, when they shrivelled and became impervious. Other flexible catheters were also formerly tried, composed of spiral springs of silver wire, covered with the skins of particular animals. These last, however, were quickly spoiled by putrefaction; and when left in the urethra any considerable time, the beak sometimes entirely separated from the rest of the instrument and was left behind in the bladder.

The gum catheters, now in use, are liable to none of the preceding inconveniences; they are formed of silk tubes, woven for the purpose, and covered with a coat of elastic gum (see BOUGIE); they are sufficiently flexible to accommodate themselves to the different curvatures of the urethra; they are not softened by the urine; and they constantly remain with their cavity unobliterated. Their smooth and polished surface makes them continue a long while free from incrustations deposited from the urine. Sometimes they are introduced with a stilet, or wire, which is passed into their canal, in order to give them a certain curvature, and a greater degree of firmness: but, in general, it is withdrawn as soon as the tube is in the bladder.

Elastic catheters are less irritating to the urethra, and less apt to become covered with calculous incrustations, than silver tubes; they can also be frequently introduced, when a metallic one will not pass.

The selection of good bougies and catheters, especially for the male subject, is a business of the first importance; for, by employing such as are disposed to break, "many a practitioner has doomed his patient to years of dreadful, and, perhaps, hopeless suffering, and brought down irreparable disgrace upon his own head." (*Med. Chir. Journ.* vol. v. p. 75.) M. Nicod, in performing the operation of lithotomy upon a male, found the stone, which was very brittle, one inch and a half long, and eight or nine lines thick, traversed, in the direction of its greater diameter by a piece of elastic gum catheter, which had acted as a nucleus for the deposition of calcareous matter. (See *Obs. sur le Danger d'employer des mauvaises Sondes de Gomme élastique; Journ. de Médicine, par Leroux*, Oct. 1816.) A short time ago M. Roux was obliged to cut into the bladder to extract an elastic gum catheter, which in consequence of not having been properly secured, had slipped into that viscus. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 921.)

Formerly, the best elastic catheters used to be fabricated at Paris; but such as are now made in London are in some respects better than French, being generally more regular. Gum catheters are of twelve different sizes, which correspond to twelve holes in a plate of brass. "Each catheter, therefore (says Mr. Crosse), has its size designated by its number, which greatly facilitates the ascertaining of the progress of the case towards a cure. Numbers 1 and 2 are so small and slender that I thought there might be danger of their breaking, until I was convinced, by seeing the method of making them, that there is no reason for fearing any such thing. A firm tissue of silk is woven upon a brass stilet, of the size of the cavity of the instrument to be made. In weaving this tissue, the orifice or eye is left, and the whole therefore consists of one entire thread. The successive layers of varnish are deposited on the outer surface of the silken tissue, their number depending on the size of the instrument; and each coating of varnish undergoes a long process of scouring before the next is put on, for which purpose women are employed by Feburier." (See *Sketches of the Medical Schools of Paris*, by *J. G. Crosse*, 1815, pp. 122, 123.)

According to this gentleman, however, English gum catheters possess advantages: — "They retain their curve better without the stilet, are less liable to crack, and have eyes more smooth and better formed." (P. 124.)

When the object of passing a catheter is merely to empty the bladder, without any design of leaving the instrument afterwards in the urethra, Langenbeck prefers one made of silver. (*Bibl. für die Chir.* b. i. p. 1176, Also *Velpeau, Méd. Opér.* t. iii. p. 912.)

In retention of urine from stricture, a surgeon will often succeed in introducing into the bladder a silver catheter, or an elastic gum catheter, mounted on a firm iron stilet. The catheter recommended on such an occasion by Sir Benjamin Brodie, if the stricture be of *recent formation*, is nearly of the full size of the urethra; but, if the stricture has been of *long duration*, the instrument should be considerably smaller. He also prefers one, which is shorter, and less curved, than an ordinary silver catheter; and which is fixed in a wooden handle, whereby it is rendered more manageable. (*On Dis. of Urinary Organs*, p. 34, ed. 2.) If an elastic gum catheter is used, he says, that the iron stilet should have a flat handle, like that of a common sound. (See URINE, RETENTION of.) In retention of urine from chronic enlargement of the prostate gland, Sir B. Brodie rarely uses anything but a gum catheter, which has one advantage, viz. that it may be retained in the urethra and bladder with very little inconvenience to the patient, which is not the case with a silver catheter. (*Brodie*, op. cit. p. 143.)

Sometimes spasm about the perineum renders the introduction of a catheter difficult. In this case, a warm bath should be had recourse to, and a dose of opium administered before a second attempt is made. When inflammation prevails in the passage, the introduction may often be facilitated by a previous application of leeches to the perineum.

The operation of introducing the catheter may be performed, either when the patient is standing up, sitting, or lying down, which last posture is the most favourable. In order to pass a catheter with ease and dexterity, the following circumstances must be observed: — The instrument must be of suitable shape and size; a just idea of the perineum and curvature of the urethra must be entertained; the catheter must be introduced with the greatest care and delicacy; and the relaxation of the abdominal muscles has been insisted upon, (*Langenbeck, Bibl.* i. p. 1177), though I confess, that it does not appear to me how this circumstance is of importance.

A catheter should always be used with a light hand, and held, as it were, loosely in the fingers. "It will then in great measure find its own way in that direction in which there is the least resistance. If you grasp it firmly, it can only go where you direct it, and it is likely to puncture and lacerate the membrane of the urethra, and the substance of the prostate, and to make a false passage." (See *Brodie, On Dis. of the Urin. Organs*, p. 145, ed. 2.) Force, says another distinguished surgeon, is never necessary. The instrument should be allowed to find its way, as much by the influence of its own weight, as by that of any extraneous power. If it meets with resistance, it is to be withdrawn a little way, and then tried in another direction. (See *Velpeau, Nouv. Elém.* &c. t. iii. p. 915.)

There are three methods of introducing a male catheter, viz. with the concavity, in the first stage of the operation, directed either towards the abdomen, towards the left groin, or towards the surgeon himself. Of course, the latter plan requires the instrument, which is introduced with the curve downwards, to be turned so as to place its concavity upwards, as soon as the beak has arrived in the perineum; and hence the French surgeons call this method the "tour de maître."

The operation may be divided into three stages. In the first, the catheter passes, in the male subject, that portion of the urethra which is surrounded by the corpus spongiosum; in the second, it passes the membranous part of the canal, situated between the bulb and the prostate gland; and in the third, it enters the gland, and the neck of the bladder.

In the first stage, little trouble is usually experienced; for the canal is here so supported by the surrounding corpus spongiosum, that it cannot easily be pushed into the form of a pouch, in which the end of the instrument can be entangled.

When the catheter is to be introduced with its concavity towards the abdomen, and the patient is in the recumbent posture, the thighs are to be separated, and the legs moderately bent. The surgeon is to draw back the prepuce, and to hold the penis between the thumb and forefinger of his left hand, which are to be applied on each side of the corona glandis, and not at all to the under surface of the penis, so as to avoid pressing upon the commencement of the urethra. [Many of the continental surgeons recommend that the penis should be held between the middle and ring fingers, the palm of the left hand being directed upwards, so that the thumb and the forefinger may be at liberty to hold the prepuce out of the way.] After the catheter has been well oiled, its handle is to be held between the thumb and forefinger of the right hand, the back of the little finger resting upon the patient's abdomen, in the vicinity of the navel. Now, while the handle is parallel to the axis of the body the beak is to be introduced into the urethra; the penis being extended, and drawn, as it were, over the instrument, while the latter is gently pushed on, until its beak has reached the arch of the pubes. When the penis cannot be drawn further over the catheter, the beak has arrived in this situation, where it stops in front of the pubic arch, and is pressing against the posterior side of the urethra. At this particular moment, the handle is to be depressed towards the patient's thighs, and the manœuvre well managed generally directs the end of the catheter at once through the membranous and prostatic portions of the urethra into the cavity of the bladder. In short, as soon as the beak of the instrument has passed under the arch of the pubes, and the surgeon very slowly brings the handle forwards, and downwards, the beak is elevated, and glides into the bladder. In this stage of the operation, the penis must be allowed to sink down, and not be kept tense, as this would only render the passage of the instrument more difficult.

The operation, however, is not always successfully accomplished. The beak of the catheter may be stopped by the margin of the urethral opening in the deep perineal fascia; or it may take a wrong direction, so as to push the membranous part of the urethra to one side or the other.

The first kind of impediment is best avoided by not depressing the handle of the catheter too soon; that is, before the point has passed beyond the arch of the pubes. When the membranous part of the urethra is pushed to one side or the other, the instrument ought to be withdrawn a little, and then gently directed in a different course; but, if this expedient is unavailing, the index finger of the left hand may be introduced into the rectum, for the purpose of guiding the extremity of the catheter. [With the finger in the rectum the surgeon can distinctly feel the curve and beak of the instrument as it passes the membranous portion of the urethra; he can also distinguish the prostate gland, through which the instrument is to be directed into the bladder. The thickness of the structures intervening between the finger and the instrument, while traversing the membranous and prostatic portions of the canal, as well as the direction the beak should take, are best studied by the frequent use of the instrument in the dead body while the finger is in the rectum.] The passage of the catheter through the opening in the deep perineal fascia, and especially the attempt to hit the entrance of the prostate gland, are the most difficult things in the operation. It is by using too much force, and directing the end of the catheter in a wrong manner, that unskilful surgeons sometimes rupture the membranous portion of the urethra.

When the prostate gland is enlarged, the urethra becomes lengthened; and, as it approaches the bladder, it makes a more sudden turn upwards than is natural. The catheter, therefore, should be longer, and more bent in that direction, than in other cases.

In the third stage of the operation, the beak of the instrument has to pass the prostate gland and neck of the bladder. The principal obstacles to its passage, in this situation, arise from spasm of the neck of the bladder and muscles in the perineum, and from the instrument being pushed against the prostate gland, instead of into the continuation of the urethra through it. The first impediment may generally be obviated by waiting a few moments before attempting to push the catheter further into the passage. The hindrance caused by the prostate is best eluded by using an instrument, the end of which is more curved than usual.

When the catheter has turned round the pubes, and is just about to enter the neck of the bladder, is the critical moment, at which may be seen whether a surgeon can or cannot manage the operation with skill; for if he knows how to pass the instrument, he suddenly, but not violently, changes its direction. He depresses the handle with a particular kind of address, and raises the point, which, as if it had suddenly surmounted some obstacle, slips into the neck of the bladder, and the urine bursts out in a jet from the mouth of the catheter.

They who are unskilful press the tube forward, and persist, as they first began, in drawing up the penis, on the supposition that, by stretching this part, they lengthen the urethra, and make it straight, whereas they elongate only that part of the canal into which the catheter has already passed. (*John Bell's Principles of Surgery*, vol. ii. p. 213.)

Dr. Quain's view of some of the foregoing points, as deduced from anatomical facts, I consider interesting:—"If (says he) the integument, superficial fascia, and muscles, be removed from the penis and perineum, we can observe what takes place on the introduction of a catheter. No impediment occurs, during its passage through that part of the tube which corresponds with the corpus spongiosum: for, there it is supported by the body of the penis, and it is also quite straight. But, where it corresponds with the bulb, it is comparatively unsupported, and also slightly dilated at its lower surface. On arriving close to the perineal fascia, should the point of the catheter deviate to either side, or be elevated, or depressed too much, it will miss the foramen, carrying the urethra with it, and so the latter will be pinched between the margin of the foramen and the instrument. If, in such a position of the parts, force be used, or if the catheter be depressed, with a view to make it correspond with the curves of the urethra, the latter must be torn through, or considerably injured. A catheter, in its construction, resembles an angular lever, though not intended to act as such; but it virtually becomes such, if, after its progress is impeded, and it is thereby rendered fixed, an effort be made to depress the handle; for, then the beak is made to move in the opposite direction, and will readily tear through the urethra. The effect of drawing the penis upwards may be exemplified in this way: when the catheter has reached the bulb (the urethra and perineal fascia being fully exposed), if it deviates to either side, the point will be observed to catch on the margin of the foramen ; but, if the urethra is drawn upwards, the impediment will be removed by the widening of the aperture." (See *Quain's Anatomy*, p. 454, ed. 3.) With respect to the opinion, that the direction of the urethra becomes horizontal and its canal straight, when the penis is drawn directly forwards, Dr. Quain states, that, when the penis is so placed, the urethra has to descend nearly an inch, to reach the urethral aperture in the deep perineal fascia, after which it turns somewhat upwards. "Moreover, the part of the urethra, between the root of the penis and the neck of the bladder, will be found loose and relaxed, no matter with what degree of force the penis be drawn forwards ; for that will affect only the part of the urethra which corresponds with the body of the organ, as must be evident, when the attachments of the latter to the bones by its suspensory ligament and crura are considered." (*Quain*, op. cit. p. 455.)

Whether the urethra can be made to accommodate itself to a straight instrument, is another question. The urethra is naturally not straight, nor nearly so. If it had been straight, it would have extended in the direction of the bulb in a line, that would pass above the anus to the point of the os coccygis. "Instead of this (asks M. Velpeau) what happens ? The urethra gradually disengages itself from the corpus spongiosum and the whole of the bulb, to pass through the deep perineal fascia, enter the pelvis, and terminate at least two inches above the level of the anus, and consequently higher up than the line above specified." (See *Nouv. Elém. de Méd. Opér.* t. iii. p 911.) When, however, the symphysis is short, the prostate not much thickened, the urethra passing through it nearer to its lower than its upper surface, and the pelvis is wide, M. Velpeau alleges, that, extending the penis will efface a good deal of this curve, and allow straight instruments (which on their part also press downwards, with more or less force, the bottom of the prostatic portion of the urethra, and the neck of the bladder) to be conveyed without much difficulty into the latter organ. The latter fact we see exemplified every day : the question whether the curve can be effaced by drawing the penis forwards, is easily settled by an examination instituted in the way proposed by Dr. Quain. For additional observations on the surgical anatomy of the urethra, see URETHRA.

When the catheter is to be introduced with its concavity downwards, or by the "tour de maître," the beak is to be passed into the urethra, and the penis drawn over it, as it were, as in the foregoing method. In other words, the instrument, well oiled, is to be introduced, with its convexity uppermost, as far as it can be, without using force. As soon, however, as the end of the catheter has reached the point at which the canal begins to form a curve under the pubes, the surgeon is to make the instrument perform a semicircular movement, by inclining it first towards the left groin, and then towards the abdomen. In the execution of this manœuvre, care is to be taken to keep the beak of the catheter stationary, so that it may be the centre of the movement, and simply revolve upon itself. This part of the operation, the object of which is to turn the concavity of the catheter upwards, ought to be done very slowly, a large sweep being made with the handle, while particular care is taken not to retract, nor move the beak from its position. The handle is then to be depressed, and the operation finished exactly in the same manner as when the first plan is pursued. As Desault properly observes, the only circumstance in which the first two methods differ from the third, is, that in this the same thing is performed by two movements, which is done in the others by one ; so that the operation is rendered more complex. No doubt there is great difficulty in keeping the point of the catheter entirely stationary during the semi-circular movement of the handle. Indeed, it is alleged, that if, after laying bare the urethra and the deep perineal fascia in the dead subject, "a catheter be passed down with its concavity turned towards the perineum, we shall find, that, as the turn is being made, the point of the instrument will describe the arc of a circle, carrying the urethra with it round the margin of the urethral foramen," and an impediment will occur, unless the urethra is kept perfectly tense. (See *Quain's Anatomy*, p. 455, ed. 3.) Hence, many judicious surgeons never practice the "tour de maître," except when their patients are corpulent ; and, indeed, many of them not then, as they prefer the method, which is begun with the handle of the catheter inclined towards the patient's left groin. In treating retention of urine from diseased prostate gland, "I generally find," says an able surgeon, "that I introduce the catheter best by keeping the handle of it at first close to the left groin of the patient. I pass it, as far as possible, in this position ; then I bring the handle forwards, nearly at a right angle to the pubes, and not elevating it towards the patient's navel. The next thing is to depress the handle, which is to be done gently and slowly, by placing a single finger on it, and pressing it downwards towards the space between the thighs. In depressing the handle, you generally find the point of the catheter slide into the bladder. Sometimes, however, this does not happen, until (supposing an elastic catheter to be used) you withdraw the stilet ; and, in the act of doing this, the introduction of the catheter is completed." In many instances, the operation will be best accomplished by taking care, at the moment when the handle is depressed, to keep the concave surface closely pressed against the arch of the pubes, so that it may turn round it as a centre. (*Brodie*, *On Dis. of Urin. Organs*, p. 145, ed. 2.)

The depth to which the catheter has entered the urethra, the cessation of any feeling of resistance to the motions of the beak when revolved upon its axis, and the issue of the urine, are the circumstances by which the surgeon knows, that the instrument has passed into the bladder. In most persons, the signs denoting the entrance of the instrument into the bladder, are sufficiently clear. But, in certain instances several of them may be absent, and the diagnosis be so obscure as to embarrass the surgeon. Then, if thick mucus, or clots of blood, fill the eyes of the catheter, the urine will not flow. Again, when the bladder is empty, or contracted, the catheter may enter to so inconsiderable a depth, the elevation and depression, and the rotation of it to the right, or left, may be so limited, that doubts may exist about the situation of its beak. A large collection of blood in the anterior half of the bladder may cause deception, as no urine will escape till the catheter has passed completely through it. A catheter also has been known to penetrate deeply between the bladder and rectum, and admit of almost as extensive movements, as if it had entered the bladder. A mistake is still more likely to happen, when, in consequence of ulceration of the lower side of the urethra, an accidental pouch has been formed, in front of the rectum, and in the substance of the perineum, as M. Velpeau once noticed in a man who died in the hospital in 1825, and as M. Roux observed in several instances. In fact, such a pouch may be supposed to be a diseased bladder, and this the more readily, as the catheter, directly it passes into it, gives issue to a small quantity of urine. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 917.)

When the catheter is to be retained in the bladder, according to the experience of Desault, the practice of gradually letting out a part of the urine is by no means advantageous. He also disapproves of running into the opposite extreme, that is to say, of letting the urine flow out of the catheter as fast as it is secreted; for, then, the bladder is kept constantly relaxed, and the detrusor muscle will not be likely to recover its tone. When the bladder is continually empty, it is liable to come into contact with the end of the catheter; a circumstance which has sometimes caused considerable irritation, pain, and even ulceration of that viscus. Besides these inconveniences, there are some others; the catheter is sooner obstructed with mucus, and lined with incrustations, than when it is closed with the stilet. The patients are likewise obliged to remain in bed, where they are either wet with their urine, or compelled to have incessantly a vessel for its reception. The best practice, therefore, seems to be that of letting out all the urine, as soon as the catheter is introduced, and then closing the instrument until the bladder has become moderately distended again; for experience proves, that such moderate distension and relaxation of the muscular fibres of the bladder, alternately kept up, have the same good effects upon that organ, as moderate exercise has upon other parts of the body.

When a catheter is to be left in the urethra, it should always be properly fixed, or else it is apt to slip out, or even pass too far into the passage. For this purpose, some surgeons use cotton thread, or a piece of narrow tape, which they fasten to the rings, or round the external end of the catheter. The two extremities of the thread or tape are then carried some way along the dorsum of the penis, when they are tied together, and afterwards conveyed in opposite directions round the part, till they meet underneath it, where they are tied in a bow. When a silver catheter is employed, a tape, or narrow riband, is passed through each of the rings, and conveyed to each side of the pelvis, where it is fastened to a circular bandage. Mr. Hunter remarks, that the common bag-truss for the scrotum answers extremely well, when two or three rings are fixed on each side of it along the side of the scrotum, and the ring of the canula is fastened to any of them with a piece of tape. (*On the Venereal Disease*, ed. 2, p. 159.) He notices another method: "When the catheter (says he) is fairly in the bladder, the outer end is rather inclined downwards, nearly in a line with the body. To keep it in this position we may take the common strap, or belt part, of a bag-truss, with two thigh straps, either fixed to it, or hooked to it, and coming round each thigh forwards by the side of the scrotum, to be fastened to the belt, where the ends of the bag are usually fixed. A small ring or two may be fixed to each strap just where it passes the scrotum, or root of the penis; and with a piece of small tape, the ends of the catheter may be fixed to those rings, which will keep it in the bladder. It seems Mr. Hunter did not, like Desault, disapprove of leaving the catheter unclosed, and he adds, therefore, a bit of rag, about four or five inches long, with a hole at the end of it, passed over the exterior end of the catheter, and the loose end allowed to hang in a basin, placed between the thighs, will catch the water, which cannot disengage itself from the catheter, and keep the patient dry: or, if another pipe is introduced into the catheter, it will answer the same purpose." (Op. cit. p. 191.) The following, which is the French method of retaining the catheter in the bladder, is the most convenient with which I am acquainted: — "A metallic ring, the circumference of which should be more than sufficient to encircle the penis, is to be covered with cloth, and four long pieces of tape, with the same number of short ones, attached to it, [or the ring may be made of wood and perforated at four separate points, for the reception of the tapes.] This ring, enclosing the penis, is fixed against the pubes by the long pieces of tape, which, surrounding the pelvis in different directions, meet and are tied posteriorly. One of the short pieces is carried through the rings or round the groove of the catheter, on each side; and being tied to its fellow, fixes the instrument securely in the bladder." (See *Averill's Operative Surgery*, p. 105.) But there are numerous modes of fixing a catheter, which need not be specified; for although they are of importance, the principles which should be observed in adopting them are the main things to be understood. These are, first, never to fix a catheter in such a way, that too much of the instrument projects into the cavity of the bladder (*Lallemand, Perforation de la Vessie par les Sondes fixés; Revue Méd.* Nov. 1822, p. 299); and, secondly, to be careful, that the thread, or tape, which is applied, will not irritate or make too much pressure upon the parts.

Mr. Hey has offered some good practical remarks on the introduction of the catheter. If, says he, the point of the catheter be less turned up than the urethra, the point will be pushed against the posterior part of the passage, instead of following the course of the canal. The posterior part of the urethra has nothing contiguous to it which can support it; and a degree of force not very considerable may push the point of the catheter through that part between the bladder and the rectum. If this accident is avoided, still the point will be pushed against the prostate, and cannot enter the bladder. Mr. Hey tells us, that the truth of this is illustrated by the assistance which is derived, whenever the catheter stops at the prostate, from elevating the point of the instrument with a finger introduced in the rectum. He notices the impropriety of pushing forwards the point of the catheter, before its handle is sufficiently depressed, as the point would move in a horizontal direction, and be likely to rupture the posterior side of the urethra.

Throughout the writings of Sir Benjamin Brodie on this subject, I find the same caution repeatedly given, not to let the catheter press too much upon the inferior and posterior side of the urethra; and the same thing is insisted upon by the best practical surgeons in France: — "If the end of the catheter were directed too much against the lower side of the urethra," says M. Velpeau, "it would pass with difficulty, and be likely to hitch first in the fossa navicularis, then in the excavation at the bulb, and next in the prostatic depression, and make in one of these situations a false passage. By making the beak keep regularly along the upper side, such accidents will be avoided, unless it be raised too much," &c. He adds, that even this erroneous direction, if not excessive, will be attended with no real inconvenience, except between the crura penis, and the part of the urethra just in front of the symphysis of the pubes. (See *Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 915.) The skill appears to this surgeon, as it did long ago to Hey and Brodie, to consist in guiding the catheter, in the axis of the urethra, from the glans to the bladder, keeping it lightly resting against the dorsal side of the passage. (See also *Malgaigne, Man. de Méd. Opér.* p. 650.)

If the surgeon uses a flexible gum catheter, it is of great consequence to have the stilet made of some firm metallic substance, and of a proper thickness. If the stilet is too slender, the catheter will not preserve the same curvature during the operation; and it will be difficult to make the point pass upwards behind the symphysis pubis in a proper direction. If the stilet is too thick, it is withdrawn with difficulty.

When the stilet is of a proper thickness, this instrument has one advantage over the silver catheter, which is, that its curvature may be increased while it is in the urethra, which is often of great use, when the point approaches the prostate gland. In all cases where an elastic gum catheter is to be worn, care must be taken that it does not pass unnecessarily far into the bladder; and, if it be too long, a part of it ought to be cut off, or a shorter one employed.

When the proper manœuvres with a given silver catheter do not succeed, the surgeon must change it, taking a larger or a more slender one, with a greater or less curve, according to such observations as he may have made in his first attempt. But, if the catheter has been of a good form or commodious size, yet has not passed easily, he should, instead of choosing a rigid catheter of another size or form, take a flexible one for his second attempt. The flexible catheter is made of various sizes, and of sufficient length, and its shape may be accommodated to all occasions and to all forms of the urethra: for, having a stiff wire, we can give that wire, either before or after it has been passed into the catheter, whatever shape we please; and, what is of still greater importance, we can introduce the instrument without or with the wire, as circumstances may require; or what is more advantageous, we can introduce the wire so as not quite to reach the point of the catheter, but only to within two inches or a little more of this part, by which contrivance the point, if previously warmed, and wrought in the hand, has so much flexibility, that it follows the precise curve of the urethra, and yet has sufficient rigidity to surmount any slight resistance. If this too fail, and especially if there be the slightest reason to suspect that the resistance is not merely spasmodic, but arises from stricture near the neck of the bladder, in a young man, or swelling of the prostate in an old one, we may take a small bougie, turn up the extremity of it with the finger and thumb, so as to make it incline towards the pubes, and, allowing no time for the wax to be softened, pass it quickly down to the obstruction, turn it with a vertical or twisting motion, and make it enter the constricted part. On withdrawing it, in about ten minutes or a quarter of an hour, the urine generally escapes, or the catheter may now be introduced. (*John Bell's Principles of Surgery*, vol. ii. p. 215.)

Mr. Hey found, that, in withdrawing the stilet of an elastic gum catheter, the instrument becomes more curved; and he availed himself of this information, by withdrawing the stilet, as he introduced the catheter beyond the arch of the pubes, by which artifice the point was raised in the due direction. He says, you may sometimes, though not always, succeed in introducing an elastic gum catheter, by using one which has acquired a considerable degree of curvature and firmness, by having had a curved stilet kept in it a long while. Introduce this without the stilet, with its concavity towards the abdomen, taking care not to push on the point of the instrument, after it has reached the symphysis pubis, until its handle is depressed into a horizontal position.

Sir Benjamin Brodie, in speaking of retention of urine from diseased prostate gland, advises surgeons to provide themselves with a sufficient number of gum catheters, "mounted not on small flexible straight wires, but on strong iron stilets, having the curve of a silver catheter. The stilets, which belong to the larger gum catheters, should have flattened iron handles, resembling that of a common sound. Like Mr. Hey, he approves of keeping catheters, thus prepared, for a considerable time before they are wanted for use; they will then become fixed in the proper curvature. With the stilet, such a catheter is as inflexible as if it were made of silver; without it, it is capable of retaining its shape to a certain extent, yet it is flexible. Sir B. Brodie always first tries to pass such an instrument. In difficult cases, he admits that the gum catheter without the stilet will not succeed. He concurs with all experienced surgeons, that, in chronic enlargement of the prostate gland, a catheter, large enough to fill the urethra, without stretching it, is more easy of introduction than a small one; and that the stilet ought to be considerably curved. (*On Dis. of the Urinary Organs*, p. 144, ed. 2.) Speaking of catheters, another excellent modern practitioner remarks, "Elles pénétrent d'autant mieux, toute proportion gardée, que leur volume est plus considérable." (*Velpeau, Nouv. Elém. de Méd. Opér.* t. iii. p. 912.)

When it is necessary to draw off the urine frequently, and the surgeon cannot attend often enough for this purpose, a catheter must be left in the urethra, till an attendant, or the patient himself, has learnt the mode of introducing the instrument.

In cases of retention of urine, where the bladder has been over distended, it is an unsettled point, whether it is best to leave the catheter in the urethra, until the power of expelling the urine has been regained, or to draw off the urine twice a day, and withdraw the catheter after each operation. Mr. Hey thinks, that no general rule can be laid down; some patients cannot bear the catheter to remain introduced; others seem to suffer no inconvenience from it. On the whole, however, he commonly prefers removing the catheter. In this manner, he is of opinion, that the power of expelling the urine again is soonest acquired.

The preceding question is often determined by the nature of the disease; and, as Mr. Hunter observes, in cases of debility of the bladder, and where a catheter passes with difficulty, or with great uncertainty, as well as in other instances in which it must be used frequently, and for a length of time, it will be necessary to keep it introduced, so as to allow the water to pass freely through it. (*On the Ven. Dis.* edit. 2, p. 191.)

In the majority of retentions of urine from diseased prostate gland, Sir Benjamin Brodie deems it prudent to allow the catheter to remain. "If you remove it, so abundant is the flow of urine, which immediately takes place from the kidneys, that you will find the bladder loaded, and requiring the reintroduction of the catheter, within five or six, perhaps even within three or four hours. It will be necessary to use the catheter again, after another short interval; and it will often happen, when there has been no difficulty in the first introduction of it, that there is considerable difficulty afterwards." (*Brodie, On Dis. of the Urin. Organs*, p. 148, ed. 2.)

In France, a conical silver catheter (*sonde conique*) has sometimes been employed in difficult cases by Boyer, Roux, &c. This instrument has a very slight curvature, and an extremity almost pointed. By force, regularly applied, it is introduced into the bladder in spite of all opposition. Care is taken to keep it in the centre of the passage, and the direction of its point is judged of by the position of the lateral rings. The rule mentioned by Roux, for commencing the great depression of the outer extremity of the instrument, is when, by the finger in the rectum, the point can be felt to have reached the apex of the prostate. (See *Sketches of the Medical Schools of Paris, by J. G. Crosse*, p. 112.) In bad cases, the conical catheter is usually allowed to remain introduced three or four days: and on being withdrawn, a small gum catheter generally admits of being used.

The forcible manner in which the conical silver catheter has been employed, must have often caused great and dangerous mischief. Thus, in two examples, which were witnessed and examined by M. Roux himself after the decease of the patients, a false passage had been made, no gum catheter could be passed, the urine was effused in the cellular membrane, and the parts were gangrenous. (See p. 116 of the above work.) I have heard of instances, in which John Hunter employed great force with the silver catheter, and overcame the obstruction. I have seen Mr. Pearson (who generally treated strictures as mildly, and, I need hardly say, as successfully, as any man) take a steel sound, and pass it gradually and forcibly on into the bladder, at the same time feeling his way, as it were, by keeping one finger in the rectum: the relief of the patient, and the ultimate cure of the disease, were the results of this practice." (P. 118.) The conical silver catheter has been used by Sir A. Cooper. Without altogether condemning the occasional employment of this instrument, I perfectly coincide with Mr. Crosse, that it is one, with which young men, of little caution and no experience, may do more harm in the first few cases they meet with, than the rest of their life will afford them opportunities of doing good.

Mr. Hunter refers to instances, in which the common catheter had been pushed through the projecting part of the prostate gland into the bladder, and the water then drawn off; but, "in one patient, the blood from the wound passed into the bladder, and increased the quantity of its contents. The use of the catheter was attempted a second time; but, not succeeding, I was sent for. I passed the catheter till it came to the stop, and then, suspecting that this part of the prostate projected forwards, I introduced my finger into the anus, and found that gland very much enlarged. By depressing the handle of the catheter, which of course raised the point, it passed over the projection; but unfortunately the blood had coagulated in the bladder, which filled up the holes in the catheter, so that I was obliged to withdraw it, and clear it repeatedly. This I practised several days; but, suspecting that the coagulum must in the end kill, I proposed cutting him (the patient) for the stone; but he died before it could be conveniently done, and the dissection, after death, explained the case," &c. (*On the Ven. Dis.* ed. 2, p. 172.)

To a surgeon duly acquainted with anatomy, the introduction of the female catheter is exceedingly simple. From motives of delicacy, the instrument should be passed without any exposure. The surgeon should hold the catheter in his right hand, while he introduces the forefinger of his left hand between the nymphæ, so as to feel upon the upper surface of the vaginal passage the little papilla, which surrounds, and denotes to the touch, the precise situation of the orifice of the meatus urinarius. Holding the concavity of the catheter forward, the surgeon, guided by the forefinger of his left hand, is then to introduce the instrument upward into the bladder. A female catheter should always be furnished with some contrivance to prevent its slipping completely into the bladder: the following case, mentioned in a respectable periodical work, fully proves the truth of this remark:

Some years ago, a surgeon, practising in the country, was required to introduce the catheter for a lady labouring under retention of urine. During the operation he was observed to exhibit signs of confusion, and to quit his patient in considerable embarrassment. The same day he abruptly left his home, and was never seen afterwards. The lady passed several years of dreadful suffering, attributed, by herself and the professional gentleman on whom the treatment of the case devolved, to aggravation of the original complaint. At length an abscess presented itself in the sacral region, and the surgeon punctured it, when his instrument came in contact with some unusually hard substance imbedded in the centre of the abscess. With a pair of forceps, he now extracted, to his utter astonishment, a blackened female catheter. From this period, the lady's sufferings all terminated. A similar accident nearly happened in the practice of another gentleman. (See PROSTATE GLAND; URETHRA; AND URINE, RETENTION OF.)

Medico-Chir. Journ. vol. v. p. 75. Lond. 1818. *J. Hunter*, On the Venereal Disease, ed. 2. in various places. *Hey's* Practical Obs. in Surgery, ed. 3. *John Bell's* Principles, vol. ii. Sketches of the Medical Schools of Paris, by *J. G. Crosse*, p. 111, &c. *Jos. M'Sweeny*, Obs. on the Catheter, Edin. Med. and Surg. Journ. No. 58. p. 52. *Richter's* Anfangsgr. der Wundarzneykunst. *Lallemand*, Perforation de la

Vessie par les Sondes fixés, Revue Méd. Nov. 1822. *Langenbeck*, Bibl. für die Chir. b. i. p. 175. 12mo. Gött. 1806. *Desault*, Œuvres Chir. t. iii. *Amussat*, Archives Gén. de Méd. t. iv. *Berton*, Op. cit. Mai, 1826. *Alf. A. L. M. Velpeau*, Nouv. Elém. de Méd. Opér. t. iii. p. 905. 8vo. Paris, 1832. *Quain's* Elem. of Anatomy, p. 454. 8vo. Lond. 1834. Sir *Benjamin Brodie*, On Dis. of the Urinary Organs, ed. 2. 8vo. Lond. 1835. *J. F. Malgaigne*, Manuel de Méd. Opér. p. 654. 12mo. Paris, 1834. [*Briggs*, On the Treatment of Strictures of the Urethra, 1845. *Townsend's* third American edition of Velpeau's Chirurgie Opératoire, with notes by *Valentine Mott*, 1851. *Thompson's* Pathology and Treatment of Stricture, 1858.]

CATLIN is a long, narrow, double-edged, sharp-pointed, straight knife, which is chiefly used in amputations of the leg and forearm, for dividing the interosseous ligaments, and the muscles, &c. situated between the two bones.

CAUSTICS [(from καίω, to burn), are substances which corrode, penetrate, and destroy the organic textures with which they are brought in contact, giving rise to the formation of an eschar, which is eventually separated from the living parts. As a general rule, they cannot act efficiently without the presence of moisture, either derived from the animal tissues, or supplied from without. The caustics which are chiefly employed are:— the mineral acids, as the nitric, muriatic, sulphuric, chromic, and arsenious; certain alkaline hydrates, as the hydrate of potash, of soda, quick lime; various metallic salts, as nitrate of silver, chloride of zinc, sulphate of zinc, chloride of antimony, sulphate of copper, bichloride of mercury.

Nitric acid is a powerful corrosive, rapidly oxidising the animal tissues, and producing a yellowish white eschar. It is used advantageously for the removal of nævus, when the integument is thin and the growth presents a deep purple colour, or where the nævus is flat, or is situate behind the ear, and where it is difficult to employ the ligature or needles. It is also resorted to for getting rid of warty growths, of vascular hæmorrhoidal tumors, and of cutaneous syphilitic tubercles. In phagedænic ulceration, it constitutes a most valuable application, arresting the septic process, and inducing a healthy action in the adjunct parts.

Hydrochloric acid occasions a hard white eschar. It has been found serviceable in diphtheria, and in foul ulcers of the fauces. Mr. Duffin informs me, that he has succeeded in curing, by its means, cases of obstinate ulceration of the neck of the womb.

Sulphuric acid is an energetic caustic; its energy may be partly ascribed to its intense affinity for water. It seems to determine a veritable charring of the part, the resulting eschar being of a dirty brownish black. Brought to the consistence of paste by the addition of powdered wood-charcoal, it is recommended by M. Ricord to be applied freely to virulent chancre within the first four days of its development. It destroys the morbid character of the ulcerous spot, and the resulting eschar drops off in a few days, leaving a healthy sore, which readily heals by suitable treatment. M. Velpeau extols the use of a paste, made by trituration of sulphuric acid with saffron in a mortar, in cases of ulcerated and fungous tumor of the mamma. A layer of variable thickness, according to the amount of tissue to be destroyed, is to be spread on the part, and the caustic allowed to remain until it has dried into a black or brown hard eschar. The whole must be exposed to the air for at least four or five hours; in this way an incredible diminution of the tumor is produced. M. Velpeau has seen fungous encephaloid cancers larger and thicker than the fist completely subside by this means, and become reduced to the level of the surrounding parts in the space of twenty-four hours. This caustic seems to prevent hæmorrhage — a notable advantage in dealing with morbid vascular structures.

Chromic acid is a powerful oxidising agent, yielding half its oxygen readily to organic substances, and being reduced to sesquioxide. On this principle I was led to employ it as an escharotic, and first directed attention to it in a notice, published several years ago, in the 35th volume of the *Medical Gazette*. It is convenient for application, inasmuch as it consists of a thick crystalline pap, which, when rightly managed, does not spread beyond the prescribed limits, and so soon as its erosive operation is finished, passes into the state of inert pulverulent sesquioxide above mentioned. Mr. Marshall considers it as an escharotic superior to any other in use for removing warts of the genital organs, whether venereal or otherwise. The solution for this purpose is made by dissolving 100 grains in an ounce of water.

Arsenious acid has long been extolled as an efficient escharotic in the treatment of cancer. It determines a powerful vascular reaction, rapidly destroying the parts with which it is in contact, and causing a severe and abiding sensation of pain, which does not abate until the flesh has become dead and arid like that of a mummy. It seems to exercise a favourable alterative influence on the adjacent tissues, and thus insures a greater immunity from a relapse of the local malady, than most other medicinal agents of the class. If properly used, there will remain, after the separation of the eschar, a healthy sore, which will heal kindly with a firm and sound cicatrix. As the topical employment of arsenious acid is not exempt from risk of danger through absorption, great caution must be observed in its application; according to Christison, (*Dispensatory*, p. 185,) absorption seems less likely to occur when a strong arsenical mixture is used, containing one-tenth or even one-fourth of its weight of arsenious acid, than when the weaker mixtures are applied, which are had recourse to generally on the Continent. A convenient mode of applying it is to form it into an ointment with lard, or into a paste with conserve of roses, thickened, if necessary, with powder of gum, and to add some powder of opium to allay the pain. M. Manec has introduced a formula, which is a modification of that of Frère Côme, and which I have employed successfully in a case of *noli me tangere*, occurring on the side of the nose of an elderly man. Its composition is as follows: arsenious acid, 1·5 parts, cinnabar 7·5, burnt sponge, 3·75. This is to be formed into a homogeneous paste with a few drops of water; a layer of this, one-twelfth of an inch in thickness, is to be placed on the diseased surface, and the whole covered over with a piece of moist amadou. M. Manec gives the judicious precept not to apply the remedy over a surface exceeding in size a two franc piece. The application may be repeated, if necessary, in a fortnight.

Taking into account the poisonous nature of the medicament, and the severity of the pain attendant on its application, the employment of arsenious acid ought to be restricted to small superficial affections; as, for example, cancer of the skin, epithelioma, and obstinate ulcers which sometimes occur at the roots of the nails. In some cases it may be advisable to use it after the ablation of circumscribed adventitious growths by the knife, in order to ensure complete removal of the disease. It ought never, however, to be applied before the third day after the operation, and when suppuration is established.

Hydrate of potash rapidly and completely destroys the vitality of the soft organised textures, inducing a kind of moist gangrene. From its liquescency it is advantageously resorted to in cases of malignant pustule. Here it was employed by Dupuytren in the form of troches. It is employed for the cure of scrofulous ulcers of a torpid character, where the surrounding integuments are undermined; in chancre, where the obstinacy of the sore is excessive; in poisoned wounds, in virtue of its extending its action to a considerable depth beneath the surface. Mr. Mayo proposed its use for the cure of varix, an eschar being made with the caustic over the vein at a sound part of its course, in order to excite such inflammation of the vessel as might suffice to occasion obliteration of its cavity by the effusion of lymph. The practice, however, is not exempt from danger, and has been followed by alarming inflammation. Mr. Wardrop advocated its employment in nævus. It is also employed for opening abscesses.

The most exact way of manipulating the potash is to fit the fused cylinder within a glass tube, and by means of a probe passed up from the opposite end to keep it in contact with the integument or morbid surface. The slimy shreds are wiped away with a soft rag, and after enough caustic has been expended, the part is covered with an emollient poultice. Hydrate of potash is generally preferred for forming issues; and the most convenient mode of employing it for that purpose is to apply to the skin a piece of linen, spread with adhesive plaster, having a circular opening in its centre corresponding to the intended size of the issue, and then to rub upon the skin within the opening a piece of the caustic, previously moistened at one end. The application is to be continued till the life of the part is destroyed, when the caustic should be carefully washed off. Poultices are afterwards to be applied till the separation of the eschar is effected. As a general rule in using this caustic, owing to its diffluent tendency, the erosion of the sound integument ought to occupy a narrower compass than that of the eschar about to be formed.

To obviate the inconvenience arising from the too rapid liquefaction of the potash, it has been found expedient to mix it with quicklime. A compound of this kind, the so-called Vienna caustic, consists of five parts of hydrate of potash, and six parts of quicklime. The mixture is kept in a well stoppered phial; when intended for use, it is made into a paste with a few drops of spirit of wine or water. In this state it determines a speedy disorganisation of the part, which is afterwards to be washed with water and vinegar. If an energetic effect is required, it may be allowed to remain on for twenty minutes. The pain, though lively, is not intense, and does not last more than half an hour. The administration of an anæsthetic agent enables the surgeon to apply efficiently these powerful escharotics. M. Velpeau considers it the best form of caustic for the destruction of a non-ulcerated malignant tumor of little thickness. It is to be surrounded with a border of diachylon plaster, and left in contact with the part for ten minutes. When the tumor is thicker, or larger and nodulated, the preference should be given to the zinc paste, be the skin ulcerated or not (*Lib. cit.* p. 560). It deserves notice, that all caustics having potash for their base, are prone to occasion sanguineous exudation, and to provoke considerable reaction in the surrounding parts.

Hydrate of soda. As an efficient substitute for the potash, I have for several years past been in the habit of using hydrate of soda. It is equally energetic as a caustic, and has not the same tendency to run. The resulting carbonate, on exposure to the air, is of an efflorescent nature, while that of potash, on the contrary, rapidly absorbs moisture. It may be had in fused cylinders.

Quicklime mixed with soap is an old-fashioned escharotic. Three parts by weight of quicklime, and two parts of dry soap, reduced both to powder, are to be intimately mixed. This is to be formed into a paste by the addition of spirit of wine, and a layer of variable thickness, according to the intended effect, is to be applied to the part which is to be cauterised. It determines a sense of smouldering heat, and a smeary decomposition of the tissues. It is less prone to cause hæmorrhage than caustic potash. I succeeded, by a compound of this nature, in destroying a cancer of the female mamma; in this case the patient enjoyed immunity from the disease for a period of seven years.

Nitrate of silver is in more extensive use than any other caustic. On a granulating surface it produces a whitish film, but if applied more freely, a kind of mummy-like transformation of the soft parts, resembling senile gangrene. Its operation is comparatively superficial, and the resulting eschar does not separate for several days, owing to the slight amount of reaction in the adjacent textures. It exercises a salutary alterative and stimulant effect when applied to foul and unhealthy ulcers, and serves also to repress exuberant granulation. It is a useful application to fistulous sores, and to fissures and excoriations at the outlets of passages lined with mucous membrane. It has been employed with advantage in some cases of irritable stricture of the urethra, producing, under such circumstances, a marked sedative effect. A cylinder of lunar caustic, moistened with water, and freely applied over an inflamed bubo, frequently promotes the absorption of the effused serous exudation and the dispersion of the swelling; to the surface of the eyelid in scrofulous ophthalmia with ulcerated cornea, it abates the intolerance of light, the morbid vascularity of the conjunctival vessels, and accelerates the cicatrisation of the ulcer; applied in the same manner round the confines of an erysipelatous surface, it frequently limits the spread of the cutaneous inflammation; passed along the outer surface of the urethra, so as to produce vesication, it has afforded relief in severe cases of spasmodic stricture; lightly applied to burns and scalds it allays pain and favours healing. Its employment is indicated in punctured and particularly poisoned wounds; here a saturated solution is generally preferable to the solid caustic.

Chloride of zinc has in a great measure superseded other escharotic agents in the treatment of carcinomatous affections. I directed the attention of the profession to its properties, in a series of papers published several years back in the 18th and 19th volumes of the *Medical Gazette.* It had been used extensively by Hanke of Breslau, and by Canquoin of Paris. Canquoin suggested its admixture with wheaten flour, in different proportions. Thus, his paste No. 1 is composed of one part of the chloride with two parts of flour; No. 2 of one of the chloride with three of flour; and No. 3 of equal parts of each. The powder is mixed with a few drops of spirits of wine, then set aside in order to attract sufficient moisture to render it soft and plastic. To augment the suppleness of the paste, one part of chloride of antimony is sometimes added. Instead of flour, powdered gum or gluten may be employed; the addition of a portion of oxide of zinc is said to counteract deliquesence. In order to fulfil the same indication, I have been in the habit of substituting a portion of anhydrous gypsum. This, while it can exercise no chemical action upon the chloride, forms a porous medium, through which the particles of the liquescent chloride may transude upon the morbid surface, with the effect of decomposing or destroying it with certainty, to any definite depth.

When the integuments are sound, the cuticle may be removed by means of a blister, and on the following day, one or other of the above preparations, corresponding to the thickness of the tissue to be destroyed, is to be applied to the cutis of the diseased part. Nitric acid will answer the same purpose; but I have generally employed, on account of convenience, caustic ammonia or hydrate of soda.

The depth to which the phagedænic paste will corrode the morbid texture, can always be estimated before hand; its action is unfailing, and the eschar is separated, in most cases, from the eighth to the twelfth day, coming away quite entire in the form of a whitish-grey mushroom-like substance, and leaving behind a singularly healthy sore, which heals with great rapidity. Unlike hydrate of potash, it does not occasion sanguineous exudation, but seems rather to act as a styptic, and stanch bleeding by coagulating the albuminous element. To insure its operation in depth, progressive incisions may be made through the eschar, and the paste spread on strips of calico, or cotton wool, daily introduced, until it has pervaded the disease in its entire thickness. (*See Report of Surgical Staff of Middlesex Hospital,* 1857.) In numerous instances, where I have employed it very largely, I have very rarely known it productive of constitutional disturbance. The pulse remains natural, and the skin cool; yet it acts as a powerful topical stimulant, causing swelling, redness, and pain. The last is of a violent burning character, persisting with great intensity for the first eight or nine hours; after that time, and when the surface is fairly eroded, it becomes supportable, as the patients express it, and continues so during the remainder of the application of the remedy. An important point is, that the pain is in a great measure under the control of opium, a full dose of this drug, previously administered, seldom failing to give great relief.

From considerable experience in its use, I am disposed to conclude that it is chiefly useful in those so-called semi-malignant tubercles and ulcers, which, make their appearance about the face of persons advanced in life, where the skin is involved, but without any depth of new structure; in the circumscribed tubercle of the cicatrix following the operations for cancer; in superficial epithelial growths of small compass; in a form of lupus which I have described (*Med. Gazette,* vol. xix. p. 328), as the erosive ulcer of the follicles of the skin, and in nævus. In true carcinoma, affecting glandular and fleshy parts, it will effect melioration, provided the disease is circumscribed, the patient's health good, and there is no morbid change in the neighbouring glands.

From the report of the surgeons of the Middlesex Hospital, already alluded to, it would appear that the plan of repeatedly introducing the caustic by means of progressive incisions into the eschar was adapted to primary cancers with or without disease of glands; to some cancers which were both ulcerated and adherent; to some which had recurred after operation; and to some in which relief could be afforded to the patient, although the whole disease could not be removed (p. 28).

In cancer of the male breast, M. Velpeau is inclined to believe that extirpation by caustics affords a better chance of success than in that of the female. (*On Diseases of the Breast,* p. 604.)

Sulphate of zinc has been recommended by Professor Simpson in the treatment of cancerous affections. It is inferior in point of energy to the chloride of the same metal. I have known, however, an instance of *noli me tangere* in which it effected a cure, where other escharotics had failed. It was applied in the form of ointment, incorporated with half its weight of stiff cerate. The eschar separates in four or five days. The salt is used in the anhydrous state, finely levigated, or made into a paste by the addition of an eighth part of glycerine. It is said to be the basis of the nostrum of certain American cancer doctors of the present day.

Chloride of antimony. This caustic, which is always employed in the liquid state, is endowed with great activity. It destroys the animal tissues at the instant of contact, provided they are stripped of epidermis, and gives rise to violent and abiding pain. The resulting eschar is white, soft, and more or less thick in proportion as the chloride is decomposed by the afflux of liquid; it separates in from ten to fifteen days. From the facility with which it penetrates the tissues, and from the fact of any excess being speedily deprived of action, this caustic has been recommended in the instance of the bite of rabid animals, or venomous reptiles, as also in malignant pustule, and anthrax. It has been resorted to with advantage in the treatment of lupus (*herpes exedens*).

Sulphate of copper. This escharotic, although not essentially active, is capable of producing great pain. The eschar which it forms, is brown and hard, and slow of separating. It is employed for removing small warty growths, and for repressing exuberant granulation on ulcerated surfaces. A strong solution has been found useful in obstinate sores of the fauces, and of the genital organs.

Bichloride of mercury is but little resorted to as a caustic, on account of its being a virulent poison. Its action does not extend deeply. The resulting eschar is white and soft, and separates in about three days. It is employed in the form of troches for fistulous passages which follow abscesses developed in the inguinal or axillary regions. The tubular eschar thus formed is detached on the third day, and allows cicatrisation to proceed, especially if aided by gentle compression.

In nævus, I have seen Gräfe use the sublimate as an efficient escharotic in the form of a paste, made by mixing one part of the salt with two of gum, and the addition of water to bring it to a proper consistence. A small caustic issue may be made by inserting a minute quantity reduced to impalpable powder, into a fine incision made with the edge of a lancet in the skin.] *Alexander Ure.*

CAUTERY (from καίω, to burn). Cauteries are of two kinds, namely, *actual* and *potential.* By the first term is implied a heated iron, by the second surgeons understand the various caustic applications treated of in the preceding article.

The high opinion which the ancients entertained of the efficacy of the actual cautery, may be well conceived from the following passage:— "Quoscunque morbos medicamenta non sanant, ferrum sanat; quos ferrum non sanat, ignis sanat; quos vero ignis non sanat, insanabiles existimare oportet." (*Hipp.* sect. 8, aph. 6.)

[The actual cautery has been employed for the stoppage of bleeding, where the vessels could neither be tied nor compressed, as for example, in the throat and dental alveoli, in vascular hæmorrhoids; and in bleeding fungus. It has also been employed for the destruction of carcinomatous tumors and ulcers. Delpech often had recourse to the actual cautery to destroy fungous tumors of the antrum. The same practice was followed by Pelletan and other eminent surgeons in France. The part of the fungus which could be cut away, was so removed, and the deeper portion, out of the reach of the knife, was cauterised. The actual cautery has been found effectual in stopping the fatal progress of bad cases of hospital gangrene, the iron being applied red hot, so as to produce an eschar on every part of the surface of the sore. It has likewise been used in carbuncle; in organic defects, such as cleft palate; for the closure of fistulous openings, and for the purpose of depriving carious bone of its vitality. In the last-named instance, the heated iron should be of a spherical or ovate shape; it ought to be pressed down firmly, and be succeeded by two or three others, until the whole morbid surface has been subjected completely to their action. The object here is to procure necrosis of the part. The principal use, however, to which the actual cautery is resorted to in the present day, is in the treatment of diseased joints. Thus, in hip-disease, "if," says M. Syme, "the pain is severe, so as to disturb the patient's sleep, recourse must be had to the actual cautery as the most powerful remedial means that can be employed. The best place for applying it is the hollow between the trochanter major and the tuberosity of the ischium, where a broad eschar, several inches in length, should be formed." (*Prin. of Surgery*, p. 22.) In like manner, in disease affecting the cartilages in other joints, its use is equally indicated, an eschar three or four inches long being formed on each side of the joint. In angular curvature of the spine, when pain and other symptoms denote the existence of inflammatory action, the actual cautery may be advantageously applied longitudinally to the extent of a few inches on each side of the affected part, except when the neck is concerned, in which case the middle line, as Mr. Syme recommends, may be selected for the purpose. (Op. cit. p. 197.) The actual cautery has proved useful in chronic inflammation of the spongy bones of the carpus and tarsus.

The cauterised streaks present a brown, black, and yellowish-grey aspect, surrounded by a red halo. The resulting eschars are occasionally not detached before some weeks have elapsed, and the ulcers of burns being slow in healing, is a main advantage which the cautery possesses over caustics. Emollient poultices constitute the local treatment. Before the cautery is applied, the patient may be rendered insensible by chloroform, or the part may be benumbed by congelation.

Burning ought never to be employed with young children, except under most urgent circumstances, because it is dangerous, prone to induce trismus and other nervous affections.

Cauteries are of different shapes and sizes. Those commonly used, are the spherical, the ovate, and the prismatic. The iron should be heated, if possible, to incandescence, and the surrounding soft parts protected by dry or moist folds of linen. Great care is required in applying the cautery within the mouth, and before each introduction of the iron, a large dossil of lint held in forceps is to be passed round, the lips and cheeks being shielded as above stated. Here folds of dry linen are preferable to wet, as tending to conduct the heat less rapidly. In cauterising the rectum, a horn or wood speculum must be previously introduced.

I may briefly allude to the galvanic cautery, which has been succesfully employed in palatal and vaginal fistulas, and would refer the reader to Mr. Marshall's writings on the subject.]

Alexander Ure.

CERATUM CALAMINÆ, (P. L.) A good simple dressing.

CERATUM CANTHARIDIS (P. L.), formerly used as a dressing for blisters, when it was wished to keep up a discharge from them. On account of the tendency of cantharides to bring on strangury by being absorbed, the ceratum sabinæ is now generally preferred to the cerate of cantharides.

CERATUM CETACEI. (P. L.) The spermaceti cerate. A mild, unirritating salve, for common purposes.

CERATUM CONII. ℞. *Unguenti conii* lbj. (See UNGUENTUM.) *Cetacei* ℥ ij. *Ceræ albæ,* ℥ iij. M. One of the formulæ at St. Bartholomew's Hospital, occasionally applied to cancerous, scrofulous, and phagedænic sores.

CERATUM HYDRARGYRI COMPOSITUM. (P. L.) ℞. *Ung. hydrarg. Cerat. saponis comp.* āā ℥ vj. *Camphoræ* ℥ jss. M. This is sometimes employed as a dressing for promoting the absorption of indolent swellings.

CERATUM PLUMBI ACETATIS. (P. L.) A mild, astringent, unirritating salve.

CERATUM PLUMBI COMPOSITUM. (P. L.) An excellent, gently astringent salve, for common purposes.

CERATUM SABINÆ. ℞. *Sabinæ foliorum recentium contusorum,* lbj. *Ceræ flavæ,* lbss. *Adipis præparatæ,* lbij. Mix the savin with the melted wax and hog's lard, and strain the composition.

The common application for keeping open blisters, on the plan recommended by Mr. Crowther. (See Blisters.)

CERATUM SAPONIS. (P. L.) ℞. *Saponis* ℥ x. *Ceræ,* ℥ xijss. *Plumbi oxydi contriti,* ℥ xv. *Olivæ olei* O. j. *Aceti c.* j. Boil the vinegar with the oxide over a slow fire, constantly stirring them until they incorporate; then add the soap, and boil again in like manner, until all the moisture is evaporated; lastly, with these mix the wax, first dissolved in the oil.

[CHAMBERS OF THE EYE.] [*Inflammation in the Aqueous chamber. Aquo capsulitis.* It seems doubtful whether we are justified anatomically in using the term, aquo capsulitis; recent investigations show that there is no distinct membrane lining the aqueous chamber. The disease is probably seated in the inner or elastic lamina of the cornea, and extends slightly and superficially over the surface of the iris: perhaps the term "corneo-iritis" would most correctly indicate its true seat. This disease resembles in some respects "true corneitis;" it occurs most frequently in children, and in young adults; it comes on very insidiously, usually attacks one eye at a time, and is often limited to one eye. The pain is slight; there is but little intolerance of light; the patient chiefly complains of dulness of vision; the sclerotic vessels around the margin of the cornea are considerably injected. On examining the cornea carefully, it is observed to be quite smooth and bright on its surface instead of finely granular, as in corneitis; and upon the inner layers of the cornea are some tolerably well-defined whitish spots or patches, varying very much in size, shape, and thickness; but they are usually round, and most thickly studded near the centre of the cornea. It is very difficult to ascertain how far the iris is involved, because looking through an altered medium its colour seems changed, and its natural transparency lost. This, however, is frequently not the case in the early stage of the disease, as shown by the perfect activity of the pupil; and when it does extend to the iris it seems to be limited to the delicate membrane covering this structure, and not to invade its proper texture, because the pupil can generally be acted upon by belladonna; and when the cornea regains its transparency no change is observable in the iris, except some slight adhesions to the capsule of the lens. This disease presents great varieties as regards its intensity. In some cases almost the only evidence of the disease is the presence of a few small well-defined spots on the inner surface of the cornea, the remaining parts being clear and bright, and vision being only slightly interfered with, and there being little or no increase of vascularity; whereas, in the other extreme, the patches on the inner surface are larger, more irregular in shape, and denser, and the intermediate parts of the cornea are hazy; the surface of the cornea is dull and vascular; the sclerotic vessels are much injected, and there is severe dull aching pain and intolerance of light; vision is also very seriously impaired. This disease may often be traced to some remote syphilitic taint, either hereditary or acquired, but usually the former. It is very protracted in its duration, and does not seem to yield to any specific plan of treatment, but usually passes away from the inner surface of the cornea at the end of some months, leaving in the more severe cases some adhesions of the pupillary margin. The treatment should be principally directed to the establishment of general power. Preparations of iodine and the iodide of iron seem useful; and where any syphilitic taint is suspected small doses of mercury are indicated and appear to act as a tonic. This medicine is of particular value in those cases which one might call strumo-syphilitic, occurring in children from eight to twelve years of age, the condition of the eyes forming part of a group of symptoms, resembling very closely the tertiary forms of syphilis, such as loss of the soft palate, exfoliation about the nasal bones, periosteal inflammations, &c. The local treatment should be merely soothing; and where there is reason to suspect that the iris is involved, belladonna may be advantageously employed in the early stages, to prevent adhesions and to counteract any tendency to closed pupil.

Pus in the anterior chamber. When pus is formed in the anterior chamber, it gravitates to the lower part of the cavity, and to this condition the term hypopion is applied (see art. Hypopion). As this is a symptom resulting from various causes, it is not correct to describe it as a separate disease; but it may be convenient to mention some of the usual sources of this morbid product within the aqueous chamber. The most common cause of pus in this situation, is the occurrence of an ulcer upon the inner surface of the cornea, corresponding to a similar ulcer on its external surface, the middle laminæ remaining entire; the matter may often be seen trickling down from the ulcerated part to the bottom of the anterior chamber, where it remains during the upright posture, but readily passes to either side when the head is sufficiently inclined either way; another source of this symptom is an abscess between the layers of the cornea bursting internally; occasionally in very acute inflammation of the aqueous chamber, pus is poured out into this cavity without any evidence either of an ulcerated surface or of a false membrane. An organised tubercle upon the iris may suppurate and thus become a source of this symptom, and in one or two rare instances I have seen hypopion follow a severe attack of fever in an eye, in other respects perfectly normal and free from every trace of inflammatory action. The presence of matter in the anterior chamber is of no moment, except as it forms an index and measure of the amount and severity of diseased action that is going on in the eye. It has been suggested to evacuate it with a small cutting needle, but this would be a rash and injurious proceeding, unless the extreme pain and severity of the general symptoms indicated aggravation from tension of the globe, when great relief may follow the evacuation of the pus together with some of the aqueous humour. Such cases must be treated in other respects upon general principles — warm and soothing appliances being more particularly indicated where pus is present.

Blood in the anterior chamber. Occasionally blood is found in the anterior chamber; it is usually the result of a blow, but in a few rare instances it has been found to be vicarious with the menstrual function. Blood becomes readily absorbed in this situation, excepting in people who suffer from some dyscrasia as diabetes mellitus, albuminuria, &c., where the blood may remain unchanged for years. In cases of injury it is important to give a guarded prognosis, as it probably results from such an amount of violence as will cause some permanent injury to one or more of the delicate structures of the eye, which will not show itself until the blood is entirely absorbed.

Turbid secretions in the anterior chamber. Another curious change in the anterior chamber is, when the natural secretion becomes altered in colour and quality, being yellow and highly albuminous and much increased in quantity. The result of these changes is, that the cavity is much increased in size by the thrusting back of the iris and lens, and the surface of the iris appears of a green colour, there is also very severe pain and tension and much dimness of vision; such eyes are more or less damaged by previous attacks of inflammation. The best mode of relieving the pain in these cases, is to puncture the cornea with a needle, and to evacuate a portion of this yellow, albuminous fluid, so as to remove all tension; this may require a repetition of the same treatment until the abnormal tendency is worn out. It is important not to allow all the fluid to escape, otherwise the iris will fall in contact with the cornea, which for a time occasions great pain.

The above remarks have been taken from the Lectures of Mr. Critchett (*On Diseases of the Eye. Lancet*, August 12, 1854). Consult also Mackenzie (*On Diseases of the Eye*, 4th edit. 1854).]

C. Bader.

CHEMOSIS (from χαινω, to gape). When the eye is violently inflamed, it frequently happens that serum, lymph, or blood is effused in the tissue which connects the conjunctiva with the anterior surface of the sclerotic coat of the eye. Hence the conjunctiva is gradually elevated from the sclerotic and projects forwards, so as to conceal within it the cornea, which appears as if it were depressed. (See Conjunctivitis.)

CHILBLAIN. [Chilblain is one of the common effects of cold. Just as heat will produce simple redness, mere vesication, or total destruction of parts of the body, according to its degree and the length of its application, so cold is followed in the same way by redness, by vesication, and by gangrene. The ordinary form of chilblain, so common in the winter in this country on the hands and feet, is an instance of the mildest form of the effects of cold brought before the surgeon.]

In its mildest form it is attended with a moderate redness of the skin, a sensation of heat and itching, and more or less swelling, which symptoms, after a time, spontaneously disappear. The intolerable itching and sense of tingling, accompanying the inflammation of the milder description of chilblains, are observed to be seriously aggravated by exposure to heat. In a more violent degree, the swelling is larger, redder, and sometimes of a dark blue colour; and the heat, itching, and pain, are so excessive, that the patient cannot use the part. In the third degree, small vesicles arise upon the tumor, which burst and leave excoriations. These often change into ill-conditioned sores, commonly known as "broken chilblains," which sometimes penetrate even as deeply as the bone, discharge a thin ichorous matter, and generally prove very obstinate. As Dr. John Thomson has remarked, "When the serum contained in the vesications is let out by a small opening, a portion of new cuticle is usually formed to supply the place of that which has been separated; but, when the inflammation is severe, and the affection neglected, or improperly treated, the parts which are the seat of vesication are liable to pass into the state of vitiated ulcers. In this state, they yield a thin, ichorous, or sanious discharge, and are in general brought, only after a long time, and with much difficulty, to a healthy suppuration. In neglected cases, these ulcers not unfrequently become covered with foul sloughs. Ulceration often supervenes, and the soft parts, covering the bones, are destroyed." (*On Inflammation*, p. 638.) The worst stage of chilblains is attended with sloughing.

Chilblains are particularly apt to occur in persons who are in the habit of going immediately to the fire when they come home in winter with their fingers and toes very cold; they are also frequent in persons who often go suddenly into the cold while very warm. Hence, the disease most commonly affects parts of the body which are peculiarly exposed to these sudden transitions; for instance, the nose, ears, lips, toes, heels, and fingers. Richter remarks, that they are still more frequently occasioned when the part suddenly exposed to cold is in a moist perspiring state, as well as warm. Young subjects are much more liable to this troublesome complaint than adults; and females, brought up in a delicate manner, are generally more afflicted than the other sex.

The most likely plan of preventing chilblains is to accustom the skin to moderate friction; to avoid hot rooms and making the parts too warm; to adapt the quantity and kind of clothing to the state of the constitution, so as to avoid extremes, both in summer and winter; to wash the parts frequently with cold water; to take regular exercise in the open air in all kinds of weather; and to take particular care not to go suddenly into a warm room, or very near the fire, out of the cold air.

One of the best modes of curing chilblains of the milder kind is to rub them with snow, or ice-cold water, or to bathe them in the latter several times a day, keeping them immersed each time, till the pain and itching abate. After the parts have been rubbed or bathed in this way, they should be well dried with a towel, and covered with flannel or leather socks.

This plan is perhaps as good a one as any; but it is not that which is always congenial to the feelings and caprice of patients; and with the constitutions of some it may even disagree. In such cases, the parts affected may be rubbed with spirit of wine, linimentum saponis, a mixture of tincture of opium and hartshorn, tincture of myrrh, or a strong solution of alum or vinegar. Mr. Wardrop speaks highly of one part of the tincture of cantharides, with six of soap liniment. (*Medico-Chir. Trans.* vol. v. p. 142.) [A solution of camphor in eau de cologne, is, perhaps, the best application for patients of the upper classes, and equal parts of turpentine and olive oil, for dispensary patients, or a table-spoonful of mustard rubbed up with four ounces of water, answers as well as either.]

Vesications from cold are treated on precisely the same principles as vesications from heat. See Burns.

When chilblains suppurate and ulcerate, they require stimulating dressings, such as lint dipped in a mixture of the liquor plumbi diacetatis dilutus, and liquor calcis; tinctura myrrhæ, or warm vinegar. If a salve be employed, one which contains the hydrargyri nitrico-oxydum, or the unguentum zinci with myrrh, camphor, opium, or the Peruvian balsam, will be found most beneficial. The muriate, or hydrochlorate of lime, in the form of an ointment, has been found by Lisfranc to be an excellent application to ulcerated chilblains. (*Revue Méd.* Feb. 1826.) Ulcers of this kind frequently require to be touched with the nitrate of silver, or dressed with a solution of it.

Chilblains, attended with sloughing, should be poulticed, till the dead parts are detached. A poultice made of linseed meal and port wine is one of the best. The sores should then be first dressed with some mildly stimulating ointment, such as the unguentum resinæ flavæ, or unguentum zinci. With the first of these, in a day or two, a little hydrargyri nitrico-oxydum may be mixed, or lint wetted in Peruvian balsam may be applied; but the surgeon should not venture on the employment of very irritating applications, till he sees what the parts will bear, and whether such will be requisite at all; for, were he too bold, immediately he leaves off the poultices, he might bring on sloughing again. [When there is much fetid discharge a soft layer of cotton wool containing peat charcoal may be applied over the other dressings with great advantage.] *T. Spencer Wells.*

Rees's Cyclopædia, art. Chilblains. *Richter's* Anfangsgr. der Wundarzn. b. 1. *Thomson's* Lectures on Inflammation, p. 637, &c. *Lassus,* Pathologie Chirurg. t. ii. p. 388, &c. *Callisen,* Systema Chirurgiæ Hodiernæ, vol. i. p. 304, &c. ed. 1798. *Pearson's* Principles of Surgery, p. 153, &c. ed. 1808. *M. J. Chelius,* Handb. der Chir. b. i. p. 72. Heidelb. 1826.

[CHLOROSIS (from χλωρὸς, paleness, yellowish-green).] [This disease is treated of fully by medical writers, but surgical cases occur in chlorotic subjects, and the morbid condition of the blood influences their course and treatment.

In chlorosis, the proportion of the solid constituents of the blood is diminished, owing to a decrease in the number of the red corpuscles. The proportion of albumen in the liquor sanguinis, in almost every case, is above the standard of health; the proportion of fibrin being about the same as in health, and accordingly large in relation to the red corpuscles and to the sum of the solid constituents. Owing to the two latter qualities the blood is more viscid than natural.

This condition commences insidiously, and may progress until the red corpuscles are reduced even to a third of the healthy standard. In one case, Andral found the cypher 38·7; it very frequently sinks from 127 to below 50 parts in 1000 of blood. It has been observed as low as 27. The corpuscles are also paler than natural, smaller, and many of them lose their proper form (*Andral*). On separating the fibrin by whipping, it is generally found somewhat less dense and consistent than usual, but the clot, although small, and sometimes soft, may yet be normal in consistence, and is occasionally even firmer than natural; it frequently presents a buffy coat, and is sometimes cupped. The serum is usually abundant, transparent and very pale, or of a greenish-yellow hue. Blood drawn from a vein has been observed to be white (*Van Swieten Com. Aph.* 25).

A great number of predisposing and exciting causes are enumerated by medical writers. It is met with most frequently in the lymphatic temperament; in young girls about the age of puberty, but occasionally at other periods of life, and rarely in the male sex; it occurs also in those of sedentary habits, who indulge excessively in the use of dilute fluids, and are subject to nervous exhaustion from the depressing passions and other influences. Although chlorosis often follows hæmorrhage, occurring insidiously, as it does other causes of debility and exhaustion, it is not produced by the loss or expenditure of blood, it is rather a defect of assimilation and of the organisation of red corpuscles. All the assigned causes more or less directly influence the processes of hæmatosis; either those constituting the primary digestion and essential to the formation of a nutritive pabulum for the supply of liquor sanguinis, or those constituting the chemico-vital metamorphoses and transpositions by which the chyle poured into the liquor sanguinis is corpusculated and converted into red blood. Their modus operandi has not been made out, but the assimilation of iron from the food appears to be essentially at fault, and the formation of hæmatin affected. "Although food be taken and converted into chyle, the chyle does not pass through its stages into red blood." (*Van Swieten.*)

The general symptoms are, deficient or depraved appetite, often with a craving for unwholesome diet, and sometimes nausea and vomiting; costiveness; pale urine; amenorrhœa or scanty pale menstruation from deficiency of red blood; blood flowing from a vessel produces a pale stain; the countenance and skin are at first pale, then often waxy, and subsequently assume a greenish-yellow tint; the conjunctivæ, lips, gums, tongue, and mucous membranes generally are pallid; the eyelids livid. As the disease advances, the soft solids become flaccid; the pulse is soft and weak; the tongue is pale, flabby, and often indented at the edges by the teeth. The viscidity of the blood, and the weakness of its moving powers, renders its motion in the capillary vessels languid, and there is a tendency to congestion and obstruction; and also to œdema, particularly in the face, tongue, and ankles; with diminished temperature of the surface generally, and cold extremities. Among the most constantly observed symptoms are also languor, listlessness, debility and torpor, an indisposition to bodily and mental exertion, great lassitude from the least motion, with dyspnœa, vertigo, palpitation of the heart, and disturbed sleep, pain in the head and side, and other nervous symptoms, most of which are referrible to the morbid condition of the blood, and particularly to the deficiency of red corpuscles; but chlorosis is often intimately associated with dyspepsia in various forms, hysteria, amenorrhœa, anæmia, and hydræmia, the two latter being among its most serious complications. There is a deficiency of biliary matter formed in the blood, the greenish-yellow hue being attributable to the retention of yellow and blue colouring matter in the liquor sanguinis.

The diagnosis is sometimes aided by the existence of a *bruit de soufflet,* which may be either arterial or venous, or both; although the occurrence of this *bruit* does not correspond with a definite degree of diminution of corpuscles, it was found by Andral as a constant symptom when the cypher ranged below 80; when above 80, it often existed, but was no longer constant; being most frequently heard when the cypher oscillated between 80 and 100, and much less frequently when it passed 100. Its intensity also, and whether intermittent or continuous, is, in some measure, subordinate to the degree of diminution of the corpuscles. The arterial and venous murmurs of chlorosis and other diseases of impoverished blood are sometimes associated with the murmurs produced by organic disease.

The influence of a chlorotic state of the blood in surgical diseases contrasts with morbid conditions in which the fibrin is essentially deficient in quantity, or defective in quality, as in scorbutus, hyperinosis, and many affections resulting from the action of septic poisons. In chlorosis there is usually a sufficient quantity of organisable plastic exudation for healing by the adhesive process, and, accordingly, less tendency to suppuration, and a rarity of hæmorrhages, either active or passive; this being due, as remarked by Andral, to the fibrin remaining normal although the corpuscles are diminished. Many of the symptoms of chlorosis contrast also remarkably with those of cholæmia.

Owing to anæmia being one of its most serious complications, loss of blood ought to be sedulously guarded against in chlorotic subjects, and operations involving a risk of hæmorrhage should, if possible, be delayed until the blood has been restored to a healthy state. Iron is the appropriate remedy. After its employment for a few weeks the solid constituents have been found on analysis to be doubled and the red corpuscles nearly trebled. The general plan of treatment is to administer fifteen to twenty grains of Pil. Aloes cum Myrrha, or some other mild and warm purgative, for two or three successive days for the purpose of clearing the primæ viæ, repeating this course as occasion may require, or giving subsequently, inspissated ox-gall, both as a purgative, and to supply biliary materials to the blood. These medicines are ancillary to iron in their operation. Iron, in some of its forms, should be steadily administered, and exercise with other hygienic measures enjoined. Friction of the surface, or shampooing, is also a most useful auxiliary. After a few days' treatment on these principles, the cheeks, lips, and gums, begin to regain their colour, and in a few weeks all the symptoms subside. On recurring to exhausting practices and defective hygienic customs, the patient is very apt to suffer a relapse; as remarked by Van Swieten, we are sometimes called on to repeat this course three or four times, even in the space of a year, before the patient becomes obedient to rules.]

Henry Ancell.

[CHOLÆMIA. *Biliary blood. Jaundice.*] [A biliary condition of the blood may result from:—1. The materials of bile being received into or formed in the blood in excess; 2. A failure in the action of the bile-secreting cells of the liver; 3. An obstruction to the passage of the bile in its ducts, followed by the reabsorbtion of its constituents. These causes may operate simultaneously; obstruction cannot continue long without producing a remora of bile in the ducts, modifying their calibre, and interfering with the function of the hepatic cells; and excessive production of the elements of bile may co-exist with diminished secretion. In some individuals there appears to be an habitual excess of the materials of bile in the blood, marking a peculiar temperament and rendering its subjects torpid and indisposed to bodily and mental exertion. When the biliary contamination is more decided, and amounts to a disordered state of the system, it is characterised by the following symptoms:—A bitter taste; a furred tongue—the fur, particularly at the base, having a yellow tinge; loss of appetite; nausea or bilious vomiting; sometimes slight bilious diarrhœa; a yellowish or greenish-yellow tint of the tunica adnata, mucous surfaces, and skin, sometimes amounting to jaundice; and there is often supraorbital headache, and various cerebral disturbances; with great indisposition to mental and bodily exertion, low spirits, hypochondriacism or melancholia. In more extreme cases, the blood probably undergoing ulterior changes, it is attended with—the greatest depression of spirits and sinking of the vital powers; irritability of stomach; arrest of the assimilating functions and emaciation; and it may give rise to hydrothorax, ascites, or œdema; or to delirium, or convulsions, or lethargy, coma, apoplexy, or palsy. When produced suddenly by a total cessation of the action of the liver, these symptoms may result in rapid or even sudden death. Long continued over-distension of the ducts leads to accumulation of bile in the secreting cells of the liver, and also to disintegration; and recent experiments on animals appear to indicate that diseased conditions of the bile-conducting apparatus lead to incrustation of the branches of the cœliac axis and mesenteric arteries, and to perforating ulceration of the duodenum. (*Brit. and For. Med. Rev.* Jan. 1857.)

Jaundice may result from either of the pathological conditions here described, but is not necessarily present when the blood is bilious. It consists in an accumulation of colouring matter, rendering the liquor sanguinis usually of a deep golden-yellow tint; the serum and clot, and the buffy coat when formed, are tinged with the same colour. Owing to the circulation of this liquor within the vessels and the discolouration of the parenchymatous fluids, the skin, mucous and serous membranes, fibrous tissues, osseous part of the teeth, and even the hairs, lymphatic glands and brain, the secretions of milk, sweat, sputa, urine, and of the serous membranes, and the pathological products of these membranes, may be tinged yellow; after a time all the free fluids and the more stationary solids become alike imbued, the only known exception being the enamel of the teeth. In this condition of blood organic chemists have detected the resin of bile, cholic acid, leucine and tyrosine (products of the decomposition of albuminous substances), and an excess of cholesterine and fatty matter generally; and it is probable that other compounds usually removed by the secretory action of the liver may be detained in the blood, and that new compounds are often formed, as indicated by a bluish, greenish, or reddish tint, superseding the pure yellow of bile pigment. In typhus fever and small-pox, leucine is detected in the blood, nitrogenous materials being probably converted into this substance instead of into bile and urea.

The effects of cholæmia on the system depend much upon the action of the skin and kidneys, which perform a vicarious function, and act as safety-valves, the materials of the bile being detectable in the urine.

The temporary re-absorption of bile, owing to obstruction of the ducts, although attended with jaundice, is not in general followed by such serious results as the retention of the biliary constituents in the blood. Some of these, as the resinous acids, are intended for absorption and for ulterior use in the economy, and the colouring matter is probably identical with that of the liquor sanguinis. The colouring matter in excess, and the resinous acids, have been observed in the blood without any train of symptoms. Absorption being gradual, the kidneys have more power to prevent accumulation and the formation of new compounds.

Jaundice thus produced may continue for months without severe effects. At the same time, complete obstruction to the passage of bile tends, as already stated, to disorganise the hepatic cells, and thereby prevent secretion and depuration, and may produce all the risks of a primary biliary state of the blood. (*Dr. T. Williams' Guy's Hospital Reports*, 1843.)

The causes of a biliary state of the blood are extremely numerous. Whether the materials of bile be derived from the disintegrating blood corpuscles or from the tissues, as taught by some physiologists, or from other sources, this diseased condition may be produced by some deep-seated interruption to the catalytic changes which those materials must undergo in the blood, in preparing them for secretion as bile. Cholæmia is liable to occur in individuals who lead a sedentary life and those who are subject to high ranges of temperature, as in cooks, bakers, and persons residing in the tropics; also in persons who take too full a diet of fatty and other hydrocarbonaceous substances. It occurs also in biliary and malignant fevers, in diseases resulting from malaria, and in the diseases produced by various poisons, and particularly by the bites of venomous animals. In all these cases it may occur without any mechanical obstruction. It results also from diseases of the liver and biliary apparatus, and particularly as a consequence of gall stones, and in diseases of the neighbouring parts producing obstruction of the gall ducts. In surgical practice it is most frequently met with in individuals addicted to the abuse of intoxicating liquors, or to venereal excesses, and in those who have been subjected to mercurial courses; it frequently accompanies acute or chronic inflammation of the liver, leading to abscess, and occurs on the retrocession of discharges and eruptions; and it sometimes takes place suddenly as the result of fright, rage, or other mental or moral emotions, and from the shock of operations.

The results of cholæmia depend not only upon the cause which has produced it, upon the actual condition of the skin and kidneys at the time, upon the continuance of the liver to perform its function in part, and upon the more or less sudden and complete invasion of the morbid condition, but also upon the particular stage at which the series of metamorphoses of biliary matter in the blood may have been arrested, and probably upon the production of poisonous compounds in some stage of its progress. Biliary materials are also often met with in the blood in connection with a state of active hyperinosis, marked by an excess of fibrin and a deficiency of red corpuscles. Whether the inflammatory state of the blood is produced by the biliary particles, or the excess of these by the increased destruction of the red corpuscles in excited states of the blood, may be uncertain, but either of these pathological results may occur. Even in an impoverished state of the blood the effects are often similar, but slighter in degree.

It is important in surgical practice to scrutinise very closely the state of the blood as to its biliary constituents. Cholæmia predisposes to many diseases. This is so much the case as respects erysipelas that you have a distinct variety described as biliary. (See ERYSIPELAS.) It predisposes also to rheumatism and to the gouty paroxysm. It probably predisposes to and certainly aggravates the course of diffuse cellular inflammation and pyoæmia. It may lay the foundation for hepatic inflammation and abscess after injuries and operations, and for cerebral and other visceral complications. Hence the necessity of preparing biliary patients for operations, and of attending to the state of the biliary secretion and the blood throughout the course of all surgical cases. Where the symptoms of cholæmia exist, the diet should be restricted, and hydrocarbonaceous food and potations withdrawn, or diminished. The action of the kidneys should be very carefully looked to, and diuretics and other remedies employed where necessary to promote their functions. Chologogue purgatives and diaphoretics are also indicated, by which the hepatic ducts and blood vessels may be cleared and the liver and skin excited to an increase in their depurating functions. In the slighter and more chronic cases a course of blue pill or of the compound calomel pill, more or less prolonged, is often completely successful; and taraxicum and the nitro-hydrochloric acid are most useful remedies when appropriately administered. Operations are not generally undertaken in a jaundiced condition. (*Jaundice is treated of in full by medical writers; a very complete article, with copious bibliographical references, will be found in Copland's Medical Dictionary.*)] *Henry Ancell.*

[CHOROIDITIS. *Inflammation of the choroid coat of the eye.*] Mr. Dixon, when speaking of this affection (*Diseases of the Eye*, p. 120, 1855), remarks:—"I believe we have at present no means of satisfactorily answering the question," (as to which are the symptoms of choroiditis,) "nor do I think we in any way advance the science of ophthalmology by assigning a name to a morbid condition, the existence of which cannot be demonstrated. No one who has examined a well-injected preparation of the choroid, and has seen how it is, for the most part, made up of a mass of blood vessels, can need to be told that such a tissue in the living body must be peculiarly liable to inflammation." (See article OPHTHALMOSCOPE.) "Indeed, we might take it for granted, that in inflammation attacking the whole eyeball, it would be in the choroid that the chief inflammatory changes would take place. We may feel assured, too, that in the severer forms of iritis the inflammation is by no means limited to the tissue from which the disease derives its name, but that the connection subsisting between the vessels of the iris and those of the choroid will involve both structures in the morbid process."

Mr. Bowman (*Lectures, &c.*, p. 43, 1849), observes:—"The capillaries form on the inner surface of the choroid, a plain plexus, with close meshes, known as the tunica Ruyshiana. This network is closer, *i.e.* its meshes are smaller in the hinder part than in front, and the vessels finer. It is the most important part of the choroid, because the capillaries are a more important structure than either arteries or veins—more important, I mean, in regard to the function of the membrane, and also as respects its diseases. In no other part of the body are the arteries and veins so separated, by a natural disposition from their own capillaries; and it is most interesting to notice, in accordance with this circumstance, that when the choroid is inflamed, so that inflammatory products result, they are poured out from its inner surface rather than from its outer."

The only two good observations of choroiditis which I am acquainted with are those given in Mr. Bowman's Lectures. (*Appendix, Cases M. and N.*, p. 123, l. c.)

"*Case M.—Phlebitic ophthalmitis after amputation, with an account of the post-mortem examination of the texture of the eye, and remarks.* . . . . The patient complained of his left eye smarting and itching, and it appeared to be affected with slight catarrhal ophthalmia. There was superficial redness with mucous discharge. On the following day the inflammation had increased with frightful rapidity; there was excessive florid chemosis partly concealing the cornea; the lids were turgid, and the eye wanted none of the characters of a severe attack of purulent ophthalmia, except the purulent discharge. The pain in the globe was of an aching, darting kind. The cornea remained clear, but the aqueous humor and iris were muddy, and sight was totally lost. The chemosed membrane was scarified, and four leeches were applied, which had the effect of speedily reducing the colour of the conjunctiva to a pale yellowish pink tint, and the chemosis became of the sort which is known as 'serous.' This speedy change was accelerated by his weakened state, and showed that active depletion was inadmissible. Fomentations were then applied. The general treatment was continued, with an opiate at bed-time. The day after, dull pain in the eye continued, and the chemosis had increased and projected between the lids, but was pale and serous. The cornea had become cloudy, the chambers were yellowish, the iris obscured by lymph, the pupil occupied by a yellow mass of lymph, which looked like an opaque lens. The lids had become less œdematous, so that the condition of the interior of the organ could be more exactly noted. . . . . One week later was the lymph absorbed from the iris and the pupil, which resumed very nearly their natural appearance, the latter only remaining rather turbid. He had lost almost all pain in the organ, and the morbid action within seemed entirely checked. Some pale chemosis remained, but the cornea was clear, and the globe wore no appearance of internal suppuration. All pain in the organ had likewise ceased.

On examination of the eye after death, the iris as seen through the transparent cornea was clear green, without lymph on its surface, but firmly adherent by its entire posterior surface to the capsule of the lens, which presented only a partial opacity near its centre. This posterior synechia and opacity of the capsule appeared of old standing, (and the patient had stated that this eye had been a poor one, and vision imperfect with it for many years). The lens itself was perfectly transparent. Under one of the recti, immediately behind its insertion, the sclerotica (and also the choroid) was much bulged and so distended as to be almost giving way, by pressure from within. It formed what would have been termed, from its shape and circumscribed figure, a staphyloma scleroticæ. In order to ascertain its nature, I carefully cut all round it through the sclerotica only, and in detaching this coat, I found that it was extremely thin, and its fibres, as it were, unravelled at the apex, where also the choroid was adherent to it by a film of recent lymph, and, like the sclerotica, distended from within. The outer surface of the choroid was perfectly natural, except at the apex of the swelling. On now cutting through the choroid, a whey-like fluid, with particles of lymph floating in it, escaped in abundance, and I found that this effused fluid was filled with nucleated and other irregular granules, hanging together in little masses and resembling lymph rather than pus. In this turbid fluid there lay loosely a great number of smooth, round or oval beads of soft yellow lymph, of every size up to that of a rape-seed, and these consisted of an agglomeration of nucleated lymph particles, with many shapeless granules in the connecting material. Scarcely any fibres could be discovered. I emptied the cavity between the choroid and retina in which this effusion had collected, by syringing it under water, and the inner surface of the choroid then exhibited a coating of yellow lymph, which appeared to be deposited not merely on the surface but also in the interstices of the capillary network which lies under the epithelium forming that surface, almost all trace of epithelium being lost. The vitreous humor in its enveloping hyaloid membrane, together with the broken remains of the retina, had been thrown by the effusion to the central part of the globe, where they occupied only about half their natural space. The retina was not at all coated with lymph, and its capillary network was perfect, but the nervous substance was in a great measure destroyed, as though macerated; yet what remained exhibited the characteristic elements of the nervous substance of that part. Jacob's membrane was nowhere visible. The hyaloid texture was everywhere entire, but thrown into innumerable minute folds, in consequence of its collapsed form. A good many lymph globules were accumulated on its exterior in certain parts, and the nuclei naturally present on its inner surface were very distinctly visible. Every part of the vitreous humor was turbid and cloudy, from a finely granular and amorphous deposit in its substance. In addition to this there were disseminated through the vitreous humor innumerable nucleated cells, like those of the lymph already described. These nucleated particles were much more numerous immediately within the hyaloid capsule, in the superficial portions of the vitreous humor, than towards the centre, where they very gradually ceased. In the central part of the vitreous humor there were none of the nucleated particles, but in the neighbourhood of the optic foramen and yellow spot, and particularly near the ciliary processes at the border of the lens, and near its posterior surface, they were so abundant as to render the vitreous humor perfectly opaque and yellow; yet even here they only differed in number from those found elsewhere. . . . . *Remarks:* The principal seat of the effusion of lymph in this case is very interesting to notice, if we bear in mind that the choroid membrane, from which it seems to have proceeded, has its capillaries on its inner surface; its arteries, and especially its ample veins on its outer surface. The effusion was on the inner surface and clearly from the capillaries; the arteries and veins forming the outer surface were quite healthy; there was not a particle of lymph about them, except where the tunics were giving way. The deposit was of lymph—of lymph consisting of little else than nucleated cells, which formed masses of rounded shape, floating in a turbid serum. The capillaries of the retina and the nervous tissue of the retina, though to some extent macerated and disorganised by the contact and pressure of the effusion within the choroid, yet did not appear to have any lymph adhering to them, or to have themselves exuded any."

"*Case N.—Ophthalmitis, similar to that of the last case, but not so clearly of phlebitic origin, accompanying extensive inflammation of heart and brain.* . . . . A. B. discovered that the sight of the left eye was impaired, and on the following day he could not distinguish light from darkness. All this was without any scintillations or other symptoms of retinitis, as ordinarily described. He had, however, some dull deep-seated pain in the globe, but not extending to the brow or head. Leeches relieved the pain for a short time, but the blindness was complete. The pupil was half dilated, almost immovable, the humors quite clear. No morbid appearance in the tissue of the iris, which was of a dark brown. Slight conjunctival and sclerotic injection. (Aug. 31.)

Sept. 1.—The pain continues in the eye, though mitigated; more injection of the conjunctiva and disposition to chemosis; the margin of the pupil slightly irregular, otherwise the eye appears the same.

2nd.—The eyelids somewhat swollen; decided serous chemosis, overlapping the cornea a little. Humors clear. Iris apparently natural, except that the pupil is puckered. The pain in the eye, as before, deep-seated and aching, not acute or intolerable, or preventing sleep.

3rd.—More serous chemosis, projecting a little between the lids, which are swollen, but allow us just to see the cornea. This is clear, and so is the aqueous humor. The lens has a pale milky tinge, especially at the border of the pupil, which is irregular. Front of the iris natural. Pain in the eye not severe. Total blindness continues in this eye.

4th.—The chemosis has disappeared, the sclerotica being still dull with vessels; pupil fixed, lens more milky.

6th.—The pupil is occupied by opaque milky effusion; the chemosis is gone, and there is much less redness.

Examination twenty-seven hours after death:— Left eye: All chemosis and outward redness has subsided, and the globe looked very much like the other, except that the pupil was rendered opaque by an effusion of lymph, adherent to its border and to the capsule of the lens. The front of the iris had hardly lost any of its brilliance; the aqueous humor was clear, and the cornea transparent. On dissecting the outer surface of the eyeball, the areolar tissue contiguous to the sclerotica was found in some parts thickened and rendered semi-transparent by the effusion, which had attended the external inflammation.

On carefully opening the sclerotica, the choroid was found everywhere in contact with it, and apparently healthy. The vessels and nerves on its outer surface seemed as usual. The ciliary muscle also natural. But the moment a puncture was made in the choroid, a turbid yellow serum, with small flakes and granules, escaped. This effusion lay between the choroid and retina, which latter was thrown somewhat inwards upon the vitreous humor, and lay in folds. The quantity of fluid altogether may have been about twenty minims. It coagulated by heat. On examination under the microscope, it was seen to contain—1. Small masses of granules, very like the agglomerated granules of the retina; 2. Many exudation corpuscles merging into pus corpuscles; and 3. Much amorphous finely granular matter. Nothing like the particles of Jacob's membrane, or fragments of them, could be found in it. The cavity in which this effusion lay, extended in a forward direction only as far as the ora serrata, in front of which the ciliary processes of the choroid adhered naturally to the vitreous body. Backwards it did not reach the point of entrance of the optic nerve, being limited by a quantity of yellow lymph (with pus in its centre) disposed in a layer one-twelfth of an inch thick, uniting the choroid and retina, but most intimately adherent to the latter. The inner surface of the choroid in contact with the effused fluid was everywhere coated with lymph, which gave it a mottled aspect, and varied in quantity at different parts. None of the pigment seemed detached, and the lymph appeared to lie on the retinal surface of the choroidal epithelium. The choroid was somewhat thickened, and tore more readily than usual. It also contained more blood than natural. . . . . . .

Glaucoma has been considered as a form of choroiditis; it will be treated of under the article Eye. Ossification of the inner (retinal) surface of the choroid has frequently been observed; it appears to constitute one of the changes which inflammatory products may undergo. Such eyes are blind, and the other tissues are considerably diseased. For wounds of the choroid, see Eye, Injuries of.

Dr. Mackenzie, when speaking of non-malignant tumors of the choroid and corpus ciliare, remarks: —" The posterior part of the choroid is sometimes the seat of a tumor, which is probably of the nature of scrofulous tubercle, or of fibro-plastic tumor. It separates the membrane in two laminæ, between which it is deposited. Much more frequently have non-malignant growths been observed in the anterior part of the choroid; cases have been reported by Lawrence, Saunders, Jaeger and others."

For malignant tumors of the choroid, see article Eye.

See *Mackenzie*, *On the Diseases of the Eye*. 4th edition. 1854; *Bowman*, *Lectures on the Parts concerned in the Operations on the Eye*. 1849; and *Dr. Stellwag von Carion*, *Die Ophthalmologie*, *&c.* 1857.] *C. Bader.*

CICATRISATION. [The formation of a *cicatrix* or *scar* is the completion of the process by which open wounds and ulcers are healed. The word cicatrix is commonly taken to signify, both the outward mark or scar or patch, and the material of which it is composed.

In the article Repair, it is shown that the lymph or reparative material of the blood, is capable of being developed into fibrous tissue, epithelium, and bone; and that the accessory structures, such as vessels and nerves, are developed within it.

Cicatrisation, then, of skin and mucous membrane must be a process in which a "solution of continuity" becomes more or less filled with fibrous tissue, and covered in with a layer of cuticle or epithelium.

In the most perfect examples of repair, those, namely, in which the edges of a wound in the skin can be accurately adjusted together; or in which an abrasion or loss of surface can be induced to heal under a scab; and in which the repair is accomplished by the exudation and development of lymph, without inflammation, the process seems to be this: the outermost layer of lymph dries into a kind of skin, or crust, under which a succeeding layer developes itself into cuticle. The newly formed cuticle is succeeded by fresh formations from the vascular surface beneath it, that is to say, from the lymph which has formed a connective tissue, uniting the deeper parts of the wound. When sufficient cuticle has been formed to admit of the natural process of exfoliation, the outside crust comes off, revealing a tender red surface or line, corresponding to the surface of the new reparative tissues. In the case of a wound or ulcer which has been the seat of inflammatory exudation, the process of cicatrisation is much slower. It consists in the gradual exudation of lymph, part of which becomes vascular and forms *granulations*, whilst part degenerates into pus; and when the granulations have increased to a certain extent, then their surface forms cuticle instead of pus, and so the sore is healed.

In order that this may be accomplished, several conditions are necessary. In the first place, all inflammation must cease, and there must be no fresh inflammatory exudation; on the contrary, one of the earliest signs of the healing of a wound is the decrease of swelling and the absorption of exudations in the surrounding parts, insomuch that the wound may be reduced to one half of its former size before one particle of new cicatrix be formed. It is evident that this must be the case so soon as the subcutaneous and other tissues are relieved of infiltration and swelling, and the skin allowed to recover its natural elasticity.

In the next place, the lymph exuded and formed into granulations, besides being in a state of vascular tranquillity, without hyperæmia and inflammatory exudation, must be endowed with the chemical composition and "vital properties" requisite for the development into epithelium. If not, the surgeon must make the requisite alteration in the condition of the blood by diet, iron, bark, and the other remedies spoken of in the article on Ulcers Weak and Indolent, Scrofula, &c.

Then, again, the granulating surface must not be subjected to local conditions which may irritate, or poison, or disturb it. The pressure of the blood must be taken off if requisite by rest and an elevated posture, or must be counteracted by a bandage. The local applications must be calculated to "agree with" the surface; and it will be shown under the head of Wounds and Ulcers, how some granulations do best if absolutely not interfered with, whilst others will not cicatrise without the application of some mineral or vegetable astringent.

So soon, however, as every requisite condition is present the work of cicatrisation begins. The sore contracts; the edge, instead of being abruptly defined, is smoothed off; it dips downwards, and is blended as it were with the surface of the granulations; and then begins a bluish white line, which gradually widens and extends from the circumference, all over the surface of the sore, and which consists of newly developed and tender cuticle. As the most external layer of granulations developes itself into cuticle, so do those beneath into connective tissue, and this contracts incessantly, so that the cicatrix when complete is much smaller than the wound which it replaces.

It is from the edge of the sore that the cicatrising process spreads, for it seems as if the impulse to the formation of cuticle is given by the skin. In certain large and irregular ulcers, indeed, islands and peninsulas of cicatrix may form, so as to countenance the idea that the centre of a sore has the power of originating cuticle as well as the edges. But in cases like these it is certain that the whole thickness of the cutis has not been destroyed throughout, and any fragment that remains has the power of commencing the work of cicatrisation.

Not only does cicatrisation seem to depend on the natural skin for its origin, but it also seems to advance to any distance from it with great slowness and difficulty. The last portions of surface are always more tedious in healing than the first.

From this it may be understood how great an obstacle the size and shape of a sore may present to the healing process. As Sir A. Cooper remarked, a sore of circular form, *cæteris paribus*, will always be longer in healing than another of much greater length, but less diameter. It may be seen further how important it is to save plenty of skin in operations, and not to leave more surface to be covered in by granulations than can possibly be helped.

Everything, too, which hinders that contraction which nature in her wise economy employs in order to abridge the cicatrising process, is equally a hindrance to the completion of the reparative process. Hence, recovery is notoriously tedious after burns, and after the destruction of large tracts of skin by nitric acid in the American cancer cure. Because in these instances the subcutaneous areolar tissue has been destroyed, and so the cicatrix, instead of resting on that natural basis, which allows of a gliding movement, and so permits the skin to be drawn together from every side, is, from the first, glued down to the surface of the fascia beneath, and is unable to move. The same thing occurs when extensive portions of skin have been lost from over the shin, or from the scalp.

Moreover, it is as Mr. Paget observes, an error to speak of the "filling up" of a chasm with granulations; for nature is as sparing in the depth as she is in the breadth of cicatrices. "In the deepest open wounds," says Mr. Paget, "the granulation layer is but from one to three lines thick; and when such a wound grows shallower in healing, it is not by the rising of the granulations, but by the lowering of its margins. The granulations and the scars of deep open wounds remain alike, thin and depressed."

A recently formed cicatrix is reddish, tender, and covered with a delicate cuticle, and consists under the cuticle of connective or areolar tissue in an imperfect state of development. Even though a cicatrix of the skin only, it is more adherent than natural to the fascia beneath; whilst, as before said, if the subcutaneous areolar tissue has been destroyed, it will be adherent to the bone or fascia beneath.

But in the course of weeks, or months, or years, there ensues a process of shrinking, of accommodation, and of perfecting of tissue. The scars become paler, then of a dense bloodless white—a change which is but too familiar after small-pox. It acquires the characters of more perfect fibrous tissue, and the elastic fibres are developed in it; the cuticle becomes more perfect; the subcutaneous portion looser, and more like natural areolar tissue, so as to allow of gliding; and, provided the whole thickness of the skin has not been destroyed, papillæ are developed on the surface, and pigment in the deeper layers of cuticle. To a certain degree also,—not any great degree if much of the skin has been destroyed,—the scar loses its distinctness, and the natural characteristics of the skin are regained.

In the case of burns, the contraction of cicatrices is commonly a source of prodigious deformity and trouble. (See BURNS.) In like manner, the contraction of the cicatrices of ulcers in the intestines and urethra, or of new fibrous tissue developed from disease, gives rise to strictures. In the mouth, after sloughing of the inside of the cheeks and gums from profuse salivation, the cicatrised surface is so rigid as scarcely to allow of the separation of the teeth, but it becomes more pliant in time. After rupture of the perinæum, the cicatrix contracts longitudinally, so as to draw the posterior commissure of the vulva down to near the anus. When cicatrices have been subjected to great and long continued irritation, they are liable to acquire the most grisly hardness, as in fistulæ of the perinæum, and in stricture.

MORBID STATES OF CICATRICES.

The newly formed tissue, even when perfected, is liable to morbid states which may occupy the surgeon's attention. Thus

It is said, that in the scurvy, cicatrices, even of years' duration, are liable to break out afresh into open wounds. If attacked by inflammation before the healing process is complete, they are sure to be melted down by suppuration, and the work of weeks or months may be destroyed in a few hours. Nevertheless, it is said that they are not attacked by the small-pox, measles, or the scarlatina. (*Dupuytren, Clin. Chir.* t. ii. p. 47.) If this is so, it is because the vascular surface, which is the seat of the erythema, is absent.

The cicatrix of a chancre, so long as it remains indurated and swelled, seems still to contain some of the syphilitic poison, and is liable to ulcerate afresh, and to propagate infection as the original sore would have done.

The contraction of cicatrices, after burns, renders it often necessary to resort to operation for the purpose of loosening parts bound together, and restoring the natural form and use to the parts implicated. (See CICATRIX.) Similar operations are sometimes requisite in the case of irregular cicatrices about the eyelids.

In contradistinction to the common process of shrinking and atrophy, cicatrices are sometimes liable to be the seat of a hypertrophic process, which produces flat, slightly elevated tumors, similar to those which are called *Keloid*. Such tumors seem to consist of the ordinary skin tissues intermixed with *fibro-plastic* elements. M. Lebert narrates the history of a child ten years and a half old, who had on the back numerous *keloid* tumors developed in the scars which resulted from several applications of fused potass by a quack, who had promised by that means to cure a scrofulous affection from which the child suffered. (*Traité pratique des Maladies Cancéreuses*, p. 683.) (See TUMORS.) As M. Lebert observes elsewhere, *keloid* may be designated a spontaneous cicatricial alteration of the skin. Rokitansky and Wedl say the same.

Lastly, cicatrices, especially of the lower extremity, are occasionally the seat of warty growths, which degenerate into epithelioma—q. v.]

R. Druitt.

[*Hunter* on the Blood, &c. *Paget*, Lectures on Surgical Pathology, &c. vol. i. *Wedl*, Pathological Histology (Sydenham Society). *Cæsar Hawkins* on Warty Tumors, of Cicatrices, Med. Chir. Trans. 1855. *Lebert*, Anatomie Pathologique. *Hannover*, das Epithelioma, &c. 1852, pp. 106, 113, &c. *Rokitansky*, vol. iii. (Sydenham Soc.).

CICATRIX. A scar: the mark left after the healing of a wound or ulcer. Also, the new formed production, or the substance of the cicatrix, which is covered with a very delicate adherent, and smooth, shining cuticle, the existence of which is easily demonstrated by means of a blister or maceration. Under this stratum is a dense tissue, composed, according to Dupuytren, of fibrous layers, more or less dense, and crossing one another in all directions. Between the *tissue of the cicatrix*, as Dupuytren calls it,—the *tissue inodulaire* of Delpech and other French writers—and the cuticle, there is no trace of rete mucosum, or deep, soft, layers of epidermis, which circumstance seems to Dupuytren to explain, why a cicatrix presents the same colour in the negro and the European. The tissue of a cicatrix contains neither sebaceous follicles, nor hair-bulbs; at all events, this is the case when the whole thickness of the skin has been destroyed. The same tissue is pierced by a small number of exhalant, or absorbent pores. [In some cases the original subcutaneous cellular tissue beneath it is in a healthy, lax condition, permitting the cicatrix to move freely upon the deeper parts. In other cases, the cellular tissue has been destroyed, or so altered that there is a firm attachment between the cicatrix and the subjacent parts.]

The appearance, and likewise in some measure the texture of a cicatrix, were observed by Dupuytren to differ according to the causes which produced the solution of continuity. The lapse of many years will not prevent a man of experience from distinguishing the cicatrices of burns from those which have been caused by sharp instruments; and both these kinds from others resulting from ulcerated cancer, herpetic diseases, syphilitic sores, or scrofulous abscesses. The importance of this kind of knowledge in medical jurisprudence is very properly insisted upon by Dupuytren, sometimes to establish the identity of individuals, and sometimes to define the nature of the cause by which the solution of continuity has been produced.

The vascularity of cicatrices is various. In general they are only furnished with a few very minute capillary ramifications, scarcely capable of being injected. In the face they are sometimes seen retaining all their whiteness in the midst of the general redness of the countenance occasioned by heat, blushing, &c.; yet they are not insensible to external impressions, and as they are acutely painful, when inflamed, they must receive nerves, though in small number. How sensitive they are with respect to different states of the atmosphere, and how faithfully the painful shootings in them announce to many individuals the temperature and moisture of the air, is another point adverted to by Dupuytren in proof of their having nerves. (See *Clinique Chir.* t. ii. p. 42.)

[The reader will find under BURNS a full descrip tion of the means employed during the healing of cicatrices, to prevent those deformities or impairments of function produced by the process of contraction which follows the healing process; a process more fully described under CICATRISATION. It only remains now to point out the means of repairing, or removing, those ill effects in cases where they have occurred.]

Of the Means for correcting the Deformities, and relieving the Impairment of Functions arising from the unfavourable Cicatrisation of Burns. These deformities consist of inequalities, fleshy bands, fræna, adhesions, depressions, a puckering up of the parts, and discolourations or stains of the skin.

With respect to the marbled or mottled discolorations left as consequences of exposure to moderate degrees of heat, the treatment recommended by Dupuytren consists in removing the exciting cause, and using astringent lotions, particularly those of the acetate of lead. He acknowledges, at the same time, that the plan is generally unavailing, and suspects that it would prove more successful if combined with methodical compression. The slow and prolonged action of caloric here adverted to he found to be not unfrequently the cause of varices.

The following are some examples of the various deformities which Dupuytren had known to follow burns. In some patients all the integuments at the base of the skull, and with them the ears and eyebrows, were strongly drawn upwards by a cicatrix which had contracted itself towards the top of the head. In others, the eyebrow and upper eyelid were drawn up and rendered immovable by a cicatrix on the forehead. In one, the eyelids were everted, with scars on their fore part or at the base of the orbit. In another, the commissures of the eyelids were drawn outwards or inwards by cicatrices on the temples or the root of the nose; or the ala of the nose was pulled upwards by a cicatrix above it, and the nostril obliterated. In others, again, the commissure of the lips was drawn upwards, outwards, or downwards, by cicatrices on various parts of the cheek; or the upper lip was united to the septum of the nose; or the lower one to the chin, so as to be incapable of preventing the escape of the saliva. In others, the ears adhered to the temples, and the meatus was contracted or obstructed; or the chin, with its prominence effaced, was fixed to the front of the neck, or upper part of the chest; or the skin of the neck adhered to the thyroid cartilage, or hyoid bone, whence a difficulty of swallowing, and an incurable *enrouement*. In other instances the shoulder was drawn upwards, and the head to one side, by a cicatrix on the lateral part of the neck. In some girls, in consequence of the horrible mutilation of the breast, the mammary glands could not be developed, or serve for the secretion of milk. In other cases seen by Dupuytren, the trunk was bent forwards, by bands extending from the front of the chest to the abdomen; or the shoulder was depressed towards the hip, and thus pulled upwards by a cicatrix on the side of the trunk; or the elbow was fixed close to the side by a cicatrix in the axilla, resembling a kind of fin, when an attempt was made to lift the humerus from the side: or the forearm was held in the bent position by the effects of a cicatrix situated on the front of it or the upper arm. In other instances the wrist was bent or extended, or the fingers similarly affected were all united, and blended together in one mass, covered by the cicatrix. Dupuytren had seen the penis either fixed to the linea alba by a cicatrix which represented a sort of fold like what prevails in quadrupeds; or else drawn to one side and adherent to the scrotum, which had grown to the thighs. In one case the thigh was fixed in the bent posture by a cicatrix in the groin, which cicatrix, though scarcely apparent when the limb was quiet, was converted into a very prominent band by the least movement of extension. Dupuytren had known the abdominal ring so weakened by a cicatrix in front of it, that a hernia took place, attended with the peculiarity that the cicatrix formed such a projection when the limb was extended, that it prevented the patient from keeping up the bowels with a truss, until it had been divided. In other cases he had seen the leg kept permanently bent by bands in the ham; or the feet twisted outwards or inwards in consequence of burns on the sides of these parts, or the legs, which had occurred in early life; or the toes pointing straight upwards, or downwards, sometimes with their dorsal surface directed towards the ground, so as entirely to incapacitate the patient from walking.

Mr. Earle has known the contraction of the cicatrix of a burn act with such force as to bring the shoulders towards one another by a partial absorption of the clavicles. He mentions another case in which not only the whole head was bowed down towards the sternum, but the lower jawbone curved downwards, so as only to admit of the last molar teeth coming in contact; the mouth being kept permanently open, and the direction of the incisor teeth so altered that they projected nearly in a horizontal line. In a third case the arm was pinioned to the side, and the hair and scalp drawn many inches down the back between the scapulæ. (See *Two Lect. on Burns*, p. 41.) Such, indeed, is the force adverted to, that dislocations may be produced by it. I have known instances of this with reference to the thumb and fingers: and Cruveilhier describes the particulars of a rare example, in which the carpus was luxated from the radius from the same cause. (See *Anat. Pathol.* liv. ix.)

However numerous or diversified the deformities from burns may be, Dupuytren considered all of them as admitting of being classed under a few heads. All of them consist either of *cicatrices*, which are *too narrow*, or *too prominent;* or in unnatural *adhesions*, or *obliterations*, or in *losses of organs.*

With respect to operations undertaken for the cure of deformities from burns, Dupuytren lays down the following principles:—1. The attempt should never be made till several months, or even years, after the formation of the cicatrix. This rule, he says, cannot be deviated from, without the risk of incurring a great loss of substance, produced by the destruction of the new-formed substance of the cicatrix. 2. An operation should never be practised unless a less deformed cicatrix than that which it is wished to correct can certainly be obtained with the aid of position and bandages. This precept Dupuytren deemed specially applicable to cicatrices on the face, which in general, he says, should not be meddled with. 3. An operation should only be undertaken when it will restore the original shape and functions of the parts. Hence, it must be abstained from whenever ankylosis exists, or the muscles and tendons are destroyed. Occasionally, however, it may be performed for the removal of deformity, though the functions of the part cannot be restored by it. (See *Clin. Chir.* t. ii. p. 51, &c.)

But in what manner, and according to what rules, is the operation, if judged advisable, to be performed? Now Dupuytren does not admit, 1. That every operation which leaves the texture of the cicatrix subsisting, will be followed by a return of the contraction as before. 2. Or that, in order to attain success, it is absolutely necessary to cut away the cicatrix, and then bring the edges of the wound together, so as to unite them by the first intention. He found, that when the cicatrices had, after a length of time, acquired their complete solidity, and the fræna or bands had become perfectly organised, that the substance of the cicatrix is scarcely more disposed to contract than an original texture. Hence the rule which he lays down, that no surgical operation should ever be done until the cicatrices and adhesions have attained this perfect organisation. When the object was to remedy too narrow a cicatrix, Dupuytren used, 1. To make, at various points of the frænum, transverse incisions completely through it, so as to be able perfectly to extend it without removing any of its texture. 2. To extend the parts, and bring them into the opposite direction to that in which they had been drawn by the burn, and thus obtain a cicatrix by the production of a new cutaneous tissue. The requisite position was then maintained by means of bandages, machinery, &c. If the parts were supple and yielding, they were put at once into the right posture; in the opposite case, a slow and gradual extension of them was made, for which purpose Dupuytren conceived that splints furnished with elastic springs, so as to keep up a gentle but permanent effect, would be of great use. In this country, springs with hinges, and allowing their angle of flexion to be regulated by a screw, are often employed. 3. The operation having been performed, the case seemed to Dupuytren to be nearly in the same condition as directly after the separation of the eschar. Hence his advice is, that the formation of the cicatrix should be regulated by the means already specified; and every effort made to hinder it from taking place by the approximation of the edges of the wound. If secondary fræna or bands form, they are to be immediately cut through, without sparing one of them. To the neglect of this precept, Dupuytren ascribes the failure of many operations.

If the removal of too prominent a cicatrix was the object, Dupuytren first sliced off the projecting part of it on a level with the skin: secondly, he kept the edges of the wound apart: thirdly, he frequently cauterised the surface, so as to keep it rather below the level of the integuments. (See *Clin. Chir.* t. ii. p. 68.)

Instead of slicing off the prominent cicatrix, Mr. Higginbottom rubs it with the nitrate of silver, exposes it to the air for three days, and then covers the part with ointment. The application is repeated as often as necessary. (See *J. Higginbottom*, *On the Use of the Nitrate of Silver*, p. 157, ed. 2.)

If the deformity consisted in simple adhesions, Dupuytren's practice was as follows:—1. After having divided them, he dissected them freely to beyond their origin. 2. Then he drew the parts asunder. 3. Methodical and constant pressure was maintained on the point whence the cicatrix must proceed, which is always at the angle of union of the parts. (*Clin. Chur.* t. ii. p. 69.)

When the surfaces adherent to one another are extensive, as in cases of union of the arm to the trunk, or the two thighs together, Dupuytren cautions surgeons not to complete the operation at once, as dangerous consequences may follow so large a wound. The same rule is applicable to extensive callous prominences. Here it is best to proceed by fractions, and to let the wound of one operation be cured before another is undertaken. (P. 73.) Another important caution given by Dupuytren is, to be certain, before any operation is attempted, that the limb, retained in a faulty position, is not incapable of being brought into a better one; if there were deformity of the articular surfaces, ankylosis, or atrophy of the limb, the division of the adhesions and contractions would be entirely useless.

[Of late years, more especially since the writings of Dieffenbach have become better known, the surgical treatment of cicatrices has become better understood, and four different methods have been planned, upon one or other of which we may proceed to remove deformity, to restore the impaired function of an injured part, or to remove a cicatrix the structure of which has degenerated into a morbid condition. These methods are—

I. *Subcutaneous Division.*
II. *Division from without.*
III. *Extirpation, and*
IV. *Incision or Extirpation with Transplantation.*

I. *The Subcutaneous Division* of disfiguring cicatrices may be frequently undertaken in cases where the skin about the face, neck, or arms is drawn inwards by a cicatrix, and attached to the subjacent bone in such a manner as to form a sort of hole or deep pit-like exaggeration of a dimple. This pitting of the skin of the face is sometimes attended with considerable deformity, commencing in the orbital region, and running in different directions over the face. Attempts are often made to loosen attachments to bone by constant rubbing and traction, or inunction of simple ointments; but all this is generally ineffectual, and it is better to recommend immediate operation in cases where the deformity is at all sufficient to warrant it. A sharp-edged needle, or a small tenotomy knife, is used. A puncture is made in the sound skin, just beyond the edge of the depression; and then, keeping the flat surface of the knife parallel with the skin, the base of the cicatrix is divided as close as possible to the bone, without enlarging the wound in the skin. When dealing with a long, narrow, trough-like depression, it is better to make several punctures than to attempt to do too much by one; because the object is to divide the attachment with the least possible disturbance of the healthy lax cellular tissue around, and to avoid subcutaneous extravasation of blood, and the suppuration to which this might give rise. After the division, it is always necessary to fix a compress over the spot firmly by straps of plaster and a bandage, so that the pressure may prevent any collection of blood from taking place. About the third day the puncture is healed, and the deforming pitting of skin completely removed.

In some cases, cicatrices which attach the skin of the face to the bones beneath may be divided without touching the skin, by making separation from the mouth. In either case, if the skin has been firmly attached to the bones to any great extent, it will be necessary, after separating it, and carefully pressing out any effused blood, to apply strips of plaster upon the skin, and draw it by them in such a direction that the apposition of the two wounded surfaces is prevented. If this be not carefully done, the parts might return readily to their former condition.

Similar cicatrix pittings about the lower jaw form after the healing of dental fistulæ; or on the inner or outer border of the sterno-mastoid, the upper part of the sternum, or the anterior part of the clavicle, after abscesses about the neck. Scrofulous abscesses in early childhood often cause such deformities. They are treated most successfully by subcutaneous division, as above described, provided the skin itself be healthy. If unhealthy, one of the other methods, to be described immediately, must be adopted. More care, to avoid important vessels and nerves, is, of course necessary, than when operating about the face.

Subcutaneous division is also often required to relieve the contraction produced by cicatrices about the hands and fingers. The condition described by Dupuytren, in which the skin is attached to a flexor tendon and shrunk up into a fold, is readily relieved by separating the attachment between skin and tendon. It is necessary to be very careful not to wound the tendon, and to adopt some means of extension afterwards by splints, or plaster of Paris bandages, or some orthopœdic apparatus, until the finger is quite straight.

In many operations where muscles and tendons are divided to improve the condition of joints, or in cases of forced extension or forcible rupture of ankylosis, subcutaneous division of cicatrices becomes an important auxiliary, especially in cases where the skin has become adherent from previous abscesses or fistulæ. If the shortened tendons and muscles, and the thickened contracted fasciæ be alone divided, in such cases the skin gives way when the joint is forcibly stretched, and there is danger both to limb and life—a danger easily avoided by dividing the cicatrices, either before dividing the tendons, or when the cicatrices become tense and cord-like on stretching after the tendons have given way.

Subcutaneous division is also occasionally useful when the skin is attached to the broken end of a bone, having been drawn inwards in consequence of compound fracture.

II. *Division from Without Inwards* may be either—(*a*) *simple transverse division;* (*b*) *repeated transverse division, or notching;* (*c*) *oblique division;* and (*d*) *division with loosening of surrounding skin.*

(*a.*) The *simple transverse* division of small cicatrices is most commonly necessary about the neck, or the flexor aspect of the limbs, when, on extending the part, the existing cicatrix is much stretched, projecting as a sharpish ridge. The result of the operation is only satisfactory when the cellular tissue beneath the cicatrix is tolerably soft and extensible, and the cicatrix not amalgamated with deeper parts.

The operation is performed in the following manner:—The cicatrix is put as much as possible on the stretch, the edge of the knife applied upon its most projecting part, and the cicatrix is completely cut across. As extension is kept up, the edges of the wound separate from each other, and the transverse wound becomes a long one. It is dressed simply, and the new position maintained by bandages and splints, or by a stiff cravat.

(*b.*) The repeated transverse division, or *notching*, is required when a narrow hard cicatrix is closely united with subjacent parts. It is done precisely like the simple division, except that it is at several spots instead of one. The deep-seated thickened cellular tissue must be also divided, and after-extension kept up.

(*c.*) *Oblique division*, as Dieffenbach has pointed out, is especially indicated in cicatrices after large wounds of the fingers or inside of the hand. A long cicatrix draws a finger crooked like a bow, and on attempting to straighten it the cicatrix projects like a bow-string, with a hard wall between it and the bow. Notching here would lead to acute inflammation, new cicatrices, and more intimate adhesion to the tendon. Simple division would be useless, while oblique division is very successful. The finger is stretched as much as possible by an assistant, and the surgeon passes a long narrow knife through the sound skin, a few lines from one end of the cicatrix on one side of it—the left, for example. The knife is then gradually passed through the whole length of the cicatrix, to its other end, until the incision ends in the sound skin beyond the cicatrix on the right side. On powerfully stretching the finger the two wounded edges are seen to glide laterally, so that the wound appears longer than the incision. If the cicatrix be very hard, it is necessary to make small notches along both edges. The finger is gradually extended by binding it on to a splint, and the lost mobility of the joint must afterwards be restored by frequently flexing and extending it.

(*d.*) Any of these modes of dividing cicatrices may be accompanied by loosening of the surrounding skin, in order to allow of the edges of the wound being brought together without stretching.

III. *Extirpation* of cicatrices may be necessary, either to remove deformity or on account of a morbid condition of the cicatrix itself.

We may be called upon to excise disfiguring cicatrices about the face and neck, which have remained after the healing of scrofulous abscesses, large boils, diseased bone, specific or cancroid ulcers, wounds and surgical operations, where union by first intention has not taken place, and to complete certain plastic operations. The operation may be either (*a*) *simple*, or (*b*) *repeated*, and in either case accompanied by loosening of the cicatrix and surrounding integument, to admit of gliding.

(*a*) *Simple* extirpation is effected by two elliptical incisions surrounding the cicatrix, which is then raised and removed by ordinary dissection; or it may be raised in some situations with hooked forceps, and cut away by a stroke of the knife or scissors. The cicatrix should be removed entirely, so that the edges of the wound to be brought together are in sound skin. These are to be carefully united by small pins and the twisted sutures. If they do not come together easily, the skin around is to be loosened by flat strokes of the knife, or by lateral incisions, if necessary.

(*b*) *Repeated* or *partial* extirpation is called for when the cicatrix is so broad that it would be impossible to bring together the wounded edges left after excising it. In this case an elliptical portion is first excised from the centre of the cicatrix and the edges united. Some weeks or months after the healing of this wound another piece is excised, and this is continued until the whole cicatrix has been removed and the edges of sound skin surrounding it have been brought together. In cicatrices of very irregular form, it is sometimes necessary to excise intermediate portions of sound skin, in order to give a regular outline to the wound. These operations are much facilitated by loosening the surrounding integument.

When a cicatrix is hypertrophied, or is the seat of morbid growths, or of obstinate ulceration, or is constantly giving way and breaking open from being kept on the stretch, it may be excised by one or other of the plans just described, or it may occasionally be necessary to amputate the part or limb on which the cicatrix is situated.

When an operation is undertaken to correct the unnatural conditions of joints dependent on contracted cicatrices, the loosening of the surrounding tissues becomes an important part of the proceeding. For instance, when the elbow joint is fixed by cicatrices, two oblique incisions, commencing one on the outer and the other on the inner side of the upper arm, are carried down converging to the fore-arm, where both meet at an acute angle. While the arm is still bent, the middle of the pyramidal flap is on the upper part of the fore-arm; but after dissecting it up from apex to base, and extending the limb, the middle of the flap glides up on to the upper arm. The narrow part of the pointed wound of the fore-arm is now united by sutures, and the union higher up is assisted by making long lateral incisions through the skin two inches distant from the edge of the wound. The flap is then united in its new position, also by sutures. It does not materially affect the good result of the operation if it should not be possible to close up the wound entirely.

In slighter cases of yielding and more extensible cicatrices, Dieffenbach speaks favourably of the following method:—Two incisions are made on the flexor side of the joint, an inch above and an inch below it, running half round the arm. The limb is then gradually stretched, and the unyielding cellular tissue cut through. The bridge lying between the two incisions then retracts and forms the flexor fold of the joint, exactly covering the point from which granulations spring up and lead to new contraction, in cases where a cicatrix has been simply divided transversely. Simple dressing and an extending splint constitute the after treatment.

After burns or wounds of the palm of the hand, when the contraction of cicatrices has led to close connection between one or more fingers and the palm, Langenbeck speaks very highly of the plan of first separating the fingers from the palm, and closing the wounded surface thus produced by loosening the skin on the sides of the fingers, and uniting the wounded edges on the palmar surface. Then the wound of the hand is closed by loosening the sound skin up to the back of the hand, and drawing it over the wound of the palm. In this way, Langenbeck says, he has cured complete adhesion of all the fingers with the palm, so that the movements of the fingers were completely restored.

IV. *Transplantation* of integument from the neighbourhood or a distance is occasionally useful in cases where incision or excision are not alone sufficient to effect the desired purpose. This is most frequently done about the neck, where, after division of the cicatrix and subjacent tissues, or the sterno-mastoid if necessary, until the head can be brought into its natural position, a large gap is left. Here a flap can be formed from the shoulder, and twisted to fill up the gap, being carefully united all round the edges by sutures. Several cases in which this method has proved very successful have been published by Mutter. When the lower lip has to be restored, operation being rendered necessary by the contraction of extensive cicatrices of the neck, the operation described by Mr. Teale (*Medical Times and Gazette, June,* 1857) is followed by excellent results, restoration being effected by the gliding of lateral flaps formed of the cheek and everted lower lip. The upper lip and eyelids may be restored by analogous operations. For further details on this subject see PLASTIC SURGERY, LIPS, EYELIDS, NOSE, &c.]

T. Spencer Wells.

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CICUTA. See CONIUM.

CINCHONA. As one of the designs of this dictionary is to embrace the subjects of a surgical pharmacopœia, Peruvian bark, which is administered in a great number of surgical cases, cannot be passed over in silence.

Under particular circumstances, bark has undoubtedly the quality of increasing the tone of the digestive organs; and whenever the indication is to strengthen the system by nourishing food, and the appetite fails, this medicine may prove of the highest utility, provided it be given in moderate doses, and it be found to agree with the stomach and bowels.

With respect to cases of mortification, in which this medicine has been very largely employed, it is most strongly indicated, when the sloughing is not surrounded with active inflammation, when the patient is debilitated, and his stomach cannot take nutritious food. I have always regarded the notion of giving bark, as a specific for gangrene, as totally unfounded and absurd. I have watched its effects in such cases, and could never discern that it had any peculiar power of operating directly upon the parts which are distempered. Whatever good it does, is by its improving the tone of the digestive organs, and making them more capable of conveying nourishment, and of course strength, into the constitution.

Mortifications arising from mere cold, compression, or constriction, generally cease upon removing the cause, and are, therefore, seldom proper cases for proving the power of bark. However, there are two kinds of gangrene, where internal remedies have a fairer trial; those are, a spreading gangrene from an internal cause, and a spreading gangrene from violent external accidents, such as gunshot wounds, compound fractures, &c. Yet, even here we cannot judge of their effect with absolute certainty; for sometimes a mortification from internal causes is a kind of critical disorder. There seems to be a certain portion of the body destined to perish, and no more; of this we have an infinity of examples brought into our hospitals, where the gangrene stops at a particular point, without the least assistance from art. The same thing happens in the other species of gangrene from violent accidents, where the injury appears to be communicated to a certain distance, and no farther; though, by the way, I shall remark in this place, contrary to the received opinion, that gangrenes from these accidents (where there has been no previous straitness of bandage) are as often fatal, as those from internal causes.

Some further remarks on this subject will be reserved for the article MORTIFICATION.

Bark is given so extensively in the practice of surgery, that there are few important cases, in which, in certain circumstances, and at some period or another, it is not indicated. When persons have been weakened by a course of mercury, or by the effects of any disease whatsoever, moderate doses of bark will frequently be found of great service. But, it only becomes so on the principles above suggested, and, so far as my judgment extends, this medicine should never be prescribed in any surgical cases in excessive and unreasonable quantities.

Modern chemistry has shown that the virtues of the various kinds of cinchona reside in two salifiable bases, or alkaline elements, termed *cinchonia*, and *quina*, and one very desirable result of the establishment of this doctrine is that of being able to prescribe preparations, which will concentrate all the efficacy of the medicine in formulæ of moderate bulk, not likely at least to disorder the alimentary canal by the mechanical effects of quantity.

The sulphate of quinine or quina, "appears to be the most efficient of all the salts of bark. We must be careful not to combine it with substances that form insoluble compounds with it. The infusum rosæ comp. is objectionable as a vehicle, on account of the astringent matter which it contains, and which therefore precipitates the quina from its solution." The form, in which Dr. Paris prefers to prescribe it, is that of solution, with a minim of sulphuric acid to every grain of the salt. (*Pharmacologia*, vol. ii. p. 163.) It is frequently made into pills, with the conserve of roses, or joined with hyoscyamus, squills, opium, and other medicines. Professor Brande does not agree with Dr. Paris respecting the compound infusion of roses being an unfit vehicle for sulphate of quinine, and recommends the subjoined formula: ℞. *Quinæ sulphatis* gr. ij. *Infus. rosæ comp.* ʒxi. *Tinct. cort. aurant. Syrupi ejusdem* aa ʒss. M. ft. haustus bis in die sumendus.

[The last edition of the London Pharmacopœia contains a *tinctura quinæ composita*, which consists of a solution of the sulphate in tincture of orange peel. Each fluid drachm contains one grain of quinine.]

"Although the pale bark yields chiefly *cinchonia*, with a small quantity of quina, and the yellow *quina*, with a small proportion of cinchonia, yet the quantities of the opposite principles are too small to give a character to the medical properties, or the chemical nature of the barks. In the red bark of the pharmacopœias, these salts exist together in nearly equal proportions." (See *Thomson's Elements of Materia Med.* p. 489, ed. 2.)

CINNABAR, ARTIFICIAL (*Hydrargyri sulphuretum rubrum, Hydrargyri bisulphuretum*) is chiefly employed by surgeons for fumigating venereal ulcers. An apparatus is sold in the shops for this purpose. The powder is thrown upon a heated iron, and the smoke is conducted by means of a tube to the part affected. [It may also, if applied to the general surface of the body, be made the means of producing the specific effect of mercury on the system. For this it is an inferior preparation to the grey oxide, and also to the chloride (calomel). This latter has been largely employed of late years for fumigating purposes by Mr. H. Lee, in the Lock Hospital.] (See FUMIGATION.)

CIRCUMCISION, (from *circumcido*, to cut round.) The operation of cutting off a circular piece of the prepuce. (See PHYMOSIS.)

CIRSOCELE, (from κιρσὸς, a varix, and κήλη, a tumor.) Cirsocele, a varicose enlargement of the spermatic vein. (See *Varicocele.*)

CIRSOPHTHALMIA, (from κιρσὸς, a varix, and ὀφθαλμὸς, the eye.) A general varicose affection of the eye.

CLAP. (See GONORRHŒA.)

CLOACA. The openings leading through the new bony shell, in cases of necrosis, down to the enclosed dead bone are termed *cloacæ*.

COLLYRIUM. [This term is commonly employed to signify a lotion used in diseases of the eye. The following are some of the formulæ of the Royal London Ophthalmic Hospital. Besides these, however, there are other solutions, which are used as *drops*, for more direct application to the conjunctival surface. (See GUTTÆ.)

COLLYRIUM ACETI.—℞. *Aceti destillati, f.* ʒss.; *Aquæ, f.* ʒvijss. Misce.

COLLYRIUM ALUMINIS.—℞. *Aluminis*, gr. viij.; *Aquæ, f.* ℥i. Liqua.

COLLYRIUM ALUMINIS FORTIUS.—℞. *Aluminis*, ℈i.; *Aquæ, f.* ℥i. Liqua.

COLLYRIUM HYDRARGYRI OXIDI (LOTIO NIGRA).—℞. *Hydrargyri chloridi*, gr. iv.; *Liquoris calcis, f.* ℥i. Misce.

COLLYRIUM PLUMBI ACETATIS.—℞. *Plumbi acetatis*, gr. ij.; *Aquæ destillatæ, f.* ℥i. Liqua.

COLLYRIUM PLUMBI CUM OPIO.—℞. *Lotionis plumbi acetatis, f* ℥j; *Tincturæ opii*, ♏iii. Misce.

COLLYRIUM ZINCI OXIDI.—℞. *Zinci oxidi*, gr. xxiv.; *Misturæ Acaciæ, f.* ʒi.; *Aquæ, f.* ʒvij. Misce.

COLLYRIUM ZINCI SULPHATIS.—℞. *Zinci sulphatis*, gr. j.; *Aquæ, f.* ℥j. Liqua.

COLLYRIUM ZINCI CUM OPIO.—℞. *Lotionis zinci sulphatis, f.* ℥i.; *Vini opii*, ♏v. Misce.]

COLPOCELE, (from κόλπος, the vagina, and κήλη, a tumor.) A tumor or hernia, situated in the vagina.

COLPOPTOSIS, (from κόλπος, the vagina, and πίπτω, to fall down.) A bearing or falling down of the vagina. (See VAGINA, PROLAPSUS OF.)

COMPRESS, (from *comprimo*, to press upon.) Folded linen, lint, or other materials, making a sort of pad, which surgeons place over those parts of the body on which they wish to make particular pressure; and for this purpose a bandage is usually applied over the compress. Compresses are termed *graduated*, when of a conical form, and the apex is so applied, as to make the pressure act very particularly on a certain point.

COMPRESSION OF THE BRAIN. (See HEAD, INJURIES OF.)

CONCUSSION OF THE BRAIN. (See HEAD, INJURIES OF.)

CONDYLOMA, (from κόνδυλος, a tubercle, or knot.) [This term has been employed to denote various prominences, excrescences, and warty growths, in the neighbourhood of the rectum and genitals, in both sexes. As some of these differ in their nature and in the treatment required for their removal, it would be desirable not to include them under the same designation. The excrescences and warty growths do not arise from the virus of syphilis, are not benefitted by mercurial treatment, and may safely be treated by excision, or by escharotics, while the smooth round slightly raised moist prominence, called by the French pathologists *tubercule muqueux*, and to which it would be better to restrict the term condyloma, is a true secondary symptom of the venereal poison, and gives way readily to a mercurial treatment general and local. To the condyloma as thus defined, the best local applications are the black wash, calomel in powder, a lotion of the bichloride of mercury of the strength of two grains to the ounce of distilled water, or mercurial fumigation directly applied.] (See SYPHILIS.)

[CONGESTION.] [(*Congestio*, from *congero*, to amass). Congestion of blood. Accumulation of blood in a part, with a languid or retarded circulation. Some of the most eminent pathologists have preferred the term "hyperæmia," which is most consonant with the phraseology relating to the pathology of the blood employed generally in this dictionary. (See BLOOD, PATHOLOGY OF; HYPERÆMIA; INFLAMMATION.)]

CONIUM MACULATUM. Hemlock. — *Cicuta.* This is a medicine to which my observations in practice incline me to impute considerable efficacy. However, there is no doubt that, when it was represented as a certain cure for cancer and scrofula, great exaggeration was employed. Hemlock certainly has no power of curing cancer; but its narcotic anodyne qualities may sometimes tend to lessen the pain of that distemper, so as to render it a useful remedy in that intractable kind of case.

The common mode of exhibiting hemlock is in the form of pills, made of the extractum conii, five grains to each. However, I have always thought three grains sufficient to begin with, the dose being afterwards gradually augmented.

The stomach being a little disordered, and the head somewhat giddy, is a sign of the dose being sufficiently strong.

The activity of hemlock is now found to reside in a resinous element, termed conia, obtained separately, by evaporating an ethereal tincture of the leaves on the surface of water. A dose of half a grain will produce vertigo and headache. The watery extract of this plant has been proved by Orfila to have but little power. (*J. A. Paris, in Pharmacologia*, vol. ii. p. 180, ed. 6.) According to Professor A. T. Thomson, the extract is an objectionable preparation, owing to the difficulty of preserving it. The best, he says, is the tincture of the Edinburgh and Dublin Colleges. (See *Thomson's Elements of Materia Medica*, p. 429, ed. 2.)

In various cases of scrofulous diseases, and also in several very painful irritable ulcers and swellings, conium is occasionally applied in the form of fomentations, lotions, and poultices. The latter are generally made by mixing the powder with the common bread and water cataplasm; the lotions, by dissolving ℨ ij. or ℨ iv. of the extract in ℥ viij. of water.

F. Hoffman, Of Hemlock, 8vo. Lond. 1763. *A. Storck*, Libellus, quo demonstratur cicutam non solum usu interno tutissimè exhiberi, sed et esse simul remedium valdè utile, &c.; editio altera, 8vo. Vindob. 1761. Also Supplementum Necessarium de Cicuta, 8vo. Vindob. 1761. *J. Pearson*, On various Articles of the Materia Medica, &c. 2d ed. 8vo. London, 1807. *J. A. Paris*, Pharmacologia, ed. 6. *A. T. Thomson*, Elem. of Mat. Med. p. 425, &c. ed. 2. 8vo. Lond. 1835.

CONJUNCTIVA. [The conjunctiva is similar in texture to other mucous membranes, but its different portions offer peculiarities. Some parts of it are thickly beset with follicles and papillæ; others consist merely of cellular tissue and epithelium. The nerves of the conjunctiva are numerous; they are derived from the fifth, and are connected especially with those of the ciliary region.

"The appearance of the conjunctiva in health," says Mr. Dixon, "varies greatly according to age, occupation, and climate. In infancy and childhood, the vessels are so small and few that, except at the inner and outer canthi, there are hardly any visible to a casual observer; and the sclerotica has, in consequence, a uniformly white and glistening aspect. As age advances, the conjunctival vessels become larger and more noticeable, especially in persons much exposed to weather, so that a considerable degree of redness of the conjunctiva may exist without constituting a disease. In most people after the middle period of life, a yellow deposit occurs beneath the conjunctiva, which in anxious persons often gives rise to a good deal of needless alarm. It appears in the form of little yellowish-white elevations, around which there is usually a fine plexus of vessels. They never overstep the margin of the cornea; they are termed 'pinguecula,' and need not be interfered with."

Congenital absence of the orbit, and also cases of anchyloblepharon, are always accompanied by absence of the conjunctiva.

A rudimentary development of the globe and anophthalmus are associated with an abnormal structure of the conjunctiva. The latter is continuous in cases of monophthalmia and cyclopia. The surface of the conjunctiva is proportionate to that of the globe, whatever may have caused its enlargement.

An increase of size of the plica semilunaris has been observed by Dubois. (*Ann. d'Ocul.*, vol. xxxiv. p. 268.)

A decrease of the conjunctival surface is observed congenitally with deformities of the globe, and in after life with diminution of its size.

A yellow colour of the conjunctiva is observed in icterus; a gray leaden colour in patients who have internally or externally used nitrate of silver for a long time.

Malignant Diseases of the Conjunctiva.—Of malignant diseases of the conjunctiva we may mention lupus, the epithelial, medullary, and melanotic cancer.

Lupus.—A primary development of lupus has not been observed in the conjunctiva. Lupus tubercles are preceded by hyperæmia, swelling, and by infiltration of a gelatinous substance. They appear as small or large yellowish-gray, whitish-gray, or yellowish-red warts, with a large base. They very rarely encroach upon the cornea.

Cancer of the Conjunctiva.—A case of primary epithelial cancer of this membrane has been observed by Seitz; the general rule is that the conjunctiva is secondarily affected. The cancerous infiltration occurs in many cases without inflammatory symptoms. The pale red or bluish hard nodules are generally painless; afterwards they become paler, softish, decay, and leave an ulcer, which has an elevated, hard, and irregular margin, and an uneven, nodular, reddish, and infiltrated base.

The medullary and melanotic cancer appear, primarily and secondarily, in the conjunctiva. Cancers which emanate from the interior of the globe, very rarely, if ever, involve the conjunctiva; the latter appears only implicated by those which spring from the tissue upon the sclerotica, from the eyelids, or from the appendages of the globe. The nodules are at first small, circumscribed, movable, painless, and of various colours; afterwards they become painful, increase rapidly in size, &c.

Such primary nodules are not unfrequently observed on the semilunar fold and on the caruncule. (See *Seitz*, *Handbuch der gesammten Augenheilkunde*, *Erlangen*, 1855, S. 99; also *L. A. Dèsmarres*, *Maladies des Yeux*, 1855, t. ii. p. 217; also *Wm. Mackenzie*, *On Diseases of the Eye*, 1854, p. 253.) Cancer of the conjunctiva, when primary, spreads by preference in the conjunctiva. It may, according to Mackenzie, be distinguished from syphilitic ulceration, by its slow progress, by its not causing so much swelling, and by its history.

As for the treatment, Dr. Jacob and Mr. Bowman are of opinion that it bids defiance to all remedies short of extirpation. The sooner this is done the better. Dr. Mackenzie (4th ed., 1854, p. 140) says:—"The upper lid will, much more than we could suspect, supply the loss of the lower lid, and the lower that of the upper. If, however, the whole of the upper lid, or if both lids be removed, the cornea will become gradually opaque from exposure, and the conjunctiva cuticular and insensible. Even when the disease is confined to the movable parts of the lids, I consider it better to remove it by a semilunar incision than by one of the form of the letter V, and to allow the wound to heal by granulation, than by bringing its edges together with stitches."

Benignant Excrescences of the Conjunctiva.—Pinguecula, or pterygium pingue. (See Mr. Dixon's account of the appearance of a healthy conjunctiva.) This little tumor contains no fat, but epithelial cells and pigment granules. (*Weller*, *Krankheiten des Menschlichen Auges*, S. 196; *Magne*, *Ann. d'Ocul.*, vol. xxix. p. 218; *Seitz*, l. c. S. 86.) It may be removed with forceps and scissors, if it gives rise to inconvenience. Polypus of the conjunctiva is analogous to those which occur on other mucous membranes. It is more or less consistent and vascular, reddish or white, superficially smooth or lobulated, from the size of a pea to that of a hazel-nut, and generally attached by a small narrow peduncule. Small lobulated warts, resembling granulations, are frequently observed on the semilunar fold and on the caruncule; and they are sometimes pedunculated, and resemble polypi in structure, consisting of nuclei, rondate cells, and of elastic and cellular tissues. (See *Graefe*, *Archiv. für Ophth.* Bd. 1, Abtheil. S. 289.) These, when removed, are very apt to return.

Mackenzie (*Diseases of the Eye*, 1854) describes two different fungous diseases of the conjunctiva. The one has been described and figured by Beer under the name of exophthalmia fungosa. (*Lehre von den Augenkrankheiten*, vol. ii. p. 223, pl. ii. fig. 6; *Wien.* 1817.) The fungus is of a deep red, inclining to a livid colour; it affects chiefly the conjunctiva covering the sclerotica, over which it is elevated in irregular soft smooth masses. It sometimes rises from the insides of the lids, but never from the surface of the cornea. If neglected, it may reach to a great size, and be confounded with other diseases. The disease is very slow in its progress, and the subjects of it are of decidedly scrofulous habit.

The second variety of fungus of the conjunctiva is almost of a gelatinous consistence, and of a light yellow or brownish colour. It is met with chiefly on the inside of the lids, especially of the upper, and in the superior fold of the conjunctiva. It sometimes attains a very considerable size; and, although soft and destitute of red vessels, is apt to prove destructive, by the pressure which it exercises upon the eyeball. Both these fungous affections are merely mechanically destructive.

The internal use of cod-liver oil appears to have been of some use. Should the disease still advance, extirpation of the fungus should not be delayed.

Warts of the conjunctiva (*Stellwag von Carion*); conjunctival and sub-conjunctival tumors (*Mackenzie*). They are attached to the conjunctiva by a broad base, and vary in size from that of a hempseed to that of a bean; are globular or oval, sometimes smooth, generally nodular, and have one or more hairs growing from them. The colours they assume are red, yellow, or white; some are soft, others of fibrous and even cartilaginous consistence. They are generally met with at the corneal edge. They may, if inconvenient, be removed with the knife, and the surface of the wound be touched with nitrate of silver. (For cases, see *Stellwag von Carion*, vol. ii. 3rd ed. p. 878; and *Arlt*, *Graefe*, *Mackenzie*, *White Cooper*, &c.)

Dr. Mackenzie (ed. 1854, p. 252) says:—"I have seen several cases of what seemed scrofulous tubercles, growing from the sclerotica, and elevating the conjunctiva. Such tumors are of a whitish or yellowish colour; they appear as if about to suppurate, but continue firm, slowly increase to perhaps the size of a hazel-nut, burst through the conjunctiva, but do not come to suppuration. If extirpation is attempted, the diseased mass is found to be soft and easily torn."

A congenital accumulation of pigment in and beneath the conjunctiva, has, among others, been described by Dèsmarres (*Traité des Mal. des Yeux*, 1847, p. 353). Telangiectasiæ, or vascular nævi of the conjunctiva, do not differ from those elsewhere. They ought to be removed as early as possible, either by ligature or with the knife, or by repeatedly touching them with the actual cautery. (For cases, see *Ammon*, *Zeitschrift für Ophth.*, 5. Bd., S. 84; and *Klin. Darstellungen*, &c., 2 Bd., Taf. ix. Fig. 50; also *Roosbroeck*, *Cours. d'Ophth.*, vol. i. p. 333.) Cysts in the conjunctiva resemble in their development those in other parts of the body. They have been observed by Weller (*Augenkrankheiten*, S. 198); by Warlomont and Testetin, Arlt, Stellwag von Carion, and others. Among the abnormal contents of the conjunctiva we may mention the extravasation of blood, œdema, emphysema, and prolapse of the contents of the globe

Extravasation of blood in the tissue of the conjunctiva has been seen after injuries to the eyes or head ; in purpura, cholera, and scurvy, in some cases no evident cause is to be found. The vessels which have given way sometimes continue to bleed for a considerable time. Weak astringent lotions, and an appropriate constitutional treatment, will be required.

Non-inflammatory œdema involves small and large portions of the conjunctiva. It occurs in people of relaxed habit of body. Small œdematous conjunctival folds may be removed with scissors : large ones generally disappear after the use of astringent lotions, and under proper constitutional treatment.

Emphysema of the conjunctiva will be recognised by the sensation of crepitation when compressing the emphysematous portion. It is observed in cases of fracture of the nasal parietes, of diseases of the lachrymal sac, &c. Should it give rise to pain or impede the movements of the eyeball, the conjunctiva may from time to time be punctured, so as to let the air escape. Till the fracture is supposed to be consolidated the patient ought to avoid forcibly blowing the nose. (*Mackenzie*, 1854, p. 242.)

Prolapse of the contents of the globe.—It occasionally happens, after an injury to the globe, that the portions of the aqueous, vitreous, or the entire or parts of the crystalline lens are displaced under the conjunctiva. (See *Rivaud Landran*, *Ann. d'Oc.*, vol. xxi. ; *Dixon*, *Lancet*, 1846, vol. ii. 23 ; *Osenvoort*, *Annal. d'Ocul.*, vol. ii. p. 130.)

Stony concretions have been observed in the acini of the caruncule ; the latter may thus increase to an abnormal size, and is called encanthis calculosa. (See *Benedict*, *Handb. der Prakt. Augenheilkunde*, I. The., S. 266; *Weller*, *Augenkrankheiten*, 1850, S. 169 ; *Graefe*, *Archiv. für Ophthal.*, 1. Bd. 1 Abthl. S. 290 ; *Blasius*, *Observat. Anatom.*, Nr. 16, §§ F. V. p. 82 ; *Sandfort* and *Schumucker*, *Riberi*, &c.)

Dacryoliths, or lachrymal calculi — Chalky concretions have been found in the folds of the conjunctiva. (See *Dèsmarres*, *Ann. d'Ocul.*, vol. vii. p. 149, § iv.)

Foreign bodies on and in the conjunctiva.— Particles of dust, steel, wings of insects, &c., when driven upon the conjunctiva, are either removed by friction and the tears, or lodged in the conjunctival folds, or not unfrequently on the inner aspect of the upper lid, near its margin.

The upper lid should always be everted when foreign bodies are to be sought for. Mr. Dixon says : — " Whenever a patient complains of having had a fragment of anything blown into the eye, and a careful scrutiny of the edges of the tarsi, the fold of the lower lid, and the surface of the globe has failed to reveal the cause of irritation, the upper lid should be treated in the following manner:—A pen, the extreme feather end of which is cut off, so as to leave a stem just thick enough to resist bending, is laid across the upper lid, about half an inch from its free margin ; then, while the finger and thumb of the other hand grasp the eyelashes growing from the middle of the lid, the pen is pressed a little downwards, at the same moment that the lid is drawn first a little forwards and then upwards ; the tarsus will suddenly tilt and fold over, so as to expose its conjunctival surface. Both hands must act together ; and if at the moment the turn is being given to the lid, the patient is told to look downwards, the eversion is much more readily accomplished. Foreign bodies should be lightly picked off with the feather or nib of the pen used for effecting the eversion."

Splinters of bone, wood, small shot, &c., may remain for a considerable time in the folds of the conjunctiva without causing much irritation. (See *Walther*, *Abhandlungen a. d. Gebiete der Prak. Med.*, 1 Bd. S. 463; *Ansiaux*, *Ann. d'Ocul.*, vol. viii. p. 96; *Wardrop*, *Morbid. Anat.*, &c., vol. i. p. 70; *Arlt*, *Prag. Vierteljahrschrift*, 12 Bd. S. 76; *Monteath*, *Mackenzie's Pract. Abhandlung.*, *&c.* 1832, S. 186; *Scarpa*, *Trattato d. Princ. Malat. degli Occhi*, 1816, vol. i. p. 170, oss. 24. See also *Seitz* and *Mackenzie*, 1854). Foreign bodies, when entering the caruncule, generally cause severe inflammation.

Incrustations in the conjunctiva are not uncommon after the prolonged use of lead lotions. (See *Cuvier*, *Ann. d'Ocul.*, vol. x. p. 264 ; *Fallot*, *ibid.*, vol. xi. p. 153.)

Insects and their eggs have been found lodged in the folds of the conjunctiva. The most common were lice, flies, and different kinds of fleas. They cause much inflammation. (See *Schin*, *Path. Mat. des Mensch. Auges*, 1828, S. 225; *Bosseau*, *Himly*, l. c. 1, Bd. S. 267; *Bouilhet*, *Ann. d'Oc.*, vol. xv. p. 138; *Ormond*, *Monthly Journal*, 1846, *March ; Eitner*, *Preussens Vereinszestung*, 1842, Nr. 49.)

Entozoa.—Of these the cysticercus telæ cellulosæ, and in hot climates the filaria medinensis, have been observed. Mr. Dixon remarks :—" I have met with two cases only of this rare affection (occurrence of cysticercus). The first was in a young woman of eighteen, who had suffered so little inconvenience from the growth that she could not precisely say how long it had existed. In dividing the conjunctiva, the parasite was punctured and collapsed. The circlet of hooks surrounding the mouth was distinctly seen under the microscope."

" The other case occurred in a girl aged six years. A little watery tumour, rather larger than a pin's head, had been noticed, it was said, eighteen months before the patient was brought to me. I found it a rounded vesicle, the size of a large garden pea, midway between the inner canthus and the margin of the cornea. It was surrounded by a good deal of conjunctival redness. The cyst was injured in removing it from the areolar tissue, or subsequently, and I could not find any hooks so as to identify it as cysticercus. The cyst was lined with a layer of granular matter, and might have contained specimens of echinococcus, which had escaped when the fluid was evacuated. (See also *Sichel*, *Journal de Chirurgie*, 1854, Dec. 1844, Janv. Fev.; *Cuvier*, *Ann. d'Ocul.*, vol. xviii. p. 225; *Horing*, *Ammans. Monatschrift*, 2 Bd. 5 Heft.; *Arlt*, Bd. 1, S. 170; *Sichel*, *Wiener nerd. Wechenschaft.* 1854, No. 31 ; *Nordmann* and *Rayer*, *Ann. d'Ocul.* vol. ix. p. 156 ; *Larrey*, *Denkwürdigkeiten*, Bd. 1, S. 67: and *Fisher*, *in Ulm Zeitschrift. für Woundärzte und Geburtshelfer*, 2 *Jahrg. g.* 4. *Heft.*)

For the different morbid changes of the conjunctiva which are treated in this article, consult *Professor Carl Stellwag von Carion*, *Die Ophthalmologie vom Naturwissenschaftlichen Standpunkte aus bearbeitet.* Bd. 2. Abthl. 3, §§ 85-88, §§ 220-248, 1857 ; *James Dixon*, *A Guide to the Practical Study of Diseases of the Eye*, *&c.* 1855 ; *William Mackenzie*, *A Practical Treatise on the Diseases of the Eye*, 4th ed. 1854 ; *W. Lawrence*, edited by *Isaac Hays*, *A Treatise on the Diseases of the Eye*, 1854; *Desmarres, Traité Théorique et Pratique des Maladies des Yeux*, ed. 2, vol. ii. 1855; and *Graefe, Archiv, für Ophthalmologie*, Bd. 1, Abthl. 1, 1854, p. 168-249, and p. 288; also Bd. 2, Abthl. 2, 1856, p. 158; also Bd. 3, Abthl. 2, 1857, p. 308.

For injuries, inflammation, and ulcers of the conjunctiva, see the articles CONJUNCTIVITIS and OPHTHALMIA. For pterygium see the article PTERYGIUM.]

CONJUNCTIVITIS (Inflammation of the Conjunctiva). [The most correct and scientific term for the primary inflammation of this membrane is conjunctivitis, but the term ophthalmia has been so long in use, that it is convenient still to retain it, and to limit its application to the various inflammations of the conjunctival membrane. We may arrange these affections under the following heads:—

Ophthalmia . .	Simple	Acute, Irritable, and Subacute Chronic.
,, . .	Pustular.	
,, . .	Catarrhal.	
,, . .	Purulent.	
,, . .	Strumous.	

In the simple form of acute ophthalmia, we usually find the following symptoms:—A sense of heat and pricking in the eye, profuse lachrymation of a burning and often acrid character, some intolerance of light, difficulty in opening the eye, great sense of uneasiness, pain and weight of the eyeball, sometimes referred to the brow; the vision is unaffected, but the power of looking is much impaired. On examining the eye, the outer portion of the conjunctiva is found to be chiefly involved. The injection of the vessels does not extend to the capillaries and secreting surface, as may be easily seen, if we contrast a case of simple and catarrhal ophthalmia together.

The only persistent result of simple ophthalmia is a deposit of small white granules, that grate upon the point of a needle, and are apparently of a chalky nature. They indicate a chronic and obstinate form of simple ophthalmia. They are usually observed in the palpebral conjunctiva.

Whatever may be the cause of the ophthalmia, the first point to attend to is carefully to examine the surface of the eye, to ascertain if there is any local irritant; and if there is any reason to suspect this, and nothing can be observed on the anterior part of the globe, the upper eyelid should be everted and examined. It usually happens that after the exciting cause of acute ophthalmia is removed, the symptoms subside spontaneously and speedily. Where this is not the case, great benefit usually follows the application of leeches. It is especially in recent and acute ophthalmia, that the local abstraction of blood is useful. The leeches should be applied close to the outer canthus, and proportionate in number to the severity of the inflammation—from six to eight being about an average. It is useless to repeat them more than once or twice, as the disease then either subsides or assumes a character and condition in which they are of no avail. We usually find that in acute simple ophthalmia, where the attack is recent and uncomplicated with constitutional disturbance, that the constant application of cold in such a manner as to abstract heat from the part, and to keep down the temperature, is productive of both comfort and benefit. This may be accomplished by means of cold water, cold evaporating lotions, or by a small fountain or stream of cold water kept gently playing on the surface of the lids—the essential point being its frequent repetition, so as to keep the temperature of the part low. On the other hand, where the inflammation is very severe, and there is considerable constitutional disturbance, and some important function is disturbed or arrested, warm applications will be found most congenial to the patient, and will soothe and allay local irritation. In those cases that have become subacute, and have assumed the asthenic type, warmth is usually preferred. In all cases of simple ophthalmia, where the secretion is aqueous, stimulating and caustic lotions, drops, and ointments, particularly those containing the nitrate of silver, not only are not indicated, but are very injurious; and often, by their injudicious application, prolong and aggravate an attack. Few cases are more painful, intractable, and obstinate than such as have been thus irritated. It seems as if a specific disease had been superadded more difficult to subdue than the original one. In such cases, lotions, if used at all, should be of a very mild character, such as rose water, weak vinegar and water, elder flower water, or a weak solution of the acetate of lead—about two grains to an ounce of water—all of which act chiefly by their cooling influence; counter-irritation does not seem to me of any value in this early and acute stage. The constitutional treatment must correspond with the conditions of the system; if there is fever, and the functions of any important viscera are interrupted, the anti-phlogistic plan must be adopted.

Mr. Dixon remarks:—"First ascertain what is faulty in the general health—the bowels, appetite, sleep, &c. In a plethoric, over-stimulated patient, restricted diet and purgatives will be as necessary as quinine and iron in a feeble and languid one, or opium and hyoscyamus in a third. Rest of the affected organ, moderate protection from light, occasionally the counter-irritation of a small blister to the temple, or, if there be much intolerance of light, the application of tincture of iodine to the skin of the upper lid and the use of warm fomentations, simple or medicated, are the usual local means. In using stimulating lotions, it should be remembered that their use is not to be persevered in too long, otherwise they keep up instead of subduing the irritability of the conjunctiva. The application of fresh spermaceti ointment to the edges of the lids at night, is a comfort in nearly all cases of ophthalmia, whether slight or severe."

In the subacute and asthenic form of ophthalmia, we find the conjunctiva highly injected, and of a deep red colour, of a darker shade than in acute ophthalmia; the lids are somewhat swollen, and of a dull red aspect near their margin; lachrymation is profuse and scalding, pain is severe, the eyeball feels heavy and full, light is distressing. On examining the general state of system, the extremities are found cold, the pulse quick, irritable, weak, and compressible, the tongue moist and flabby, the countenance pallid, the surface clammy.

Local means are comparatively unavailing, whatever may have been the source of the state of things. A soothing plan, such as the combination of warmth with opiates, as in the ordinary poppy fomentation, together with an occasional blister, is beneficial; local stimuli being here as much contra-indicated as in the very acute form. The main point to attend to is the state of the system; and wherever we can trace the train of symptoms I have been describing, however severe and threatening the local symptoms may be, the treatment must consist of the free exhibition of tonics, together with a generous and even stimulating diet.

After prolonged lactation, a very severe and obstinate ophthalmia of this type comes on, which requires the same plan of treatment, and, of course, immediate weaning of the child; but the system is often so disturbed, and the powers are so completely undermined by this continuous drain, that the symptoms may remain in full force long after the exciting cause has been removed. In some few cases of ophthalmia, there is a remarkable tendency to relapse or to recur at short intervals, without any obvious cause. Such instances are very distressing to the patient, and embarrassing to the surgeon. Where all our ammunition has been exhausted in vain, and no obvious cause of failure can be detected, an entire change of air, or what is still better, a sea voyage, is the most likely means of accomplishing a permanent cure.

Ophthalmia sometimes assumes an irritable type. The vessels are but slightly injected; light is annoying, and distress is especially experienced when the eye is used even to a moderate extent; there is a frequent and rapid movement of the lids; some tendency to lachrymation; and what is peculiarly indicative of this state of things, if you examine the ocular margins of the lids and the inner canthus, you find a fine fringe of froth. This must be carefully distinguished from mucus or pus; it evidently arises from the ordinary secretions, slightly altered in character, and filled with minute air-bubbles by the rapid and constant friction of the lids. This state is irksome and obstinate; it requires that the eyes should be kept at rest, and protected from the stimulus of strong light by means of a shade or of neutral tint glasses. Soothing applications usually give temporary relief, but that which I have found most decidedly beneficial in this class of disease is the wine of opium, dropped into the eye two or three times a day. It is rather painful at first, and must act primarily as a stimulant; but this effect soon passes away, and the soothing influence of the opium is then felt. Counter-irritation and careful constitutional treatment may in some cases be required. Simple ophthalmia has a tendency, more particularly at an advanced period of life, and in a feeble state of system, to pass into a chronic form, and sometimes takes on that form from the commencement of the attack. The symptoms are mild but protracted. There is a sensation of pricking and uneasiness in the eye, particularly towards night, and a tendency to water, when used upon small or bright objects. A few large and tortuous vessels may be seen coursing over the globe, and the inner surface of the lids is preternaturally red, and two or three of the little chalky deposits we have already alluded to may be observed in the conjunctiva. The lids are often thickened, and the roots of the lashes inflamed.

The treatment of such cases is unsatisfactory, and temporary relief is more probable than permanent cure. Astringents and stimuli are the most likely means, but they require to be varied in strength and altered from time to time as their effects become worn out. Alum, zinc, and lead in solutions, are useful in different cases, and must be empirically applied and varied. The sulphate of copper rubbed over the inner surface of the lid is sometimes a valuable application. Ointments composed of the nitrate of mercury or the nitric oxyde and lard, and applied to the lids, are often useful. The frequent and free application of cold water, by immersion of the face, or by a continuous stream by means of a little fountain, strengthens the enlarged vessels, and gives great comfort.

Pustular Ophthalmia.—The essential distinction between this affection and simple ophthalmia, lies in the tendency of the vessels to arrange themselves in groups and patches around the margin of the cornea. Sometimes there is a single group, sometimes there are three or four, and sometimes an elevated fringe of vessels surrounding the cornea. Usually the remainder of the conjunctiva is in a normal state; sometimes it is found uniformly red and inflamed. In this latter case, pustular ophthalmia is superadded to and engrafted upon either the simple or catarrhal form. On examining these cases more minutely, we find some modifications. There may be merely an elevated thickened spot, covered with bright red capillaries, and with three or four long vessels leading to it. This may become arrested at this stage and subside, or a little vesicle may form, or a small pustule; these, at a latter stage, may open and form a little aphthous ulcer. All these constitute varieties with some authors, but such distinctions are not of much practical value. This disease is almost invariably due to some irritation of the mucous membrane of the alimentary canal, and is the result of some error of diet, or arrested cutaneous action, or weak digestion with acrid secretions. The treatment must be chiefly directed to this point. The disease usually subsides quickly on the restoration of a healthy state of these organs. Active aperients, a combination of calomel and rhubarb or jalap with an alkali, are given, at the same time the skin is acted upon by means of mild antimonials and a warm bath. After this, when the tongue is clean and the skin moist, a tonic combined with an alkali is sometimes useful. Great attention must at the same time be paid to the diet, some error in which has probably been at the root of the mischief; all stimuli, sweets, acids and rich dishes are especially to be avoided. The local treatment should be mild and soothing; usually, warm applications are most agreeable and beneficial. These may be combined with opiates, as the ordinary poppy fomentation; when there is much feeling of irritation and distress in the eye, stimuli are almost invariably injurious, except in the very chronic stage and in the aphthous form, where one frequently finds advantage from touching the surface of the aphthous ulcer with the solid nitrate of silver, at the same time protecting the rest of the eye with glycerine. It sometimes happens, that when the disease has been neglected or mismanaged in the early stage, it is rather obstinate, and continues after the constitutional derangement, upon which it originally depended, has subsided. Counter-irritation and the cautious use of mild stimulating collyria may be useful.

There is a modification of this disease, in which the vesicle or pustule encroaches upon the margin of the cornea, and, after breaking, gives rise to a troublesome little ulcer of the cornea, which undermines its edge, and encroaches upon its substance; it is surrounded by a thick tuft of red vessels ; these ulcers do not penetrate through the substance of the cornea, but they are very intractable, and indicate a strumous diathesis.

Another modification of this disease is the following:—A patch of red vessels is seen on the outer part of the eye, near the cornea ; it is elevated, of a deep red colour, and rather large ; it seems to have no tendency to form pustule, vesicle or ulcer ; it is apparently situated in the subconjunctival tissue, where a distinct plexus of capillary vessels may be noticed, organising a fibrinous deposit. The conjunctival vessels over it are also enlarged ; it does not involve contiguous tissues and produces but little disturbance to the eye ; it is rather rare; it occurs between the age of thirty and forty, and seems to depend upon an asthenic condition of system. It is very persistent and disobedient to treatment, and it is important to distinguish it from the more common forms when giving an opinion as to its probable duration.

Mr. Dixon, when speaking of the treatment of pustular ophthalmia, remarks:—"Independently of any medical means which the patient's general health may require, the true pustular ophthalmia commonly yields to very simple treatment. A weak tepid lotion of acetate of lead, twice or thrice a day, and if there be any intolerance of light, a small blister to the temple, comprise all that is usually requisite." (Consult also *Slade*, *Ophthalmia*, p. 23. *London*, 1838 ; *Rognetta*, *Traité Philosophique et Clinique d'Ophthalmologie*, p. 275. Paris, 1844; *Dèsmarres*, *Traité Théorique et Pratique des Maladies des Yeux*. 1855.)

Cartarrhal Ophthalmia.—This is one of the most common diseases of the conjunctiva. It usually commences in the conjunctiva lining the lids, and gradually spreads to the ocular portion ; the membrane is highly injected ; the minute vessels and the secreting surface being involved in the inflammation, so as to present a nearly uniform red colour. The arrangement of the blood vessels, wherever it can be traced, is reticular. In severe cases you may observe small patches of "ecchymosis," from the giving way of some little vessel, and also occasionally some swelling of the membrane round the margin of the cornea, from effusion beneath, giving rise to that symptom called "chemosis." The ordinary secretion is increased in quantity and altered in quality, becoming thick, glutinous and muco-purulent. It collects round the lids and at the inner canthus, and causes the lids to adhere, particularly after sleep. There is a complete absence of intolerance of light, which forms a curious contrast with the severity of the other symptoms, and distinguishes this from all other forms of ophthalmia. The cornea appears sometimes dull on the surface ; this is occasioned by the smearing of the discharge, and not by any change in the cornea itself ; the eyelids also appear rather red and swollen, particularly near the margin. These are the principal objective symptoms. The patient at the same time complains of a feeling of sand or grittiness in the eyes, together with heat and fulness ; these symptoms are always considerably aggravated towards night, and are often very distressing, giving the impression to the sufferer of a much more formidable disease than really exists. The sight is sometimes rather dim, but this is entirely owing to the smearing of the thick muco-purulent discharge over the surface of the cornea. This affection is very rarely attended with any constitutional symptoms.

The causes of this affection are obscure ; exposure to damp and cold, and to a powerful light, and even local injury, will sometimes produce a train of symptoms similar to those just described. It is very probable that it resembles other epidemics, in that it owes its origin to atmospheric influence, and its diffusion, in some measure at least, to contagion. It has been observed, that when the disease has been improperly treated, and has existed for some time, that, instead of pursuing the course I have just described, the discharge becomes aqueous, and it assumes all the characteristics of simple sub-acute ophthalmia.

This disease may be cured rapidly and almost invariably by local stimuli ; and of these by far the best is a weak solution of the nitrate of silver, in strength about two grains to the ounce of distilled water, gradually increased to six grains. If applied in the early stage, however severe and well marked the disease may be, it will generally subside in a few days, the time for cure required being pretty accurately measured by the interval between the first development of the disease and the commencement of the remedy. As, for example, if the treatment be commenced on the third day, it will be well by the sixth day, and so on. The solution of nitrate of silver should be carefully dropped into the eye with a camel's hair brush or a quill, and may be repeated every three or four hours, in severe cases. It causes slight smarting at first, which rapidly subsides, and then the patient feels great relief.

Mr. Dixon remarks, on the treatment of this disease :—"It is in this purely conjunctival form of catarrhal ophthalmia that the application of nitrate of silver is of such remarkable utility. When the sclerotica is much injected, or there is any rheumatism present, as evinced by the pink zone around the cornea, tenderness of the globe, pain about the orbit, and neuralgia throughout the branches of the fifth nerve, the nitrate of silver is contra-indicated, at least until the affection of the fibrous tissues has been subdued by appropriate treatment. It is from a want of duly discriminating between the purely conjunctival form of catarrhal ophthalmia, and that in which the sclerotic and cornea are also affected, that many surgeons have been disappointed at the effect of the treatment by nitrate of silver. As for constitutional treatment, the common sense of the surgeon must teach him to keep his patients on the proper level in these matters, and not to stuff or starve them indiscriminately, in accordance with any scientific theory of disease." Consult also *Velpeau*, *Manuel Pratique des Maladies des Yeux*, p. 180. Paris, 1840 ; *Assalini*, *Manuale di Chirurgia*, parte ii. p. 117. *Milana*, 1812 ; *Barcillé-Parise*, *Hygiène Oculaire*, p. 19. *Paris*, 1823; *Spain, by Henry D. Inglis*, vol. ii. p. 223. *London*, 1837 ; *Bibliothèque Ophthalmologique*, t. i. p. 81. Paris, 1820 ; *Edinburgh Medical and Surgical Journal*, vol. ii. p. 411, 1816 ; also *Medical and Physical Journal*, vol. iv. p. 327. *London*, 1826.

Purulent Ophthalmia.—Purulent and gonorrhœal ophthalmia are grouped together, because there is no important practical distinction between the two, either as regards the symptoms or the treatment. The disease will be considered, in the first place, as it is found in adults, and, secondly, as it occurs in infants. The early symptoms very closely resemble catarrhal ophthalmia; one eye is primarily affected, and, if the disease is the result of gonorrhœa, it is often limited to the eye first attacked. It commences in the conjunctiva lining the palpebræ, and rapidly spreads to the ocular conjunctiva; the eyelids become of a bright red colour, much swollen and closed; escaping from between the lids is some thick yellow pus, which flows out readily and abundantly when the lids are separated. The ocular conjunctiva is swollen, infiltrated with serum, or, in the more severe cases, with lymph, so that the cornea seems buried and partly overlapped by its elevated margin, giving rise to the symptom known as chemosis. Blood as well as serum is extravasated beneath the membrane; this symptom is termed "ecchymosis." This condition may be developed in as short a space as twenty-four hours, or not till some days. Generally about the third day the second eye becomes affected, and pursues the same course, though usually in rather a milder form. As the disease progresses, the cornea becomes involved; its surface appears hazy, then the layers are infiltrated with pus, become gradually disorganised, and give way; in other cases, the cornea rapidly ulcerates, the ulcer usually commencing round the margin of the cornea, and gradually penetrating its substance. The cornea then gives way, the aqueous humour escapes, the iris and lens fall forwards into the opening, and staphyloma is the result; the globe becomes flaccid, the swelling diminishes, the redness becomes of a deeper colour, and the disease rapidly loses its intense character, the integrity of the organ having been the price paid for the subsidence of this truly formidable disease. During the development and acme of the purulent ophthalmia, the pain is of a very severe and distressing character; there is intense burning and tension of the globe and eyelids, with constant irritation, as if a foreign body were in the eye, succeeded by deep-seated throbbing, as if the eye would burst. These symptoms are usually attended with considerable constitutional irritation, a foul tongue, loss of appetite, a dry skin, &c., and often exhibit themselves in their most violent form in persons whose powers have been impaired by previous illness or intemperate habits. With regard to the cause of purulent ophthalmia, it is essentially a disease of hot climates, where it is very common and very destructive to sight, and where it probably arises from some atmospheric poison and spreads by contagion. In the year 1800–1–2, our troops suffered severely from this disease in Egypt, from which circumstance it has been called by some "the Egyptian ophthalmia." In this country, the cause of the severer forms of the disease is the contact of gonorrhœal matter; it may also arise from the accidental intrusion of matter from an abscess; it may result from atmospheric influence in a constitution prone to its development; also from severe injury to the eye. Symptoms resembling very closely those I have now described occasionally follow the operation of extraction. It must not be supposed that the disease always produces the extreme results I have mentioned. It may be arrested at any stage, and the result, though usually more or less damaging to the eye, is regulated by the period at which the disease is checked. Thus it was found that the epidemic, which committed such ravages in the army in Egypt, did not in the onset always involve any other structure but the conjunctival membrane. The result of this severe and protracted form of inflammation was in most cases found to be an alteration in the surface and enlargement of the villi of the conjunctiva, and a condition to which the term "granular conjunctiva" is applied. This becomes a serious and constant irritation to the cornea; by degrees its surface becomes dull and covered with red vessels, and thus "a vascular opacity" of the cornea results, seriously interfering with vision, and giving rise to more injurious consequences than the purulent attack in its early and acute stage. It not unfrequently happens that one eye is staphylomatous, and the other presents a dense opacity and adhesions, more or less complete, of the iris and cornea.

Treatment:—We may consider the subject under the twofold aspect of local and constitutional means. As the disease may arise from purely local causes, the local treatment assumes considerable value and importance. The plan to adopt, when there is extensive chemosis and swelling of the lids, and the cornea is threatened, is, in the first place, freely to divide the membrane by the method recommended by Mr. Tyrrell, which consists in a series of incisions with an ordinary cataract knife, radiating from the cornea towards the circumference of the globe in every direction, placing the back of the knife on the surface so as to divide the conjunctiva without injury to the cornea or sclerotica, and in addition to this, to endeavour to relieve the distended vessels by the application of leeches to the swollen lids. A piece of lint, dipped in cold water, is constantly to be kept applied to the surface of the lids, and a strong solution of nitrate of silver, varying from five to ten grains to the ounce, is to be dropped between the lids every hour or every two hours, as the patient can bear it. It is very important that the discharge should be carefully removed previous to the insertion of the drops, so as to ensure their getting into contact with the surface of the membrane; this can be best accomplished by means of a syringe and a little luke-warm water; if the nitrate of silver causes great pain, some other astringent may be advantageously employed; the sulphate of copper may be brushed over the surface, or a strong solution of alum may be substituted. If there is an ulcer threatening to penetrate, a finely-pointed piece of the nitrate of silver may be often advantageously applied to the ulcerating surface. It is advisable that, while the vessels or the part are relieved by local depletion, the system be sustained in every possible way. Tonics and diffusible stimuli must be freely administered. Decoction of bark with carbonate of ammonia, or a combination of steel with quinine, in full doses may be given, taking care, at the same time, that the bowels be freely acted upon. The diet should be liberal, and even stimulating—a full allowance of good fresh meat and, at least, a pint of porter daily.

[The constitutional treatment here advised is directly opposed to that hitherto recommended in this Dictionary, and may be denominated the modern method. The surgeon will do well to use his own judgment in each individual case, and probably his patient will be more safely carried through his disease by the avoidance of the extremes of the old depleting and of the modern stimulating plan. Under the article OPHTHALMIA, the reader will find the lowering constitutional treatment fully detailed, and also a full description and historical account of the contagious nature of certain forms of purulent Ophthalmia.—ED.]

We may now briefly consider this disease when it occurs in infancy. The symptoms are very similar to those I have described as occurring in adults; but as it is by no means uncommon in infancy, and if neglected may be most destructive to sight, it is of great importance to recognise its leading symptoms, and understand the principle upon which it should be treated. This disease almost invariably shows itself on the third day after birth; both eyes are usually affected, though one often more severely than the other. The disease has been observed to exist a few hours after birth, and a week or more may elapse before the disease comes on. There are two symptoms that may be selected as a gauge of the intensity of the disease as it occurs in infants;—the one is the condition of the lids; the other, the colour and consistence of the discharge. If the lids are of a bright red colour and much swollen, and if the discharge is yellow and thick and very abundant, it is a severe case, but only in the first stage, and the eye is as yet probably safe; but if the lids appear of a bluish-red colour and rather flaccid, the disease has most probably seriously damaged the eye. There is often considerable difficulty in examining the condition of sight in these little patients, on account of the swelling of the lids, the smallness of the palpebral aperture, and the amount and thickness of the discharge. On separating the lids, the space is immediately filled with discharge; this must be carefully wiped away, and the lids re-opened. This must be repeated until no more discharge escapes, when the state of the cornea may be ascertained. The rapidity and destructive character of the disease are regulated by the nature of the morbid secretion that has been applied to the eyes, and also by the constitutional powers of the little sufferer. If the disease in its severe forms be allowed to pursue its course unchecked, the cornea gives way either by sloughing or by ulceration, but most frequently by the latter, the iris prolapses, and the globe becomes either atrophied or staphylomatous. In milder cases, ulcers form that leave dense central opacities that are often very detrimental to sight. A curious result of these cases, even where the cornea remains bright, is a small central white spot upon the inner surface of the aqueous capsule. The treatment of these cases is merely local; it is very simple, and the result highly satisfactory. All that is required is the frequent application of some mild astringent or caustic lotion to the surface of the conjunctiva. At the Ophthalmic Hospital a solution of alum is used, from five to ten grains to the ounce; but a weak solution of nitrate of silver answers equally well. The essential point is, that whatever is used is well applied to the surface of the membrane.

A prolonged existence of catarrhal and purulent ophthalmia produces an alteration in the secreting surface of the conjunctiva, and as a consequence of this, more or less serious damage to the cornea. After the severer symptoms of the primary disease have passed away, and when the cornea is still bright and clear, some sensation of grittiness is complained of, particularly as night approaches; and some thick secretion, though to a much smaller extent than before, of a puro-mucous character, still glues the lids together, collects at the inner canthus, and sometimes smears the corneal surface. If this state is allowed to continue unchecked for some time, the conjunctiva, particularly of the lids, acquires a velvety and raised appearance. The villi thus raised and enlarged, may become still further and somewhat irregularly developed, so as to resemble the granulations of an ulcer, in consequence of which this condition has been termed "granular lids," though it must be borne in mind that this change occurs in the villi and is entirely due to the hypertrophy of these little bodies. If the disease limited itself to this structure, it would be of little importance, but such is seldom the case; by degrees the vessels in the ocular conjunctiva become enlarged, particularly those corresponding to the upper lid, and from thence they creep down over the surface of the cornea, gradually covering its upper half, and producing the appearance of a thin, delicately-organised false membrane, overlaying the transparent tissue of the cornea. This is a slow but almost sure result of granular lids; and whenever the one is found, the other may with certainty be prognosticated. This opacity may gradually increase both in its superficies and in its density until two-thirds of the cornea is covered more or less thickly. The vessels organising this new product may all be traced as coursing down from above, except in very severe and protracted cases, when the cornea appears as one uniform mass of organised lymph. In all these extreme cases we find the original disease has been contracted in tropical climates; it is termed "vascular opacity of the cornea." A condition somewhat resembling the above is occasionally found without any well-marked granular condition of the conjunctival surface. It occurs about the age of puberty, and results from a strumous condition of system. It may be distinguished from the form just described, by the fact that the vessels encroach upon the cornea from all sides, instead of from above only. They also appear to involve more deeply the corneal tissue, and not to be limited so entirely to its surface; and as a result of this, the resistant power of the cornea becomes diminished, and its convexity increased, and its refraction so much augmented, as seriously to interfere with vision, even after transparency is restored. The size, shape, and colour of the villi in their enlarged state vary much, according to the severity of the primary disease, the treatment then adopted, and the constitution of the patient. They are sometimes large, loose, flabby, and pale; at others, they are small, round, red, and highly organised, and between these two extremes there are many shades of difference, depending upon the time the disease may have existed, the state of the constitution, and the previous treatment. The causes of this curious change in the mucous surface may be traced to severity in the original disease, to insufficient local treatment or entire neglect, or very active constitutional measures, and to a diseased state of the digestive organs.

Some of the most marked and obstinate forms of vascular opacity have occurred in men who have served in the Indian army, where the original disease is probably due to atmospheric influence, and where we find that all diseases of mucous membranes are severe, intractable, and prone to lapse into this hypertrophied state, and so to continue for an indefinite period. This condition has never been observed in infants, even after the most severe purulent ophthalmia. As may readily be imagined, the existence of even a thin vascular layer over the surface of the cornea very seriously interrupts vision; and the worst cases only allow perception of light and a dim outline of objects ; and it becomes an anxious question to what extent the brilliancy of the cornea can be restored by suitable treatment. In forming a judgment upon this point, what we have especially to notice is the direction of the vessels—whether they creep down from above only, or whether they encroach from all sides—as upon this circumstance depends the fact as to whether the vascular opacity is entirely due to the granular condition, or to some inherent vice in the conjunctiva and cornea, and in the general state of the system. If we can satisfy ourselves that the disease is purely local, and due to the mechanical change of the conjunctiva, we are justified in giving a favourable opinion as to the result. Our treatment must be exclusively directed to the removal of the granular condition. If we can succeed in this, the subsequent vascularity, which is a consequence of it, spontaneously subsides, and leaves a clear cornea.

The treatment that is most uniformly recommended, is the application of some powerful astringent or stimulant to the surface of the enlarged villi. This should be done by everting the upper lid and applying the remedy freely over the surface. The principal stimuli for this purpose are the solid nitrate of silver, or a strong solution ; the sulphate of copper, the acetate of lead, alum, zinc, &c. &c. In the selection of a stimulus attention must be paid to the condition of the granulations, their size, amount of organisation, nervous sensibility, and the time they have existed. In the more recent cases, where they are small, round, vascular, and sensitive, the stimulus must be mild —as, for instance, a solution of the nitrate of silver or sulphate of copper, about ten grains to the ounce of distilled water ; in the large, pale, insensible forms, the solid nitrate of silver may be freely and frequently applied. The sulphate of copper is far less irritating than the nitrate of silver ; and, except in very indolent cases, produces a sufficient effect. Whatever caustic or astringent is selected, it is desirable to limit its effect as much as possible to the part to which it is applied, and to protect the rest of the conjunctival surface. This is more particularly necessary when the nitrate of silver is applied in substance. The best mode of effecting this object, is to put a little glycerine into the eye previous to applying the caustic, and also to keep the eyelid everted for some little time after the application. Although caustics and powerful astringents are the only reliable means in these cases, it is only when applied carefully to the part, and at stated intervals, that they are of service. In undertaking a case of this kind, it is important that the patient should be made aware that, under the most favourable circumstances, and with the most judicious management, the process of treatment must be tedious, extending over many months, and requiring great perseverance in the use of remedies. If the disease be limited to the upper half, or even two-thirds of the cornea, and if the vessels can be all traced from above, a cure may be depended upon, provided the treatment be judiciously carried out.

There is a modification of this disease, in which the vessels can be seen encroaching over the surface of the cornea from all sides, and converging towards the centre. This condition would seem to depend to some extent upon the state of the constitution, and upon a diseased condition of the cornea itself, and only to a partial degree on the mechanical and local cause. This morbid change is exceedingly intractable, and will remain, after the surface of the conjunctiva is restored to a smooth state. In these cases, the surface of the cornea is more thickly and uniformly covered with a highly-organised false membrane, consequently vision is more extensively interfered with. Another more serious and fatal result of a continuance of this form of disease is a certain amount of softening of the corneal tissue, so that it no longer offers the same amount of resistance, but yields to the pressure from within, so as to change its shape and increase its convexity—a state of things that seriously and permanently damages the sight, even after the transparency of the cornea shall have been restored. The management of this modification of vascular cornea is very difficult, and the result usually very unsatisfactory. If the villi are enlarged, the primary consideration is to restore a smooth surface to the palpebral conjunctiva ; if the cornea does not improve after this is accomplished, the cause will be found chiefly in the state of the constitution, and in some unfavourable sanitary conditions, as close, ill-drained and ill-ventilated dwellings, improper and insufficient food, &c. Tonics are useful, and sometimes a very mild but protracted mercurial course seems to be of advantage. This disease frequently occurs in females about the period of puberty, therefore attention must be especially directed to the due performance of menstruation. The thorough establishment of this function is often attended with a very marked amelioration of the symptoms. As regards local means, so soon as the conjunctiva is smoothed down, no good results from the continuance of stimuli. When the surface of the conjunctiva is brought into a smooth condition, one ought to abstain from all further local stimuli, and trust chiefly to constitutional treatment. The only local treatment which is found advantageous in this stage is the formation of an issue in the temple, which should be kept up for some months. It appears to be peculiarly applicable to those affections of the conjunctiva and cornea, in which there is organised morbid deposit superadded to the original healthy tissue. Some few cases resist all means of relief. A permanent change of air, particularly to the sea-side, offers the best chance of improvement under this unpromising state of things.

Dr. Walker (*Observations on Two Distinct Varieties of Ophthalmia prevalent in the Army—The Edinburgh Medical and Surgical Journal*, 1811, vol. vii. p. 5) observes, when treating of pannus and granulations of the lids,—"Disappointed by every method hitherto recommended, I endeavoured to make the eye affected with the latter variety (a slow and insidious vascularity of the cornea) assume the inflammatory action of what has been called purulent ophthalmia, and to this I applied the usual remedy, venesection. In several cases the practice has proved successful, not a single enlarged vessel remaining at the end of a fortnight. How far it may answer the purpose intended I have not yet had sufficient evidence to enable me to decide. Daily reports of the practice and its effects may enable me at a future period to lay it before army surgeons."

Dr. Walker does not mention the means he employed to produce purulent ophthalmia, neither does he clearly specify the cases. A severe case of pannus, when inoculated with gonorrhœal matter, requires some two to four months to recover the transparency of the cornea.

Mackenzie (edit. 4, 1854) says :—"The idea of curing granular conjunctiva by exciting in the diseased membrane the inflammatory action of an acute attack of purulent ophthalmia, to be treated by venesection and other remedies, was first suggested by my friend, the late Dr. Henry Walker. The method of exciting such an inflammation, adopted by Professor Jaeger and Dr. Piringer, is to inoculate the conjunctiva with matter taken from the eye of a child affected with mild ophthalmia neonatorum. The matter is applied to the inside of the lids, with a miniature pencil, and in a few hours produces its effect; the inflammation thus excited is to be treated like an ordinary attack of purulent ophthalmia, and although the practice does by no means appear a very safe one, it is undeniable that cures have in this way been effected," &c. &c. For a full account of this practice, I refer the reader to a paper by Dr. Hamilton, in the *London and Edinburgh Monthly Journal of Medical Science for July*, 1843.

Some fifty cases of pannus have thus been treated by Jaeger and Piringer; others by Dèsmarres, Tallot and Hairion, Dudgeon, &c. Those cases (some fourteen) which have been treated by inoculation of gonorrhœal matter, at the Ophthalmic Hospital, are progressing very favourably; some have already recovered a normal transparency of the cornea. Only cases where the whole of the cornea is obscured by a vascular network should be inoculated; the treatment of these cases consists in feeding the patient well, and letting the gonorrhœal ophthalmia run its course.

Upon the subject of purulent and of granular inflammation of the conjunctiva consult *Piringer, Die Blennorrhoe am Menschenauge, Gratz*, 1841; *Zeitschrift der K. K. Gesellschaft der Aerzte zu Wien*; *Seitz, Handbuch der Gesammten Augenheilkunde, Erlangen*, 1855, S. 30 und S. 33; *Graefe, Archiv. für Ophth.* 1 Bd. 1 Abth. S. 168, etc.; *Ann. d'Ocul.*, vol. xi. p. 20; *Mildner, Prager Vierteljahrschrift*, 13 Bd.; *Loiseau, Annal. d'Ocul.* vol. iv. 1840, p. 41; *Rosas, Handbuch der Theor. und Pract. Augenheilkde*, 2 Bd. 1830, S. 130; *Zeitschrift für Ophth.* 3 Bd. S. 235; *Gulz, über die Sogenannte Egyptische Augenentzündung, etc., Wien*, 1850, S. 103; *Stellwag von Carion, Zeitschrift der K. K. Gesellshaft der Aerzte zu Wien*, 1851, 2 Bd. S. 917; *Cuvier, Ann. d'Ocul.* vol. xx. p. 152.

Strumous Ophthalmia.—The distinguishing peculiarity of this disease is intolerance of light, or photophobia. This symptom often exists in a slight degree in ordinary ophthalmia, and at all periods of life; but in strumous cases it becomes the distinguishing feature, and is sometimes so intense and distressing as to cause spasmodic closure of the eyelids, shading of the eyes, and avoidance of light; and even in extreme cases the poor little sufferer seems to find and to shrink from some faint remnant of light, even where all is apparent darkness. Thus he will forsake all the active habits natural to childhood, and will bury his head in a pillow, as if striving to realise outer darkness, and so he will remain, with but little intermission, for weeks and even months. This distressing symptom is probably due to a morbid excited state of the retina, or that section of the fifth pair of nerves devoted to the ophthalmic apparatus, the stimulus to which, even in its least appreciable state, is light. It has the power of attaching itself to any form of ophthalmia, however mild or however severe. The circumstances and constitutional peculiarities that give birth to strumous ophthalmia are as various as the disease to which it gives its name. Sometimes we find a feverish condition with dry skin, restlessness, foul tongue, costiveness and loss of appetite; or, again, there may be aphthæ about the lips and mouth, diarrhœa, profuse perspirations, eruptions about the head and face.

This group of constitutional symptoms frequently follows one or other of the exanthemata, in which case there will generally be evidence of irritation of all the mucous surfaces, the discharge from the nose and eyes is profuse and acrid, the alæ of the nose red and excoriated, the eyelids and lips swollen, and the general condition very distressing. In other cases the face is pallid, the pulse feeble, the extremities cold, and the condition anæmic and indicative of want of power. On making an examination locally, the eyelids are found spasmodically closed, so that any inspection of the condition of the eye is extremely difficult, and sometimes almost impossible, except under the influence of chloroform. The state of the lids is often a reliable index to that of the eye; if they are swollen and red, we may suspect that some acute ophthalmia, and perhaps ulceration of the cornea exist; if, on the other hand, they are quite natural in colour and size, we may rest satisfied that very little mischief has taken place. It is always undesirable to make a forcible examination of the case, for if a deep ulcer exist, it may cause serious mischief; it always increases the irritability of the little patient, and it generally happens that after many efforts no really satisfactory view of the eye is obtained. The objections to a periodicity of the photophobia are that some of the most severe cases have no period of intermission, and also that the hour at which the photophobia subsides so exactly corresponds with the setting of the sun, that it is difficult to avoid regarding the two events in the light of cause and effect, which does not quite realise our previous notions of intermittent disease. At the same time, it must be admitted that cases occasionally come before our notice, in which the contrast is so very remarkable between the intensity of the intolerance of light during the day and the perfect emancipation from every symptom of the kind, so soon as the shades of evening appear, that we can scarcely ascribe the change entirely to the diminution of light, and it seems more probable that it is in some measure due to a feeble and excitable nervous system, assuming its periods of exacerbation and repose.

Treatment: Even with the clearest views, and after large experience, our treatment must often be tentative and empirical. It naturally divides itself into constitutional and local, which may be dwelt upon separately, for the sake of arrangement, though, at the same time, it must be borne in mind that they bear an intimate relation to each other. There are three principal digressions from the normal standard that are particularly favourable for the incubation of this form of ophthalmia. The first is the "inflammatory type." It is rapidly developed; the symptoms are acute; there is severe pain in the eyes, attended with profuse lachrymation of a scalding character; red, swollen lids and spasmodic closure. The constitutional symptoms are a hot and dry skin, a rapid pulse, foul tongue, loss of appetite, arrest of all the natural secretions, constant restlessness. The treatment under these circumstances consists chiefly of salines, antimonials, mercurial purgatives, and the use of the warm bath; this latter is peculiarly useful in such cases. The diet must be light, and not either stimulating or too nutritious. At the same time, care is required not to persevere in this plan too long—not in fact, a day longer than the state of the secretions indicates its propriety, otherwise a feeble condition is induced, and the disease continues in a sub-acute or chronic state.

The second class of cases may be denominated the "irritable type." In these cases the mucous membranes are congested and disordered, and their secretions increased in quantity and vitiated in quality; the tongue and lips are aphthous and swollen; the nose excoriated, the skin inflamed: combined with this there is often a tendency to prolapse of the rectum and chronic diarrhœa; this condition frequently follows one or other of the exanthemata and may be kept up by the presence of worms. You may readily recognise this form of disease by the general outpouring from the mucous outlets. Unsuitable food and want of cleanliness are fertile sources of this deranged state of the mucous membranes. In the treatment of these cases all causes of irritation must be removed; if worms are suspected, one or two drastic aperients are required. The secretions may be improved by a mild mercurial and an alkali. The diet must be carefully attended to; many of the symptoms result from crude, undigested food, improper in quality or superabundant in quantity. It often happens that the irritation of the mucous membranes remains, which purgatives only seem to increase; under these circumstances, the greatest possible benefit is found from Battley's solution, regulating the dose by the age of the patient, allowing a minim for each year, and giving it once or twice in the twenty-four hours. Tonics of any kind are not well borne, and seem to aggravate all the symptoms.

The third division of these cases may be termed "the asthenic type." It is found most commonly amongst the children of our poor population. The chief symptoms are emaciation and pallor, with a rapid and weak pulse, cold extremities, moist tongue, frequent perspirations, co-existing with a considerable amount of ophthalmia and extreme photophobia. It is in this group of cases that we commonly find the intermittent form of the disease. A tonic treatment is most valuable in these cases. Where intermittence of symptoms and periodicity can be traced, quinine seems to act like a specific. The dose must be, of course, regulated by the age of the patient, but rather a large dose can be borne, and seems to be required. Where the fibre is very lax, and the limbs feel flabby, steel is useful, and seems to be indicated. At the same time a liberal diet, with a moderate amount of stimulus, may be given. When the strumous diathesis is very marked, the glands enlarged, the upper lip thickened, cod-liver oil may be given with advantage, either alone, or combined with steel. If the tongue is foul and the secretions disordered, it is a good plan to commence the treatment with an emetic, and then to exhibit tonics. If there is much mucous and cutaneous irritation, arsenic may be given—about two minims of the liquor arsenicalis three times a day immediately after meals. The effect must be carefully watched, and the medicine must not be given at any one time for a longer period than a fortnight or three weeks. Change of air, particularly to the sea, will sometimes effect a cure when all else has failed.

Local Treatment.—In the earlier stages of the attack, where the symptoms are acute, the vessels full and numerous, and of a bright red colour, or in a sudden relapse of an old-standing case, in which you can trace fresh organised deposit or a false membrane on the cornea, the abstraction of blood by means of leeches is often useful. In less acute cases, where the vascularity is not so prominent a symptom, or where it has been diminished by local depletion, blisters are very useful. They must be frequently repeated, and, in mild cases, will effect complete relief of the more prominent symptoms. In cases in which vascularity and other evidence of diseased action are slight, and photophobia exists as the prominent and principal symptom, the tincture of iodine may be painted on the skin covering the eyelids.

Cases occasionally occur in which the symptoms are severe and protracted, and in which great benefit has been observed from the use of the nitrate of silver. The motive of its employment has been the exhaustion of all other available means. In those forms of strumous ophthalmia in which irritability is a prominent symptom, in which the disease is limited to the conjunctiva, forming aphthæ and phlyctænulæ, attended with aqueous secretion of a frothy character, local sedatives are very useful. Of these, perhaps, the best is the opium wine of the Pharmacopæia, dropped into the eye two or three times a day. It generally causes rather severe pain, that lasts several minutes, but is followed by a marked improvement in the symptoms.

Syphilitic affections of the conjunctiva.—Cases of syphilitic ulceration have been observed by Dèsmarres and others; a case of syphilitic discoloration of the conjunctiva is reported by A. Smée (*Annal. d'Ocul.*, t. xiv. p. 31); several cases of tubercular syphilides are mentioned by Dèsmarres. For Cancerous Growths, see Eyelids (Cancer of the).

The above remarks on inflammation of the conjunctiva and on strumous ophthalmia have been taken from the practical lectures on diseases of the eye, by Mr. Critchett (*Lancet*, 1854 and 1855—*A Course of Lectures on Diseases of the Eye*). Of other works, consult *Professor Carl Stellwag von Carion, Die Ophthalmologie*, &c., vol. ii. 3rd ed. 1857; *Dèsmarres, Traité Théorique et Pratique des Maladies des Yeux*, vol. ii. 1855; *Mackenzie, On the Diseases of the Eye*, 4th edition, 1854; *Dixon, A Guide to the Practical Study of Diseases of the Eye*, &c. 1855.] *C. Bader.*

Consult *Avicenna*, Canon. I. iii. fen. 3. tract. i. cap. 6. *Maître-Jan*, Traité des Maladies de l'Œil, 12mo. Paris, 1722. *St. Yves*, Traité des Mal. des

Yeux, p. 176, &c. *Janin*, Mém. sur l'Œil, &c. 8vo. Paris, 1772. *L. F. Gendron*, Traité des Mal. des Yeux, tom. ii. 12mo. Paris, 1770. *C. F. Reuss*, Dissertationes Med. Selectæ Tubingenses Oculi Humani Affectus medico-chirurgice consideratas sistentes, 3 vols. 8vo. Tub. 1783. *Truka de Krzowitz*, Hist. Ophthalmiæ omnis ævi observata medica continens, 8vo. Vindob. 1783. *G. Power*, Attempt to investigate the Causes of the Egyptian Ophthalmy, &c. 8vo. Lond. 1803. *H. Reed*, On Ophthalmia, 8vo. Portsea, 1806-7. *J. B. Serney*, On Local Inflammation, more particularly applied to Diseases of the Eye, &c. 8vo. Lond. 1809. *J. P. Marat*, An Inquiry into the Nature of a singular Disease of the Eyes, hitherto unknown, and yet common, produced by the Use of certain mercurial Preparations, 4to. Lond. 1770. *James Ware*, Chir. Obs. relative to the Eye, 2 vols. 8vo. Lond. 1805. *Richter*, Anfangsgr. der Wundarzn. b. iii. *G. Peach* and *J. Wardrop*, in Edinb. Med. Surg. Journal for January, 1807. Also *J. Wardrop*, in Med. Chir. Trans. vols. iv. and x.; and Essays on the Morbid Anatomy of the Eye, 2 vols. 8vo. 1808—1818. *John Vetch*, An Account of the Ophthalmia which has appeared in England since the return of the British Army from Egypt, 8vo. Lond. 1807. Also Obs. relative to the Treatment by *Sir Wm. Adams* of the Ophthalmic Cases of the Army, 8vo. Lond. 1818. Letter on the Ophthalmic Institution for the Cure of Chelsea Pensioners, 4to. Lond. 1819. And a Practical Treatise on Dis. of the Eye, 8vo. Lond. 1820. *W. Thomas*, On Egyptian Ophthalmia, and Ophthalmia Purulenta, 8vo. Lond. 1805. *P. Assalini*, On the Plague, Dysentery, and Ophthalmy of Egypt, &c. Transl. by *A. Neale*, Lond. 1804. Also Manuale di Chirurgia, 8vo. Milano, 1812. *F. Vasani*, Storia dal' Ottalmia contagiosa dello Spedale Militare d'Ancona, 8vo. In Verona, 1816. Also Risposta à cio che la riguarda nei Cenni del *Dr. Omodie* sull' Ottalmia d'Egitto et sulla sua propagazione in Italia, 12mo. In Verona, 1818. *T. F. Baltz*, De Ophthalmia Catarrhali Bellica, 4to. Heidelb. 1816. *Arthur Edmonstone*, On the Varieties and Consequences of Ophthalmia, with a Preliminary Inquiry into its contagious Nature, 8vo. Edinb. 1806. *De Wenzel*, Manuel de l'Oculiste, t. ii. 8vo. Paris, 1808. *C. Farrell*, On Ophthalmia, and its Consequences, 8vo. Lond. 1811. On the Utility of Blisters in the Ophthalmia of Infants, in Ed. Med. Surg. Journ. No. 58. p. 156. *R. C. Graefe*, Journ. de Chir. b. i. Also Repertorium augenarzlicher Heilformeln, 8vo. Berlin, 1817. *G. Benedict*, De Morbis Oculi Humani Inflammatoriis, 4to. Lips. 1811. *J. C. Saunders*, On Dis. of the Eye, ed. by *Dr. Farre*. Lond. 1811, or the later editions. *K. Himly*, Ophthalmologische Beobachtungen, &c. 12mo. Bremen, 1801. Also Einleitung in die Augenheilkunde, 12mo. Jena, 1806, and his Bibliothek für Ophthalmologie, &c. 12mo. Hannov. 1816. *F. J. Wallroth*, Syntagma de Ophthalmologia Veterum, 8vo. Halæ, 1818. *C. J. M. Langenbeck*, in Bibl. and Neue Bibl. für die Chirurgie, in various places. *Ant Scarpa*, sulle Principali Malattie degli Occhi, Venez. ediz. 5ta; or the Transl. by *Mr. Briggs*, 2nd ed. *Roux*, Voyage fait en Angleterre en 1814, ou Parallèle de la Chirurgie Angloise avec la Chirurgie Françoise, p. 37, &c. *P. M'Gregor*, in Trans. for the Improvement of Med. and Chir. Knowledge, vol. iii. p. 30, &c. *Larrey*, Mém. de Chir. Militaire, t. i. p. 202, &c. *J. A. Schmidt*, Ueber Nachstaar und Iritis, 4to. Wien, 1801. *J. G. Beer*, Lehre von den Augenkrankheiten, b. ii. 8vo. Wein, 1813—1817. *C. H. Weller*, A Manual of the Diseases of the Human Eye. Transl. with notes, by *G. C. Monteath*, 2 vols 8vo. Glasgow, 1821. *B. Travers*, On Iritis, in Surgical Essays, part i. Also, A Synopsis of the Diseases of the Human Eye, 8vo. Lond. 1820. *E. A. Lloyd*, On Scrofula, 8vo. Lond. 1821. *W. Lawrence*, On Dis. of the Eye, 8vo. Lond. 1833. *G. Frick*, On Dis. of the Eye, ed. 2. by *Welbank*, 8vo. Lond. 1826. *R. Middlemore*, On Dis. of the Eye, vol. i. 8vo. Lond. 1835. *Wm. Mackenzie*, On Dis. of the Eye, ed. 2, 1835.

CORNEA, (from *cornu*, a horn.) [The anterior, transparent convex part of the eye, which in texture is tough like horn. "The two surfaces of the cornea are parallel to one another, the greater portion of the thickness of the cornea is formed by the cornea proper, or the lamellated tissue; this gives it strength and toughness. It is bounded anteriorly by a peculiar lamina, the anterior elastic, on which rests the anterior or conjunctival epithelium. It is bounded behind by another peculiar lamina, the posterior elastic (the membrane of Démours or of Descemet), behind which is the epithelium of the aqueous humor. It is the cornea proper alone which is strictly continuous with the sclerotica."] (*Bowman's Lectures on the Parts concerned in the Operations on the Eye, &c.* 1849. See also *Dr. A. Kölliker's Microscopische Anatomie.* 1850.)

(*a*) *Abnormal States of the Cornea.* An absence of one or both corneæ has been observed, with arrest of development of one or both eyes, anophthalmus and monophthalmus, and union of both corneæ into one in the so-called Cyclops eye. A congenital increase or decrease of the size of the cornea has been observed. (See *Turnari, Annal. d'Ocul.* vol. x. p. 145.) For cases of congenital or partial opacity of the cornea, see *Himley, Ophthalm. Biblioth.* 1801, S. 113; *Kieser, Ibid.* 3 Bd. S. 79; *Ammon, Zeitschrift für Ophth.* 2 Bd. S. 257; *Maclagan, London Med. Gaz.* 1847; *Tavignat, Annal. d'Ocul.* vol. xviii. p. 21; *Travers, Minerva Med.* 1849, p. 150; *Schön, Handb. der Path. Anat.* S. 67; *Arlt, Lehrb. der Rikhten des Menschl. Auges,* 1 Bd. S. 253, &c.

General atrophy of the cornea has always been observed with atrophy of the other portions of the eyeball. The arcus senilis is a partial atrophy of the cornea. (See *Ammon, Zeitschrift für Ophthalm.* 1 Bd. S. 170; *Virchov, Virchov's und Reinhard's Archiv. für Path. Anat. &c.* 4 Bd. S. 88; *Beer, Lehre von den Augenkrankheiten,* 2 Bd. S. 79; *Ammon, Gräfe und Walther's Journal, &c.* 13 Bd. S. 114).

An increase of the curvature of the cornea is not the sole cause of myopia, neither a decrease that of presbyopia. A loss of elasticity, a flaccid corrugated state of the cornea, is called atonia corneæ; it has been noticed with a fistulous opening in the cornea, with deep-seated inflammation of the globe, after acute purulent ophthalmia, &c. (See *Dèsmarres, Traité des Mal. des Yeux,* 1847, p. 322; *Raleigh,* in *Boirisson's Essay, Annal. d'Ocul.* vol. xvii. cap. 1.)

An abnormal colour of the cornea may be caused by bile, hæmatin, &c. (See *Ammon, Hecker's Annalen,* 13 Bd. S. 87; *Hoffmann, Schön's Handb. der Path. Anat. des Auges,* S. 182; *Hecker's Annal.* 1 Bd. S. 129; *und Zeitschrift für Ophthalm.* 2 Bd. S. 446.)

A rare disease of the cornea is its *malace*, *i.e.* a disintegration and softening of its elements, which, leaving a transparent loss of substance, spreads generally at the margin of the cornea; it proceeds sometimes with, and sometimes without, inflammatory symptoms. For cases see *Dr. Carl Stellwag von Carion Ophthalmologie*, Bd. 1, S. 314, No. 48; S. 318, No. 62.

Sloughing (gangrene) of the cornea occurs concomitant with other inflammations of the globe, or idiopathic in young or old weakly people, or after operations, &c. (See *Dèsmarres, Traité des Malad. des Yeux*, p. 326; *Sanson, Dictionnaire en* 15 *Vol.* t. x. p. 610; *Beclard, Hébréand prin. de la Société de Med. de Paris*, p. 47; and *Schindler*, in *Ammon's Monatschft*, 1 Bd. S. 284.)

Middlemore gives several cases; also Bidlos (*Exerc. Anat. Chir.* l. ii. 8.) It consists in a discoloration, softening and decomposition of the corneal elements, with the development of offensive gas, &c., and is in its course and process of repair similar to that of other tissues. Cleanliness, pressure on the globe, and general tonic treatment will be required.

The above remarks have chiefly been taken from the *Ophthalmology of Dr. Carl Stellwag von Carion*, vol. i. 1853.

(*b.*) *Injuries of the cornea.* Abrasion of epithelium. "A slight scratch on the surface of the cornea will sometimes scrape off a portion of its epithelial covering, and give rise to acute suffering. A minute flap of epithelium may be found doubled down, or the surface of the cornea at one small spot appears roughened. The motion of the lids causes a sudden dart of pain, and there is sometimes a considerable amount of zonular redness in the sclerotic. Instantaneous relief is caused by a drop of perfectly fresh castor oil being dropped upon the surface of the cornea. The eye should then be closed with a suitable bandage, which should only be removed after a lapse of several hours, for a re-application of the oil. In cases of extreme irritability, it is well to bandage both eyes for twenty-four hours, to ensure perfect repose of the injured one. As soon as a fresh layer of epithelium has been formed, all pain ceases, and the sclerotic redness soon subsides." (See *James Dixon's Guide to the Practical Study of Diseases of the Eye*, 1855.)

Foreign bodies in the cornea.—Mr. Bowman, in his Lectures on the parts concerned in the operations on the eye, says:—"The existence of the anterior elastic lamina will help to explain the tenacity with which small particles of steel or other sharp angular fragments stick in the front of the cornea, only just within the surface. These will remain for many days, or even weeks, and prove the cause of much inflammation, and yet still be found difficult of extraction, which could hardly be the case if the lamellated tissue and the conjunctival epithelium were the only textures in which such particles could be imbedded." Mr. Dixon remarks:—"If any foreign body is seen or suspected to be fixed on or in the cornea, a careful examination of the corneal surface should be made, whatever may be the amount of irritation of the eye. The surgeon commands the movements of the patient's eye by placing the point of one finger on the sclerotic, just above the cornea, and the other against the inner side of the globe; he then tilts out the foreign body, by inserting beneath it the thinned rounded extremity of a spatula. Bathing with warm water and resting the eye for a day or so are usually all that is required by way of after-treatment. If a sharp little fragment of metal be driven straight into the cornea, so that one end projects above the surface, it may be drawn out with a forceps. If the fragment strikes the eye in a slanting direction, and buries itself completely among the fibres of the cornea, a little cut must be very carefully made with a cataract-knife, through the superficial fibres of the cornea, to the extent of the whole length of the fragment, which may then be tilted out with the spatula.

"If one end of the fragment extends backwards into the aqueous chamber, the other being at the same time too deeply buried in the cornea to allow of its seizure with the forceps, a broad cutting-needle is first thrust through the margin of the cornea, and then carried onwards until its anterior flat surface is brought into contact with and pressed against the point of the foreign body, which is now to be tilted out with the spatula, held in the other hand.

"Bodies which are laying loose in the aqueous chambers may sometimes be got rid of by simply making an incision through the cornea sufficiently large to allow of their escaping with the aqueous humor; others may require, in addition, the aid of some forceps."

Penetrating wounds of the cornea.—"Within a few hours, the edges of a clean cut of the cornea become hazy, and the wound is at once traceable as a whitish line; but if the wound is seen while its edges are still transparent, it may require the closest scrutiny to detect it. If the aqueous humor has drained away, the obliteration of the anterior chamber, caused by the falling forwards of the iris against the cornea, will aid the detection of the wound. We often find wounds of the cornea from blows with a stick or whip, quite indistinguishable from those done with the sharpest instruments. Wounds from blows are attended with a considerable shock to the whole eyeball, and we must be extremely guarded in our prognosis.

"*Treatment:* Foreign bodies must be removed, and anything that can hinder the perfect adaptation of the cut surfaces; and then absolute rest and a due performance of the nutritive functions are the main requisites. When the foreign body has gone into the eye and it can be seen, an attempt should be made to extract it; if the iris protrudes it should be replaced with the spatula.

"When a fragment of stone or metal strikes the cornea and bruises without rupturing it, very serious consequences often ensue, especially in old or enfeebled persons. Suppuration within the substance of the cornea quickly sets in; the softening and breaking down of the corneal tissue rapidly extends, until the whole is reduced, except perhaps the extreme margin, to a greyish or buff-coloured mass. As soon as the aqueous humor escapes, the pain, which had previously been severe, subsides, and the case terminates in staphyloma. By supporting the patient's feeble powers with ammonia and bark, good diet, and suitable stimulants, and, if necessary, soothing pain by the use of narcotics, some check may occasionally be put to the destructive process.

Whenever the cornea has been perforated, there is a likelihood of the lens having been injured, and the pupil should therefore be carefully explored. Sometimes the lens does not show any opacity until several hours after it has been wounded. The foreign body should carefully be looked for and extracted." (See *James Dixon's Guide to the Practical Study of Diseases of the Eye*, 1855.)

Boiling water, when touching the cornea, coagulates its tissue; burning charcoal, hot metal, &c., produce an eschar. Much depends upon the duration of the contact of such substances; the contact of the flame of a fire with the cornea is singularly dangerous to the existence of the eye; an apparently superficial eschar of cornea and conjunctiva may be followed by suppuration of the globe. The contact of many chemical substances render the cornea opaque; it becomes white when alcohol, vinegar, quicklime, &c., yellow when nitric acid, and brownish-black when nitrate of silver act upon it. A long-continued contact or a concentrated state of such chemicals transform the corneal tissue into a soft pulpy mass, or into a dry eschar of different colours.

Tumors and excrescences of the cornea.—(For the latter see also article CONJUNCTIVA.)

Of the different forms of cancer the following have been observed on the cornea—the gelatinous, epithelial, and medullary cancer, including what is called fungous hæmatodes and melanosis. A case of gelatinous cancer involving also other parts of the orbit has been reported by *Stellwag von Carion, Ophthalmologie*, Bd. 1, S. 341, No. 176—179. Also *Wardrop, Observat. on fungous hæmatodes*, Edinb. 1809. It consisted of a yellowish, tough, transparent mass, which, microscopically, showed a faint arrangement in fibres interspersed with darkish nuclei.

Epithelial cancer has not yet been observed as a primary disease; its secondary appearance is also rare; it has in some cases involved the remainder of the globe; it is preceded by hard nodules on the outer surface of the lids. When on the cornea it appears under the form of small, millet-seed sized, white, hard nodules, with a hazy slightly vascular halo round their base. These nodules ulcerate and perforate the cornea; microscopical examination shows the elements which are generally peculiar to the epithelial cancer. (See *Stellwag von Carion, Ophthalmologie, &c.* vol. i. p. 180; and *Jacob in Dublin Hospital Reports*, vol. iv. p. 232; and *Med. Chir. Transactions*, vol. ii. pp. 216 and 225.) The medullary cancer of the cornea is, like the foregoing species, preceded by a simple infiltration of the corneal tissue; this cancer also appears under the form of nodules of bluish, or white reddish, brown, or black colour, of cheesy, fleshy or cartilaginous consistence. It spreads more on the surface than in the substance of the cornea; it appears primary, and secondary encroaching from the neighbouring parts upon the cornea. Its elements are microscopically those generally known. (See *Stellwag von Carion, Ophthalmol.* Bd. 1, S. 344, No. 183—185.) A case of spontaneous cure of this species of cancer is mentioned by Ritterich (*Schöns Handbuch der Pathol. Anatomie des Auges*, S. 180). For treatment see EXCISION OF THE EYEBALL.

Lupus of the cornea. It resembles the epithelial cancer of the cornea in its manner of infiltrating: it is an endemic disease, of which two chief forms must be distinguished; the one is characterised by an abundant and peculiar exudation, the other by a paralysis of the sensitive nerves with subsequent atrophy of the eye, &c. Lupus, as far as has been hitherto ascertained, does not appear primary on the cornea; it is preceded by lupus nodules in the subconjunctival tissue round the cornea; the latter becomes hazy and inflamed, and the further products of this inflammation appear as lupus nodules, &c., which gradually ulcerate, and lead to perforation of the cornea, &c. (See *Himley, Ophthalm. Beobachtungen und Untersuchungen, Bremen*, 1801, p. 118; *Pruner, Die Krankheiten des Orients, Erlangen*, 1837; *Riegler, Die Turkei und deren Bewohner, Wien*, 2 Thl.; *Danielsen und W. Bœck, Traité de la Spedalsked, or Eléphantiasis des Grecs; traduit en français par L. A. Casson, Paris*, 1848; *Fr. Krause, Zeitsch. der Gesellschaft der Aerzte in Wien*, 1851, 1 Bd. S. 468.) Occasionally we meet with excrescences on the cornea, which resemble nævi on the skin; they appear as reddish, soft, easily bleeding warts; sometimes hairs grow on them, they have been observed congenitally; they may have a large base or be pedunculated. (See *Dèsmarres, Traité des Mal. des Yeux*, p. 352; *Stellwag von Carion, Ophthalmol.* vol. i. p. 354, 1853; *Wardrop, Morb. Anat. of the Human Eye*, vol. i. cap. 4, p. 29; *Graefe, Die Angiectasien, Leipzig*, 1808, S. 30; *Schön, Handbuch der Path. Anat. das Auges*, 1828, S. 180; *Gazelles, Journ. de Med.* tome xxiv. p. 332; *Lerche, Vermischte Abhdlg. aus dem Gebiete der Heilk. &c. Petersb.* 1823, p 199; *Ryba, Dusensy Diss. über die Krankheiten der durchsichtigen Hornhont. Prag.* 1833, S. 63; *Fischer, Lehrbuch der ges. Entzündungen*, S. 303; *Kölliker, Mikroscop. Anat.* 2 Bd. 1 Hölft. S. 133, &c.)

For different new formations on the cornea, the nature of which has not been examined, see *Plaicher, Diss. de Fungo Oculi, Heidelb.* 1780; *Schön, Adb. d. Path. Anat.* S. 180; *Himley, Krkhtn. und Missbildungen, &c.* 2 Bd. S. 20.

Ossifications in the cornea have frequently been observed. They can only be distinguished microscopically from earthy concretions; they are always overlaid by epithelium or some other organic tissue, and are a further development of inflammatory products, similar to those observed on the inner surface of the choroid. Plates of bone have been observed, which obscured the whole extent of the cornea.

Cases of extravasation of blood into the lamellated tissue of the cornea have been observed by *Stellwag von Carion, Ophthalmol.* vol. i. p. 301. Incrustations on corneal ulcerations have been noticed after the use of lead lotions, and of lotions which contained opium with some salt of cadmium, zinc, or copper. (See *Cunier, Ann. d'Ocul.* vol. xiii. p. 255.)

For inflammation, abscess, and ulcer of the cornea, opacities of the cornea, earthy deposits, staphyloma and fistula of the cornea, the reader is referred to the subjoined account of *Corneitis*.

For the subjects treated of in the above article on cornea, see *W. Bowman, Lectures on the parts concerned in the Operations on the Eye, &c.* 1849; *Dr. A. Kölliker, Microscopische Anatomie*, 1850; *Dr. Carl Wedel, Grundzuge der Pathologischen Histologie, Wien*, 1854; *Dr. Carl Stellwag von Carion, Die Ophthalmologie, &c.* vol. i. 1853; *James Dixon, A Guide to the Practical Study of Diseases of the Eye, &c.* 1855; *William Mackenzie, A Practical Treatise on the Diseases of the Eye*, 4th ed. 1854; *W. Lawrence, edited by Isaac Hays, A Treatise on the Diseases of the Eye*, 1854; *Dèsmarres, Traité Théorique et Pratique des Maladies des Yeux*, edit. 2d. vol. ii. 1855; and *Graefe, Archiv. für Ophthalmologie*, Bd. 1, Abthl. 2, S. 287, 1855; Bd. 2, Abthl. 2, S. 334, 1856; Bd. 3, Abthl. 1, S. 166, 1857; Bd. 3, Abthl. 2, S. 405.

Inflammation of the cornea (corneitis, keratitis).—It is a disease of childhood and youth, very rarely occurring after the middle period of life: it usually developes itself in a few days, with little or no pain, and with scarcely any evidence of conjunctival inflammation, the slight pink discoloration seeming rather to be due to injection of the sclerotic vessels, probably those vessels which are described as being specially dedicated to the nutrition of the proper layers of the cornea. That which usually first attracts the notice of the patient is dimness of sight in one eye, accompanied sometimes with a slight, dull, aching pain. On examining the eye, the cornea presents an uniform pale-white opacity, with just sufficient transparency remaining to enable one to see the iris and pupil, but not with such clearness as to show with certainty its colour and condition, although its activity may usually be made out. The surface of the cornea, when closely inspected, is found to be finely granulated, resembling a thin layer of finely-granulated ground glass. The opacity is very generally and equally diffused over the cornea, though usually rather thicker towards the centre. But it is difficult to determine the extent to which it penetrates and involves its layers, and in this respect there is probably considerable diversity. The pain is very slight, sometimes altogether wanting, and there is no intolerance of light. One eye is almost invariably affected in the first instance, and the disease may be limited to the eye first involved; but more commonly, when it has existed some time, and is subsiding, or has just passed away, the second becomes similarly affected, and runs through the same phases. This is by far the most common form of corneitis. Mr. Jonathan Hutchinson (*Ophthalmic Hospital Reports, Moorfields;* October, 1858, p. 229) remarks:—"This form of keratitis, respecting which I hope to be able to sustain the proposition that it is almost always a direct result of inherited syphilis, is a well-marked disease, the individuality of which has long been recognised. In Dr. Mackenzie's excellent work, he devotes a section to it under the name of 'Scrofulous corneitis,' and states that,—'It is specifically different from every other ophthalmia.' Dr. Jacob, in his *Inflammations of the Eyeball*, gives a description of it, which, as with all that comes from his pen, bears the stamp of careful observation; and, more recently, Mr. Dixon, in his work on *Diseases of the Eye*, and Mr. Critchett, in his published Clinical Lectures, have devoted special attention to it. The manner in which, by interstitial deposit, the cornea is made to assume the appearance of ground glass, the absence of ulceration and of any tendency to pustules; the comparatively small amount of sclerotic and conjunctival congestion—are facts in its history as to which all observers agree. Nor is the testimony of writers much less unanimous as to its being hardly ever met with except between the ages of five and eighteen—as to its almost invariably affecting first one eye and then the other—as to its being of exceedingly slow progress—or, lastly, as to the fact that the ultimate result is almost always very much better than could have been hoped for, judging from the condition of the cornea in its early stages." Although I will not make so sweeping an assertion as that interstitial keratitis never occurs excepting in the subjects of inherited taint, yet I cannot conceal from myself that such is my present belief. I have proved it now in so many cases, to the full satisfaction of much more able ophthalmic observers than myself, that the attitude which my mind has involuntarily assumed is as just stated. Chronic interstitial keratitis usually commences as a diffuse haziness in the centre of the cornea of the eye. There is at this stage no ulceration, and exceedingly slight evidence of the congestion of any tunic. The patient, however, almost always complains of some irritability of the eye, as well as of dim sight. If looked at carefully, the dots of haze are seen to be in the structure of the cornea itself, and not on either surface; they are also separated from each other, like so many microscopic masses of fog. In the course of a few weeks, or it may be more rapidly, the whole cornea, excepting a band near its margin, has become densely opaque, by the spreading and confluence of these interstitial opacities. Still, however, the greater density of certain parts—centres, as it were, of the disease—is clearly perceptible. At this stage the comparison to ground glass is very appropriate, and there is almost always a zone of sclerotic congestion and more or less intolerance of light, and pain around the orbit. After from one to two months, the other cornea is attacked, and goes through the same stages, but rather faster than the first. A period in which the patient is so far blind that there is but bare perception of light now often follows, after which the eye first affected begins to clear. In the course of a year or eighteen months a very surprising degree of improvement has probably taken place. In mild cases, or under suitable treatment, the duration may be much less than this, and the restoration to transparency may be complete, but in many instances patches of haze remain for years, if not for life. In the worst stage, the corneal surface looks slightly granular, and has lost its polish. In certain cases, after the ground-glass stage is passed, a yet more severe one ensues, in which the whole structure of the cornea becomes pink, or salmon-coloured, from vascularity, at the circumference of which crescentic fringes of vessels are often noticed. In the best recoveries the eye usually remains somewhat damaged as to vision, and often a degree of morbid expansion of the cornea is apparent. Only in one or two cases have I ever observed ulcers of distinguishable size on the surface of the cornea, and I have never seen pustules on any part of it.

My reasons for believing that this disease is dependent upon an inherited syphilitic taint are the following:—

1. That in certain instances, patients whom I knew beforehand to be the subjects of inherited disease have, whilst under observation, been attacked by it.

2. That in a large number of other cases I obtained from the parents of the patient a free confession as regards themselves, and a distinct history of specific symptoms in the child during infancy.

3. That in almost all cases the subjects of it present a very peculiar physiognomy, of which a coarse flabby skin, pits and scars on the face and forehead, cicatrices of old fissures at the angles of the mouth, a sunken bridge to the nose, and a set of permanent teeth peculiar for their smallness, bad colour and vertically notched edges, are the most striking.

4. That in many cases, one or more of the following suspicious forms of disease have either been coincident with it, or have occurred previously,—ulcerative lupus, nodes on the bones, psoriasis on the face, otorrhœa, chronic enlargement and subsequent atrophy of the tonsils, ulcers in the throat, a thickened condition of the parts under the tongue, and chronic engorgement of the lymphatic glands.

5. That the effect of specific treatment in mitigating the severity of these inflammations and in shortening their duration, is often very marked, whilst mere tonic or dietetic plans are of no avail.

6. That it is either accompanied or preceded by iritis.

As regards the treatment, it appears that the disease has its period of development, that it remains in full force for a given time, varying from two to four or five months, and then gradually passes away, the opacity clearing from the circumference, like a vanishing cloud, and ultimately leaving no trace behind. Any expectant treatment appears better than active constitutional and local means.

It occasionally happens that corneitis manifests itself under another and severer form, and though probably differing only in degree, spreads deeper, produces more formidable results, and more seriously interferes with vision, from the circumstance that it usually involves the second eye before the first has recovered its transparency. The corneal opacity, instead of being uniform, exhibits one or more patches of a reddish-brown colour, not on the surface, but between the layers of the cornea. On a superficial view, these appear like small masses of extravasated blood; but, if carefully examined, are found to be made up to a great extent of minute vessels, and to be in fact masses of highly-organised lymph. In this severe type of corneitis, there is much more evidence of increased vascularity; the conjunctiva is considerably injected; the deeper vessels are involved; there is both lachrymation and some intolerance of light; the patient also complains of a dull aching pain. It is very important not to confound this disease with the vascular opacity of the cornea, as the result of a villous state of the conjunctiva in strumous subjects. This disease never produces ulceration. It may occur in children, but the worst forms of it have been observed in adults between thirty and forty years of age. It is very protracted in its duration, and resists every kind of treatment, but ultimately gets quite well, when perhaps every plan has been tried and abandoned in despair.

We must limit ourselves to such means as will restore power to the system, but without anticipating any favourable results to the disease, except indirectly, hoping merely that it may run its course more speedily, when the system is in a healthy condition.

Cases sometimes present themselves, in which a superficial layer of the cornea is separated from the rest by the infiltration of a small quantity of clear serous fluid, resembling a minute blister. This may be raised and flaccid, so that on pressing the surface with the lid, the fluid may be seen to move between the layers; or it may form a defined circumscribed, tight, transparent blister; or the fluid may be somewhat opaque and infiltrated between the layers of the cornea, so as to resemble, on a cursory view, a circumscribed opacity of the cornea. This change is met with in eyes which have previously been injured by deep-seated inflammation of the globe; and when they occur in a healthy eye, they produce more or less permanent damage to the sight. The pain is severe and intermittent, and does not very readily yield to any form of treatment. Mr. Tyrrell has very clearly described this curious affection. He is of opinion that it occurs in persons suffering from some organic disease, and mentions its extreme intractability, and particularly recommends warm baths. If there is undue tension of the globe, with severe pain, it may relieve the symptoms to introduce a fine needle through the cornea, and allow some of the aqueous humor to escape, and this may be repeated, if necessary, from time to time, until permanent ease is obtained.

Ulceration of the cornea.—If the conjunctiva be inflamed beyond a certain point, or if the inflammation be prolonged to a certain height beyond a given time, and if there exist at the same time a condition of constitution unfavourable to the subsidence of morbid action, the nutrition of the cornea becomes impaired, and its surface becomes, at some time or other (usually near the centre), the seat of ulcerative absorption. On careful examination, we find these ulcers in one of four conditions,—1. in process of formation; 2. in a stationary condition; 3. in a state of overaction; 4. in a healing or cicatrizing condition. An ulcer of the cornea during its formation and progress may present an excavation of a circular or irregular shape, with defined edges, and often perfectly transparent, as if a portion had been cut or punched out, or transparent at one part and opaque at another. If it be recent and in process of development, the opacity round the ulcer is rather deep, circular, white, and well-defined; whereas, during the healing process, the opacity is thinner, less defined, and more delicately shaded off. The ulcerative process may be arrested at any point, or may proceed until it has penetrated the entire substance of the cornea, giving rise to a small hernia of the elastic tunic, and when that yields, to a hernia of the iris; again, it may form a slight abrasion, scarcely perceptible, or a deep excavation. It may be situated at any part of the cornea, most commonly near the centre, which is particularly the situation of the *glassy* ulcer, but it may invade the margin, especially in purulent ophthalmia. An ulcer sometimes attacks both surfaces of the cornea, leaving the central layers unaffected. One result of this curious affection is the occurrence of "hypopion," or pus, in the anterior chamber. When the ulcerative stage has ceased, the subsequent progress of the case will vary very much, and will be regulated by the state of the system and the amount of conjunctival inflammation, to which the ulceration owes both its origin and its continuance. "Some chronic ulcers of the cornea will heal," observes Mr. Bowman, "in the most gradual manner, without the formation of any vessels in their vicinity;" but, "if any ulcer exists, having to heal by a slow and gradual process, we usually find, in the interval between it and the neighbouring vessels, a grayish half-transparent tract, distinguishable from the healthy cornea; and in this there is soon developed a series of vessels, which presently declare themselves as arteries, capillaries and veins, carrying the blood in a circuit through and about the seat of reparative action. . . . Thus is the cornea made dull and useless for a time, by the introduction of a structure destructive of its transparency, in order that its integrity may be restored according to the natural laws of growth. When its restoration is somewhat advanced, and less blood is required, these vessels dwindle, their coats, which are at best imperfectly organised, soon disappear, and the cornea becomes once more permeable to light." If the general health be good, and the case well managed, the ulcer will be observed to be gradually filled up with opaque lymph, until it reaches a level with the surface, when it will rapidly and perfectly heal, leaving a dense white cicatrix. Ulcers, in some cases, heal with transparent material; in others, when the ulceration is extensive, but shallow, it may heal over transparently, without filling up, so as to leave a flattened surface very detrimental to clear or accurate vision. When the general powers of the patient are at a very low ebb, the ulcer will remain in a glassy transparent state, without any appreciable change of form or depth for a considerable time. In other cases the conjunctiva is highly injected, the surface of the ulcer, instead of being excavated, is raised somewhat above the natural level of the cornea, and one or two vessels, carrying red blood, may be distinctly seen passing over the cornea to the lymph filling up the ulcer. The usual condition, after an ulcer is healed, is a dense white opacity, gradually shaded off into the transparent cornea, the centre being the cicatrix of the ulcer and the margin interstitial deposit.

Treatment.— During the first stage, that in which the ulcer is in process of formation, there is usually an excess of local action in the conjunctival membrane and the usual symptoms of acute ophthalmia. Soothing applications, such as poppy fomentations, or warm water, together with the local abstraction of blood by means of a few leeches to the temple, followed up by counter-irritation behind the ear, are the most likely means of arresting the ulcerative process; at the same time it may be necessary to sustain the general power and counteract by constitutional treatment any abnormal state of the system that may exist. Thus, in children struma is often found in league with corneal ulceration. At puberty the menstrual function may be at fault; prolonged lactation is a fertile and very embarrassing cause; and, later in life, a feeble, shattered, and physically depraved state of system, the result of constant and prolonged intemperance, gives rise to ulceration of the cornea. We must ever bear in mind, that the most active and destructive inflammatory and ulcerative processes are compatible with and even dependent upon a very feeble state of system, which may require tonics, stimuli, and a very liberal dietary for their cure. In cases of acute and spreading ulcers, where penetration of the cornea is threatened, it becomes a matter of extreme importance to determine whether there is any means of arresting the progress of the ulceration. However judiciously the constitutional treatment may be conducted, there is every fear that penetration may occur, before a favourable reaction has time to take place; it, therefore, is an anxious question, whether we can, by any local application, bring about an altered action in the part and avert the impending danger. It is in such cases as these, that the nitrate of silver in substance is of great value; it should be finely pointed, and its application carefully limited as much as possible to the ulcer itself. In order to effect this object, glycerine should be dropped into the eye previously, so as to protect the remainder of the surface from the action of the caustic. In other cases it must be admitted that the effect is less favourable — that it is productive of considerable pain and increased inflammatory action, and of infiltration of matter between the corneal layers. This is chiefly observed amongst the old and feeble; but the happy result that occurs in numerous cases, and the extreme urgency and threatening aspect of the symptoms, fully justify the use of the caustic. If we are unable to arrest the progress of the ulcer and perforation occurs, the iris immediately falls forward in contact with the opening, which, gradually enlarging, allows of its protrusion, and thus "prolapsus iridis" occurs, the natural resisting power and elasticity of the globe is weakened, the prolapse increases, the anterior surface of the eye bulges forward, and "staphyloma" occurs.

It is very desirable, if possible, to obviate this latter result; the best remedy is either puncturing the prolapse with a needle, which often causes it to contract and shrivel away, and thus to close up the corneal opening; or in case that fail, and the protrusion still increases, to remove it entirely. Under the most favourable circumstances, when the disease has produced such results, the integrity of the organ is seriously compromised; but it is quite possible that sufficient space may be preserved for the formation of an artificial pupil, and under any circumstances, it is most desirable to prevent the occurrence of a large staphylomatous protrusion. In the glassy ulcer there is very little to combat locally, the conjunctiva is very slightly injected, there is no surrounding opacity in the cornea, and no indication of any morbid action in the part except the loss of substance. Here we have evidently an error of nutrition, and our chief efforts must be directed toward the constitutional condition of the patient; one of the remarkable features in the transparent ulcer is, the very lengthened period during which it will remain stationary and unaltered in its size and other characters. The local treatment is comparatively unimportant, and should be of a very mild character. It has been suggested that the salts of lead, in solution, should not be employed in ulcers of the cornea, on account of the tendency to a permanent deposit upon the surface; and as there is no counteracting advantage to be gained by the use of the lead lotion, it is better to abstain from it altogether where ulceration exists. Some cooling unirritating collyrium, such as rose-water or elder-flower water, or a weak solution of vinegar, is the best application. Where the case is very protracted and the surface of the ulcer becomes irritable, it is sometimes advantageous to touch the surface lightly with the fine point of nitrate of silver. It is particularly important in the glassy ulcer, to apprise the patient or his friends, that an opacity of the cornea must be expected, otherwise the symptoms are so mild, and the evidence of breach of surface so faintly appreciable to uneducated vision, that discredit may easily attach to the surgeon who is in attendance, and, as the ulcer begins to fill up, an impression will be gained that the case is retrograding, at the very time when it is drawing to an auspicious close.

In cases of ulcer, with a vascular membrane, and organised deposit upon its surface, which is usually somewhat raised above the level of the rest of the cornea, and in which red vessels may be seen travelling to supply it, the treatment is difficult. We have here new and organised tissue to deal with; diseased action seems to have established itself, and to have taken up its abode in the part, and this very much increases its power of resisting all remedial means. These cases generally occur in young females about the age of puberty, or a little anterior to this, although they are also found in young strumous children. They appear to be due, in the first instance, to a disturbed, altered, and arrested function of some important organ in a feeble and strumous diathesis, aggravated by an active depleting plan of treatment, or by the injudicious and protracted use of strong local stimuli, particularly the nitrate of silver.

As for the local treatment, stimuli of all kinds are injurious; soothing applications are the best; sometimes one or two leeches, applied about every other day for a week or two, are of use, particularly when the vessels are rather numerous and full, and the inflammation is in a subacute stage; but that which appears to be of the most marked and essential service in this form of disease are issues and setons inserted in the temple, and kept there for many months. I have succeeded in completely and permanently curing several cases of this kind by the prolonged use of issues when they had baffled all other means for many months and even years, and when the constant irritation and necessary confinement were casting a gloom upon what would otherwise be the brightest period of life.

When the cicatrizing process is going on favourably, the only practical point we have to consider has reference to the opacity remaining in the cornea. Mr. Dixon (*Diseases of the Eye*, p. 86, 1855), remarks: "Opacities of the cornea have received different names, according to their density. Those having a whitish, cloudy appearance are called nebulæ, while the perfectly opaque white patches are distinguished by the terms albugo and leucoma. A forced distinction has sometimes been drawn between the two latter terms, but their etymology shows them to be perfectly synonymous (λευκός — albus.) Cloudy opacities, diffused throughout the greater part of the cornea, result from long continued inflammation of its tissue; those which are confined to certain portions of the cornea, the rest remaining clear, are the effect of superficial ulcers. The perfectly opaque chalky white patches overspreading a large part, perhaps nearly the whole of the cornea, are the cicatrices succeeding to extensive suppuration, and breaking down of its fibres. Penetrating ulcers produce cicatrices almost as white and opaque as those following suppuration; but the former are of smaller size, and they have almost always a portion of iris adherent to their posterior surface. Caustic lime, when it does not produce actual sloughing of the whole cornea and subsequent staphyloma, renders the part opaque, but the opacity has not that chalky appearance which follows loss of corneal substance and the formation of a cicatrix: it rather resembles what one sees in the dead subject when decomposition is just commencing."

Much confidence is expressed by some in the action of various local stimuli in promoting the absorption of such opacities; thus, solutions of the nitrate of silver, of zinc, of iodide of potassium, calomel, and various other stimuli, are each of them in high favour with different observers. It is extremely difficult to estimate the value, either positive or relative, of these means, when we know the natural tendency is towards a gradual absorbent action. If anything, we generally use a solution of the iodide of potassium—five grains to an ounce of distilled water, dropped in three times a day. It does not cause pain, and its action is gently stimulating and absorbent.

Conical cornea (*keratoconus*) is an alteration in the form of the cornea, which, instead of presenting its usual convex surface, is gradually raised from the circumference towards a central elevation, more or less prominent, so as to present a complete cone. The appearance is peculiar and characteristic, and can always be recognised when it has been once seen; the apex glistens and the eye looks as if a piece of solid glass had been stuck on to the centre of the cornea; in fact, it was thought formerly to consist of a solid thickening of this body. In the latter stages the extreme apex sometimes becomes opaque, probably on account of the friction and irritation of the lids; it occurs usually soon after puberty, and most commonly in females; it generally attacks both eyes, but not simultaneously nor to an equal extent, and one remains permanently more seriously damaged than the other. This change occurs very slowly, occupying many months and even years, and having attained a certain point, usually remains stationary; there is no pain or other evidence of inflammatory action. The cause of this change is very obscure; it is generally observed in feeble, ill-nourished persons; and is probably due to some partial arrest of nutrition, giving rise to a gradual thinning of the cornea towards its centre. Such, in fact, was found to be the condition of the part, in a case examined by Professor Jaeger of Vienna, after death; and it seems highly probable that this is the usual condition of the part in this disease. (*Jaeger*, *Zeitschrift. f. Ophthalm.* 1 Bd. S. 544; and *Walker*, *Principles of Ophth. Surgery*, London, 1834, p. 80.) The important practical point is the serious damage to the sight occasioned by this change; the rays of light are so very much refracted, that images are very imperfectly formed upon the retina, and objects are only seen when held very close to the eye, and when they are of some considerable size. Where the apex of the cornea has become opaque, even this very short and imperfect vision is lost.

As regards treatment, we certainly possess no means, either local or constitutional, that can restore to the part its normal shape; the utmost we can hope for, is to arrest the morbid change at the stage at which it first comes before our notice, and even this, it must be admitted, is very doubtful. The best plan seems to be to use some mild local astringent collyrium, and by the exhibition of tonics to try to check the progress of the disease. Another important consideration is to endeavour, by some mechanical means, to obviate or diminish the extreme refraction of the rays of light; various plans have been suggested for this purpose; thus, it has been proposed to remove the lens, and also to employ an extremely concave glass, both these means having the tendency to counteract the effect of the extreme convexity of the cornea. Mr. Tyrrell proposed to draw the pupil towards the margin of the cornea, where the convexity of the cornea is not extreme; and he states, that he has done this with very marked benefit in some cases. The same treatment has with satisfactory result been employed in several cases by Messrs. Bowman and Critchett. Again, it has been proposed to shut off all rays, except those passing through the apex of the cornea by means of a small aperture through a thin, dark substance, or, what is better, by means of a horizontal slit through some dark medium. This last method has in several cases been found of great service, enabling the patient to see both near and distant objects with great precision, and even to read with ease. This is, upon the whole, the most efficient palliative means we possess, but in some cases it altogether fails, and we may then try the effect of an extremely concave glass.

In an ingenious monograph upon this subject, by Dr. Pickford, of Brighton, the writer stated, that he had found considerable advantage from the constant and prolonged use of emetics.

Staphyloma Corneæ. — Mr. Bowman (*Lectures on the Parts*, &c. 1849, p. 40.) observes: I shall conclude the present lecture with a short description of the structure, which replaces the cornea when wholly or partially destroyed, and which is liable to become bulged, so as to constitute the state known as staphyloma corneæ. The whole thickness of the cornea, in a larger or smaller extent, having perished from any cause, the iris is exposed, and occupies the breach, becoming adherent to the border of the gap formed by the removal of the lost part. If the contents of the globe do not further escape, and the eyeball consequently collapse, time is afforded for the reparative process to take place, by which the opening is filled with new material by granulation. At first this new material is soft, vascular, and nearly on a level with the surrounding parts; and, if nature is allowed to proceed with her operations undisturbed, it gradually acquires firmness, toughness, and considerable density, so as to appear not unlike the natural cornea, except that it is opaque. It becomes covered with an epithelium continuous with the conjunctival, just as an ulcer of the skin acquires an investment of cuticle as it heals. This process was first explained by Mr. Wharton Jones, in an able paper, published in the *Medical Gazette*, vol. xxi. p. 847. Now in some cases, from causes which it is unnecessary for me at present to specify, this cicatrix contracts more or less, and continues to retain the contents of the globe within their proper bounds, the patient experiencing little inconvenience beyond the loss of vision; but in other instances the new material begins after a time to evince its want of coherence and strength, by bulging slightly under the pressure occasioned by the accumulation of fluid behind it—that is of course behind the iris, in the posterior chamber of the eye. Should the projection increase beyond a certain size, it assumes an unsightly appearance, interferes with the movements of the lids, so as at last even to prevent their closure, and, in a word, grows into such a source of annoyance and irritation, that it requires to be got rid of. This is usually done by the knife, and the lens being allowed to escape, the eyeball permanently shrinks to a small size.

The whole substance of the cicatrix being shaved off from the front of the globe, affords us now and then the opportunity of examining its structure in the perfectly recent state, which we can seldom do with any other of the morbid tissues of which this organ is the seat. I had such an opportunity last summer in the case of a little girl; the following in few words is a description of the structure of the tough opaque membrane, which occupied the place of the lost cornea. Its thickness was very unequal; its posterior surface, to which portions of the iris adhered, being irregularly pitted, or as it were worm eaten; its anterior surface was formed by a thickish coating of epithelium, somewhat resembling cuticle, being composed of eight or ten layers of cells, the deep ones globular, the superficial ones scaly, and more like epidermic cells than those of the healthy cornea. There was no anterior elastic lamina and no posterior elastic lamina. The entire remaining portion of the thickness of the staphyloma consisted of a dense and most irregular interweaving of white and yellow fibrous tissue, with imperfectly developed nuclei intermingled, and the meshes of the tissues large, unequal, and open on all sides. In this condition we have an eminent example of those results of the reparative action, after loss of substance of the cornea, which we have already had occasion to notice as the consequence of ulcers or small sloughs, the chief difference being that here the new material is derived, in a great measure or wholly, from the vascular iris rather than from the cornea itself. We see how far the reparative powers fall short of restoring the complex and elaborate structure of the cornea as it is originally laid down in the development of the body. The thickness of the new cuticle is attributable in part to the constant friction of the lids.

For injuries of the cornea see article "Eye, Injuries of the." Most of the above remarks on corneitis, and its consequences, &c., have been taken from Mr. Critchett's practical Lectures, which are published in the *Lancet*, 1854. For further information on this subject, and for numerous references, consult *Bowman, Lectures on the Parts concerned in the Operations on the Eye*, &c. 1849; *Dixon, A Guide to the Practical Study of Diseases of the Eye*, 1855; *Mackenzie, On the Diseases of the Eye*, 1854, 4th edition; *Dr. Carl Stellwag von Carion, Die Ophthalmologie, &c. &c.* Bd. i. 1853; *Dèsmarres, Traité Théorique et Pratique des Maladies des Yeux*, tome ii. edit. 2, 1855, pp. 226—386; and *Graefe, Archiv. für Ophthalmologie*, Bd. i. Abtheil. i. 1854, S. 297; Abtheil. ii. S. 306; Bd. ii. Abtheil. i. 1855, S. 206, Abtheil. ii. 1856, S. 151—157; Bd. iii. Abtheil. ii. S. 387.]

C. Bader.

CONTUSED WOUNDS. (See Wounds.)

CONTUSION (from *contundo*, to bruise). A bruise. Bruises, when slight, seldom meet with much attention; but when they are severe, very bad consequences may ensue, and these are the more likely to occur when the accidents are not taken proper care of.

In all severe bruises, besides the inflammation which the violence necessarily occasions, there is an instantaneous extravasation of blood into the cellular tissue, in consequence of the rupture of many of the small vessels of the part. In no other way can we account for those very considerable tumours, which often arise immediately after injuries of this nature. The black and blue appearance, instantly following many bruises, can only be explained by there being an actual effusion of blood from the small arteries and veins, which have been ruptured. Even largish vessels are frequently burst in this manner, and considerable collections of blood are the consequence. Blows on the head often cause a large effusion of blood under the scalp, and sometimes a smaller extravasation under the aponeurosis of the occipito-frontalis muscle. I have attended cases in which more than a pint of blood was effused in the former of these places. The most copious extravasations on the head, indeed, are generally directly under the scalp, where the larger branches of the temporal, occipital, and frontal arteries are situated.

I attended a man in the King's Bench, over whose sacrum an extravasation of three quarts of blood took place from a severe contusion.

Besides the rupture of an infinite number of small vessels, and an extravasation of blood which attend all bruises in a greater or less degree, the tone of the fibres and vessels which have suffered contusion, is considerably disordered. Nay, the violence may have been so great, that the parts are from the first deprived of vitality, and must slough.

Parts at some distance from such as are actually struck, may suffer greatly from the violence of the contusion. This effect is what the French have named a *contrecoup*.

The bad consequences of bruises are not invariably proportioned to the force which has operated; much depends on the nature and situation of the part. When a contusion takes place on a bone which is thinly covered with soft parts, the latter always suffer very severely, in consequence of being pressed, at the time of the accident, between two hard bodies. Hence, bruises of the shins frequently cause sloughing and troublesome sores. Contusions affecting the large joints are always serious cases; the inflammation occasioned is generally obstinate, and abscesses and other diseases, which may follow, are proper grounds for serious alarm.

The species of mischief which is alleged to result from what are termed wind contusions, is noticed in the article Gunshot Wounds.

In the treatment of bruises, three indications present themselves. The first is to prevent and diminish the inflammation, which from the violence done must be expected to arise. The bruised parts should be kept perfectly at rest; and either be fomented, or covered with linen constantly wet, with the liquor plumbi acetatis dilutus, or the lotio ammon. acetatis. When muscles are bruised, they are to be kept in a relaxed position, and as quiet as possible.

If the bruise be violent, it may be proper to apply leeches, and even in some cases, particularly when joints are contused, to take blood from the arm, but this is rarely found to be necessary. In every instance, the bowels should be kept well open with calomel and saline purgatives.

A second indication is to promote the absorption of the extravasated fluid by discutient applications. These may at once be employed in all ordinary contusions, not attended with too much violence; for then nothing is so beneficial as maintaining a continual evaporation from the bruised part, by means of the cold saturnine lotion, and, at the same time, repeatedly applying leeches. In common bruises, however, the *lotio ammoniæ hydrochloratis* is an excellent discutient application; but most surgeons are in the habit of ordering liniments for all ordinary contusions, and as these applications prove serviceable in accelerating the absorption of the extravasated blood, the practice is highly praiseworthy. The linimentum saponis, or the linimentum camphoræ, is as good as any that can be employed. (See Linimentum.)

In many cases, unattended with any threatening appearances of inflammation, but in which there is a good deal of blood and fluid extravasated, bandages act very beneficially, by the remarkable power which they have of promoting absorption by means of the pressure which they produce.

A third indication is to restore the tone of the parts. Rubbing the parts with liniments has a good deal of effect in this way. But, notwithstanding such applications, it is often observed, that bruised parts continue for a long while weak, and even swell, and become œdematous, when the patient takes exercise, or allows them to hang down, as their functions in life may require. Pumping cold water, two or three times a day, on a part thus circumstanced, is the very best measure which can be adopted. A bandage should also be worn, if the situation of the part will permit. These steps, together with perseverance in the use of liniments, and in exercise gradually increased, will soon bring every thing into its natural state again.

When blood is extravasated under the skin in large quantity, so as to form a considerable tumour, the best practice is generally to avoid making any opening for its discharge. The opening would not procure the evacuation of a great part of it; if internal bleeding were going on, it would encourage it; and the air having access to the blood remaining behind, would certainly be followed by its putrefaction. Hence, irritation, suppuration, and sloughing. In the greater number of instances, collections of blood under the skin, from contusions, are quietly, though sometimes slowly, absorbed; and the kinds of mischief, here specified, are thus avoided. In the remarkable case which I have adverted to as occurring in the King's Bench Infirmary, this observation was well illustrated.

[In serious accidents, contusions and even lacerations of the internal organs are of frequent occurrence, especially in the solid viscera, such as the liver, kidney, or spleen. Blood is found to be effused in these cases, both in the parenchyma of the organ, and in the visceral cavity. The kind of injury received, and its locality, will lead the surgeon to diagnose an internal bruise. The pallid countenance and collapse, accompanied by faintness, and the scarcely perceptible pulse, will often indicate the internal hæmorrhage. In addition to the ordinary remedies for contusions, these internal injuries will require special treatment, having reference to the organ implicated, the inflammation which may have ensued, or the loss of blood that may have occurred.]

COPAIBA (*Balsamum Copaibæ*). Its properties closely resemble those of turpentine. Exhibited by surgeons principally in gonorrhœa, gleet, leucorrhœa, piles, and some diseases of the bladder. [Copaiba has a stimulative action upon all the mucous membranes, but it operates more especially upon that of the genito-urinary organs, and it is the most efficient of all internal remedies in the treatment of gonorrhœa and gleet, especially in the male sex. (See Gonorrhœa.) "Under its influence," says Dr. Pereira, "the urine is increased in quantity, and altered in quality; its colour is heightened, its odour becomes balsamic, and its taste bitter; not unfrequently it is turbid, as if containing mucus." (*El. of Mater. Med.*, vol. i. p. 1880, ed. 3.) Dr. G. O. Rees has shown that the oleo resinous matter of copaiba enters the urine, and causes the secretion to simulate an albuminous condition, inasmuch as it becomes precipitable by nitric acid. The precipitate may be distinguished from that of albumen by the fact of its not subsiding as albumen does after it has been set aside for a few hours. (*On

Urinary Diseases, p. 204.) Pain in the loins, and other signs of renal irritation, are sometimes occasioned by copaiba, and render it necessary to discontinue its use. In some persons it exerts a purgative action on the intestinal mucous membrane, and cannot be taken except in combination with small doses of opium to counteract this effect. In others, but this is more rare, it produces a red patchy eruption on the skin, of the nature of urticaria. This eruption sometimes breaks out almost simultaneously over the whole surface of the body and limbs, causing great irritation and annoyance, and some constitutional disturbance. It subsides, however, rapidly, as soon as the medicine is discontinued.]

The common dose is from ten drops to half a drachm, two or three times a day. Mr. Brande gives the following formula:—℞ *Mucil. Acaciæ* ʒss, *Copaibæ* ʒss tere simul et adde gradatim, *Aq. Menth. vir.* ℥j. *Tinct. Capsici* ♏v.—M. ft. Haustus bis vel ter quotidie sumendus. (See *Manual of Pharmacy*, p. 70.) Copaiba may also be given in a solid form. For this purpose it may be combined with an alkali to form a soap, which can be made into pills, the dose being from gr. xii. to ℈j. (See *A. T. Thomson's Mat. Med. and Therapeutics*, p. 859, ed. 2.)

[The nauseating effect of copaiba may often be prevented by adding ten or fifteen minims of dilute sulphuric acid to each dose. In private practice, however, the most convenient mode of giving it is in gelatine capsules. The capsule is swallowed, and the gelatine becoming dissolved in the stomach, the liquid balsam escapes. The nauseous odour and taste are thus altogether avoided. Ten or twelve minims of copaiba are usually contained in each capsule. Two or three, therefore, are required for a dose. A very thin membrane has also been employed as the investing substance. Capsules thus made, "*capsules organiques,*" are perhaps even still more effectual in concealing the unpleasant flavour.]

COPPER. The diacetate and sulphate are used in surgery. The former, often called ærugo or prepared verdigris, is employed as an escharotic, Mixed with an equal quantity of powdered cantharides, it is sometimes applied for the removal of warts and other excrescences. [The latter, which is known by the name of blue vitriol, is used in substance as a mild and safe escharotic. In solution it also forms an useful astringent and slightly stimulating lotion to indolent ulcers. Injections for leucorrhœa, for gonorrhœa, both in the male and female, and collyria for the eye, are not unfrequently composed of the sulphate of copper. The strength adapted for these purposes is from one to five grains, or more, to the ounce of distilled water.]

CORNS. *Clavi. Spinæ pedum. Calli. Condylomata,* &c. A corn, technically called *clavus*, from its fancied resemblance to the head of a nail, is a brawn-like hardness of the skin, with a kind of root sometimes extending deeply into the subjacent cellular tissue. When this is the case, the indurated part is fixed; but while the hardness is more superficial, it is moveable. Some corns rise above the level of the skin, in the manner of a flat wart. They are hard, dry, and insensible, just like the thickened cuticle which is formed on the soles of the feet, or on the hands of labouring people.

In the first instance, a corn is a thickening of the cuticle, which is secreted by the cutis in a redundant horny form, from the influence of pressure. But, every thickening of the cuticle is not a corn, which term seems to Sir Benjamin Brodie only applicable where the cuticle is thickened on a a projecting portion of bone, on which the pressure is concentrated. A complete corn, he observes, is combined with the formation of a small bursa between the cuticle and the cutis. The thickened cuticle of corns, situated externally, becomes dry, hard, and horny; while that of corns placed between the toes, remains soft, and in some degree moist: and hence the distinction into *hard* and *soft* corns. (See *Brodie* in *Lond. Med. Gaz.* for 1835, 1836, p. 776.)

Corns are entirely owing to repeated and long-continued pressure. Hence, they are most frequent in situations exposed to pressure, and where the skin is near bones, as on the toes, soles of the feet, &c. However, corns have occasionally been seen over the crista of the ilium, from the pressure of stays, and even on the ears, from the pressure of heavy ear-rings.

Corns of the feet are usually owing to tight shoes, and, consequently, are more common in the higher classes, and in women, than other subjects. In females, indeed, the old ridiculous fashion of wearing high-heeled shoes was very conducive to corns. In shoes thus made, the weight of the body falls principally on the toes, which become wedged and compressed.

Though some persons who have corns suffer little, others occasionally endure such torture from them, that they are quite incapable of standing or walking. Doubtless the great pain proceeds from the irritation of the hard corn on the tender cutis beneath, which is frequently very much inflamed in consequence of the pressure. Everything which accelerates the motion of the blood, which heats the feet, which increases the pressure of the corn on the subjacent parts, or the determination of blood to the feet, or which promotes its accumulation in them, exasperates the pain. Hence, the bad effects of warm stockings, tight shoes, exercise, long standing, drinking, &c. The pain in warm weather is always more annoying than in winter.

If a person merely seeks temporary relief, it may be obtained by pulling off his tight shoes, sitting down, placing his feet in a horizontal posture, and becoming a little cool; the prominent portion of the corn should be cut off, as far as it can be done, without exciting pain or bleeding, and the feet should be bathed in warm water.

When the bursa, under the horny cuticle, in consequence of inflammation, becomes distended with fluid, or suppurates, the pain and soreness are excessive, and the slightest pressure cannot be endured. Here the removal of the hard cuticle and letting out the confined fluid, small as it may be in quantity, give prompt relief. (See *Brodie*, in *Lond. Med. Gaz.* for 1835, 1836, p. 999.)

The radical cure essentially requires the avoidance of all the above causes, and, particularly, of much walking or standing. Wide, soft shoes, should be worn. Such means are not only requisite for a radical cure, but they alone very often effect it. How many women become spontaneousyl free from corns in childbed, and other confinements! Though the radical cure is so easy, few obtain it, because their perseverance ceases as soon as they experience the wished-for relief.

When business, or other circumstances, prevent the patient from adopting this plan, and oblige him to walk or stand a good deal, still it is possible to remove all pressure from the corn. For this purpose, from eight to twelve pieces of linen, smeared with an emollient plaster, and having an aperture cut in the middle, exactly adapted to the size of the corn, are to be laid over each other, and so applied to the foot, that the corn is to lie in the opening, in such a manner that it cannot be touched by the shoe or stocking. When the plaster has been applied some weeks, the corn commonly disappears, without any other means. Should the corn be in the sole of the foot, it is only necessary to put in the shoe a felt sole, wherein a hole has been cut, corresponding to the situation, size, and figure of the induration.

A corn may also be certainly, permanently, and speedily eradicated by the following method, especially when the plaster and felt sole with a hole in it are employed at the same time. The corn is to be rubbed twice a day with an emollient ointment, such as that of marshmallows, or with the liniment of ammonia, which is still better; and in the interim, is to be covered with a softening plaster. Every morning and evening, the foot is to be put for half an hour in warm water; and whilst there, the corn is to be well rubbed with soap. Afterwards, all the soft, white, pulpy outside of the corn is to be scraped off with a blunt knife; but the scraping is to be left off the moment the patient begins to complain of pain from it. The same treatment is to be persisted in, without interruption, until the corn is totally extirpated, which is generally effected in eight or twelve days. If left off sooner, the corn grows again.

A multitude of other remedies for curing corns are recommended. They all possess, more or less, an emollient and discutient property. The principal are green-wax, soap, mercurial and hemlock plasters, a piece of green oil-skin, &c. They are to be applied to the corn, and renewed as often as necessary. A successful composition consists of two ounces of gum ammoniacum, the same quantity of yellow wax, and six drachms of superacetate of copper. In a fortnight, if the corn yet remain, a fresh plaster is to be applied.

It is frequently difficult and hazardous to cut out a corn. The whole must be completely taken away, or else it grows again; and the more frequently it is partially cut away, the quicker is its growth rendered. When the skin is moveable, and, consequently, the corn not adherent to the subjacent parts, its excision may be performed with facility and safety, but not without pain. But, in the opposite case, either leaving a piece of the corn behind, or wounding the parts beneath, can seldom be avoided.

Mr. Wardrop recommends cutting, or tearing away, as much of the corn as can be done with safety; then keeping the toe for some time in warm water; and after the adjacent skin has been well dried, rubbing the exposed surface of the corn with the argentum nitratum, or wetting it, by the means of a camel's-hair pencil, with a solution of the oxymuriate of mercury in spirit of wine. Either of these applications, two or three times repeated, he says, will mostly effect a cure. (See *Med. Chir. Trans.* vol. v. p. 140.)

Mr. Higginbottom recommends the employment of nitrate of silver nearly in the same manner as Mr. Wardrop. The corn is to be softened by keeping the foot in warm water for half an hour. As much of the corn is then to be removed, with a sharp knife, as can be done without making a wound. The corn and surrounding skin are then to be moistened with warm water, and the nitrate of silver rubbed on the corn very freely and lightly on the skin, so as not to occasion vesication. The part is then to be exposed in order that it may become dry. About the fourteenth day, when the cuticle around the corn is peeling off, the foot is to be put in warm water again, and the nitrate of silver, and as much of the subjacent corn as possible, removed with a knife. Then the nitrate of silver is to be reapplied, and the plan repeated, till the corn is perfectly destroyed. (See *Higginbottom on the use of Nitrate of Silver*, p. 177, ed. 2.)

COUCHING. The depression of a cataract out of the axis of sight, or the displacement, breaking, and disturbance of the opaque lens in various ways with a kind of needle formed for these purposes, so as to bring about the dispersion and absorption of the cataract. (See CATARACT.)

COUVRE CHEF. The name of a bandage. (See BANDAGE.)

COXALGIA. (See JOINTS, DISEASES OF.)

CRANIUM, FRACTURES OF. (See HEAD, INJURIES OF.)

CREOSOTE. (See KREOSOTE.)

CREPITUS. The grating sensation, or noise, occasioned by the ends of a fracture, when they are moved and rubbed against each other; one of the most positive symptoms of the existence of such an accident.

CUPPING is performed by means of a scarificator, and a glass, shaped somewhat like a bell. The scarificator is an instrument containing a number of lancets, sometimes as many as twenty, which are so contrived, that when the instrument is applied to any part of the surface of the body, and a spring is pressed, they suddenly start out, and make the necessary punctures. The depth to which the lancets penetrate, may be made greater or less, at the option of the practitioner. As only small vessels can be thus opened, a very inconsiderable quantity of blood would be discharged, were not some method taken to promote the evacuation. This is commonly done with a cupping-glass, the air within the cavity of which is rarified by the flame of a small lamp, containing spirit of wine, and furnished with a thick wick. This plan is preferable to that of setting on fire a piece of tow, dipped in this fluid, and put in the cavity of the glass: "a clumsy expedient, adding unnecessarily to the sufferings of the patient, by cauterizing the skin; doing harm also by rarifying the air more than necessary within the glass, in consequence of which the edges of the cup compress the cutaneous vessels so much as to obstruct the influx of blood. The larger the glass, if properly exhausted, the less pain does the patient suffer, and the more freely does the blood flow." (See *Mapleson on the Art of Cupping*, pp. 63—65. 12mo. Lond. 1813.) According to Dr. Osborne, those cupping-glasses which have broad spreading edges are far inferior, both in convenience of application and in power of preserving a vacuum, to those with perpendicular edges. He also recommends an assortment of cupping-glasses with oval and other shaped mouths. (See *Dublin Journ. of Med. Science*, vol. iii. p. 341.) The mouth of the glass is placed over the scarifications, and when the rarified air in it becomes condensed as it cools, the glass is forced down on the skin, and a considerable suction takes place.

When the operation is about to be done, a basin of warm water, a piece of fine sponge, and a lighted candle, should be provided. As many of the cupping-glasses as may be judged necessary are to be put in the basin. If sixteen or twenty ounces of blood are to be taken away, four glasses of a size adapted to the surface to which they are to be applied will generally be required. Each glass is then to be held for an *instant* over the flame of the spirit-lamp, and immediately placed upon the skin. Upon the quickness with which this is done, the neatness and efficacy of the operation will depend. If dry cupping be only intended, the glasses may be allowed to remain on the skin for a few minutes, and be replaced five or six times, with a little variation of their position, in order to prevent the skin from being hurt by their pressure. If the intention be to scarify and take away blood, the glass ought not to remain more than a minute, when the scarificator is to be *instantly* applied; for by the quickness with which the application of the scarificator succeeds the removal of the glass, the patient is saved a degree of pain, which he would otherwise suffer from the making of the punctures. When the glasses are so full as to be in danger of falling off, or the blood is coagulated in them, they should be removed, emptied, and applied again. For the sake of neatness, care should be taken to insert the nail under the upper part of the glass, and remove it so as to keep its bottom downwards, the scarifications being at the same time wiped with a sponge wet in warm water. The glasses also, previously to each application, should be rinsed in warm water, but not dried. For other useful directions, see *Mapleson's Treatise*, p. 64, &c.

Trials have been made of syringes, calculated to exhaust the air from cupping-glasses; but the plan is not found so convenient as that above described.

A common pledget of lint, or bit of rag, is usually applied as a dressing for the punctures made with the scarificator, or they may be covered by a piece of adhesive or soap plaster.

If a little smarting be not minded, Mr. Mapleson prefers the application of arquebusade water, or spirits of wine, as it immediately stops the oozing of blood, and prevents subsequent itching. (P. 69.)

Instead of a scarificator, Dr. Osborne recommends an instrument, which he proposes to name *polytome*, which consists of several lancets with circular edges, fixed parallel in a frame, to which a convenient handle is attached. The instrument is drawn rapidly along the skin, so as to make a row of continuous incisions of about one-sixteenth or one-eighth of an inch in depth, and an inch in length. This instrument has been suggested as better calculated, than a scarificator, to insure an adequate discharge of blood. (See *Osborne in Dublin Journ. of Med. Science*, vol. iii. p. 340.) Such an instrument might perhaps be added to the case of cupping instruments with advantage, if it were only to be employed where the short deep punctures of common scarificators failed to procure a sufficient degree of bleeding.

CUPRI SULPHAS (*Sulphate of Copper*) is an escharotic, and an ingredient in several lotions for ulcers, collyria for the eyes, and injections for the urethra. (See COPPER.)

CURETTE (French). An instrument, shaped like a minute spoon, or scoop, invented by Daviel, and used for taking away any opaque matter, which may remain behind the pupil after a cataract has been extracted.

CURVATURE OF THE SPINE. (See VERTEBRÆ, DISEASES OF.)

CYSTITOME (from *κύστις* and *τέμνω*, to cut). An instrument, invented by M. de la Faye, for opening the capsule of the crystalline lens.

CYSTOCELE (from *κύστις*, the bladder, and *κήλη*, a tumor). A hernia, formed by a protrusion of the bladder. (See HERNIA.)

CYSTOTOMIA (from *κύστις*, the bladder, and *τέμνω* to cut). The operation of opening the bladder, for the extraction of a stone or calculus. (See LITHOTOMY.)

D

DACRYOMA (from *δακρύω*, to weep). An impervious state of one or both the puncta lachrymalia, preventing the tears from passing into the lachrymal sac.

DAUCUS. (See CATAPLASMA DAUCI.)

DECOCTUM ANTHEMIDIS. ℞ *Florum anthemidis*, ℥ ss. *Aquæ destillatæ*, Oct.j. Boil ten minutes, and strain the liquor. A common decoction for fomentations. (See FOMENTUM.)

DECOCTUM HELLEBORI ALBI.—(*Decoctum Veratri.*) ℞ *Pulveris radicis hellebori albi*, ℥ j. *Aquæ destillatæ*, Oct.ij. *Spiritûs vini rectificati*, ℥ ij. Boil the water and powder till only one-half the fluid remains, and when cold, add the spirit.

This is used as a lotion for psora, porrigo, and some other cutaneous affections.

DECOCTUM PAPAVERIS. ℞ *Papaveris somniferi capsularum concisarum*, ℥ iv. *Aquæ*, Oct.iv. Boil for a quarter of an hour, and strain. A common fomenting fluid.

[DECOCTUM PAREIRÆ. ℞ *Pareiræ*, ℥ x. *Aquæ destillatæ*, Oct. jss. Boil down to a pint, and strain.—Ph. Lond. This decoction is frequently used with great advantage in cases of chronic inflammation of the bladder. It has been strongly recommended by Sir B. Brodie, who says he is satisfied that it has a great influence over this disease, lessening very materially the secretion of ropy mucus; and, he believes, diminishing the inflammation of the bladder also. He employs half an ounce of the root to three pints of water, gently boiled down to one pint; eight or twelve ounces to be taken daily. It may be combined with tincture of hyoscyamus, and in those cases in which there is a deposit of the phosphates, some nitric or muriatic acid may also be added. (*On Dis. of the Urinary Organs*, p. 112.)]

[DECOCTUM QUERCUS. ℞ *Quercûs corticis contusæ*, ʒ x. *Aquæ destillatæ*, Oct. ij. Boil down to a pint, and strain. Decoction of oak bark is in constant use as an astringent injection, gargle, or lotion. It is an excellent injection for vaginal and uterine discharges, and may be used with advantage, both as lotion and injection, in hæmorrhoids or prolapse of the rectum.]

DECOCTUM SARSÆ. ℞ *Sarsæ radicis concisæ*, ℥ v. *Aquæ ferventis*, Oct. iv. The sarsaparilla is to be macerated for four hours, near the fire, in a vessel lightly closed. The root is then to be taken out, bruised, and put into the fluid again. The maceration is to be continued two hours longer, after which the liquor is to be boiled till only two pints remain. Lastly, it is to be strained.

DECOCTUM SARSÆ COMPOSITUM. ℞ *Decocti sarsæ ferventis*, Oct. iv. *Sassafras radicis concisæ, guaiaci ligni rasi, glycirrhizæ radicis contusæ, aa.* ʒ x. *Mezerei radicis corticis*, ʒ iij. To be boiled together for a quarter of an hour, and then strained. This, and the preceding decoction of sarsaparilla, are much prescribed in venereal cases, and, at the present time, are often prescribed in combination with iodide of potassium, in doses of from three to five grains of the latter, three times a day. Sarsaparilla is also given for the cure of a variety of cutaneous diseases, and in scrofula. The simple decoction is frequently directed for the restoration of the constitution after a course of mercury, sometimes mixed with an equal quantity of milk. The common dose of both the decoctions is from four to eight ounces, three times a day. The compound one possesses similar qualities to those of the famous Lisbon diet drink, for which it is now a common substitute.

DECOCTUM ULMI. ℞ *Ulmi corticis recentis contus.* ℥ ijss. *Aquæ*, Oct. iv. Boil to two pints, and then strain the liquor. Frequently prescribed in cutaneous diseases.

[DECOCTUM UVÆ URSI. ℞ *Foliorum Uvæ Ursi*, ℥ j. *Aquæ destillatæ*, Oct. jss. Boil down to a pint, and strain. This decoction is used in chronic affections of the bladder; it is slightly astringent and diuretic. Dr. Prout says, that if steadily persevered in for a considerable time, it seldom fails to diminish the irritation and quantity of mucus, and thus to mitigate the sufferings of the patients. Sir B. Brodie, on the other hand, states that it has frequently disappointed him, and that he has seen much more good done by the decoction of pareira.]

DELITESCENCE. When an external inflammation, with its usual effects, swelling, redness, &c. subside with extraordinary rapidity, the case is said to terminate in *delitescence*.

DEPRESSION OF THE SKULL. (See HEAD, INJURIES OF.)

DEPRESSION OF THE CATARACT. (See CATARACT.)

DETERMINATION. When the blood flows into a part more rapidly and copiously than is natural, it is said, in the language of surgery, that there is a *determination* of blood to it. (See HYPERÆMIA.)

DIÆRESIS (from διαιρέω, to divide). A division of substance; a solution of continuity. This was formerly a sort of generic term applied to every part of surgery, by which the continuity of parts was divided.

DIGESTION (from *digero*, to dissolve). By the *digestion* of a wound, or ulcer, the old surgeons meant bringing it into a state, in which it formed healthy pus.

DIGESTIVES. Applications which promote this object.

DIORTHOSIS, (from διορθόω, to direct). One of the ancient divisions of surgery: it signifies the restoration of parts to their proper situations.

DIPLO'PIA (from διπλοῦς, double, and ὤψ, the eye, or ὄπτομαι, to see). *Visus duplicatus.* Even when the eyes are perfectly healthy, an object, under certain circumstances, appears double when viewed with both of them. "Thus (as Dr. Arnott has observed), if a person hold the two forefingers in a line from his eyes, so that one may be more distant than the other, by then looking at the nearest, the more distant will appear double, and by looking at the more distant, the nearer will appear double." (*Elem. of Physics*, vol. ii. p. 217.) It is not, however, double vision of this kind, which I mean here to consider; but only those forms of the disorder which depend upon, or are connected with, morbid or abnormal states either of the eye itself, or other parts, which directly or indirectly exercise an influence over it. Double vision is of two kinds. For instance, the patient either sees an object double, treble, &c. only when he is looking at it with both his eyes, and no sooner is one eye shut than the object is seen single and right; or else he sees every object double, whether he surveys it with one or both his eyes. The disorder is observed to affect persons in different degrees. Patients seldom see the two appearances which objects present with equal distinctness; but generally discern one much more plainly and perfectly than the other. The first distinct shape, which strikes the eye, is commonly that of the real object, while the second is indistinct, false, and visionary. Therefore, patients labouring under this affection, seldom make a mistake, but almost always know which is the true and real object. However, there are cases in which the patient sees with equal clearness the two appearances which things assume, so that he is incapable of distinguishing the real object from what is false and only imaginary.

The disorder is sometimes transitory and of short duration, and may be brought on in a healthy eye by some accidental cause, generally an irritation affecting the organ. Sometimes the complaint is continual; sometimes periodical. In particular instances, the patient only sees objects double when he has been straining his sight for a considerable time, as, for example, when he has been reading a small print for a long while by candlelight. In this case the disorder becomes lessened by shutting the eyes for a few moments. There are also instances in which the objects have a double appearance only at a particular distance, and not either when they are nearer or further off. Sometimes the patient sees objects double only upon one side; as, for example, when he turns his eyes to the right hand, while nothing of this sort is experienced in looking in any other direction. In certain cases objects appear double, in whatever way the eyes are turned and directed.

The causes of double vision may be divided into four classes. Namely, the object which the patient looks at may be represented double upon the retina; which is the effect of the first class of causes. Or, the object may be depicted in one eye differently from what it is in the other, in regard to size, position, distance, clearness, &c.: this is the effect of the second class of causes. Or, the object may appear to one eye to be in a different place from that which it seems to the other to occupy; the effect of the third class of causes. Or, lastly, the sensibility of the optic nerves is defective, so that the image of an object, though it may appear single to one eye as well as the other, yet, in one identical situation will seem double to both of them. When the complaint originates from causes of the first and fourth class, the patient sees things double, whether he is using only one, or both eyes; but, when it proceeds from the second and third classes of causes, the patient sees objects double only when he is looking at them with both eyes, and no sooner does he shut one, than objects put on their natural single appearance.

The following are the chief causes of the first class, of a single object being depicted upon the retina as if double:—1. An unevenness of the cornea, which is divided into two or more convex surfaces. (*Haller*, *Element. Physiol.* t. v. p. 85.) According to Beer, this conformation of the cornea is mostly a result of several preceding ulcers of that membrane, in which circumstance the patient sees with the affected eye not merely double, but treble, and quadruple, of which facts Beer has met with some examples. (*Lehre von den Augenkr.* b. ii. p. 31.) However, in a far greater number of instances, such unevenness of the cornea, though equally considerable, does not occasion this defect of sight. We have principally an opportunity of observing cases of this sort after the operation of extracting cataract. Hence it would seem, that the inequalities must be of very particular shape to produce double vision. The diagnosis of this cause is easy enough; but the removal of it is impracticable; for, how is it possible to restore the original shape of the cornea? On this case, however, Beer delivers a more favourable prognosis than Richter; for he states, that, when the patient is not decrepit, the double vision, from altered shape of the cornea, will gradually disappear of itself, when proper care is taken of the constitution, and in particular of the eye. (B. ii. p. 32.) 2. An inequality of the anterior surface of the crystalline lens, whereby the same is divided into several distinct surfaces, it is suspected may be one cause of diplopia. M. Prévost has given the history of his own case of double vision with a single eye, which he conceives may arise from such a cause. (See *Annales de Chimie*, &c. t. 51, p. 210. Paris. 1832.) An instructive case of irregular refraction from some defect in the lens, is that of Professor Airy, who derived vast assistance from a lens, the spherical surface of which was 3½ inches, and the cylindrical 4½ inches. Vision was most distinct when the cylindrical surface was turned from the eye, and the glass close to the organ. (See *Trans. of Cambridge Phil. Soc.*) A double aperture in the iris, or, as the case is termed, a double pupil, and a deviation of the pupil from its natural position, have been enumerated as causes of diplopia. (*Baumer, in Act. Soc. Hassiac*, t. i. No. 27.) However, Richter deems the reality of the first of these causes doubtful; for cases have been noticed where double vision was not the effect of there being two openings in the iris. (*Janin*, *Mém. sur l'Œil.*) But, were the disorder actually to originate in this way, the experiment might be made of converting the two apertures into one.

The causes of the second class, by the effect of which the object is represented, in regard to its size, position, distance, &c. differently in one eye from what it is in the other, are for the most part rather possible, than such as have been actually observed. The causes which make objects assume an appearance contrary to the real one, may sometimes be confined to one eye, to which things are depicted diversely from what they are to the other healthy eye, so that the patient sees, as it were, double. Thus, for example, there may be a stronger refraction of the rays of light in one eye than the other; the patient may be *myopic* with one eye, and *presbyopic* with the other; and then the object will seem to one eye large, to the other small; to one eye distant, to the other plainly near. This state of the sight, indeed, is said to have occurred after operating upon a cataract in one eye. (*Heuermann.*) However, that this is not always the consequence of operating upon a cataract in one eye, while the other is perfect, is sufficiently clear. (See CATARACT.) In particular examples, perpendicular objects seem to have a sloping posture. When it is considered that only one eye is thus affected, and that to it things will appear sloping, and to the other straight, double vision must be the effect. (See SIGHT, DEFECTS OF.)

When both eyes are so directed to an object that it becomes situated in the axis of vision of each of these organs, such object is represented in both at the same place, that is, it is depicted upon that part of the retina on which the axis of sight falls. Thus, the object seems to both eyes to be in the same place, and though the two organs discern the thing, it only communicates a single appearance. But when one eye is turned to any object in such a way that the object is situated in the axis of vision of this eye while the opposite eye is so turned that the same object is placed on one side of its axis of vision; in other words, when a person squints; the object is depicted in one eye upon a different part of the retina from what it is in the other; consequently, the object appears to the two respective organs to be differently situated, and the patient is affected with diplopia. This is the third species of this disorder, which arises from strabismus as a third kind of occasional cause. Such patients naturally see objects double only when they behold them with both eyes. A lady, whom I know, is much annoyed with diplopia, the effect of deep-seated disease in the orbit, whereby the eye is forced out of its natural position. See STRABISMUS.

A person who squints usually has one eye stronger than the other, and the weakness of one of those organs is the common cause of the strabismus. Such a person does not see objects double, because he only sees with one eye well, and with the other so faintly and imperfectly, that scarcely any impression is made. Hence, every case of strabismus is not necessarily combined with diplopia; indeed, the common kind of squinting is not joined with it. A person affected with strabismus, only sees double when the sight of each eye is equally strong, and when the squinting does not depend upon any weakness of one of the eyes, but upon some other occasional causes. The principal causes of the latter sort are of a spasmodic nature, viz. an irritation affects some muscle of the eye in such a manner, that the patient is incapacitated from moving both his eyes according to his will, and from directing them to any object, so that such object may be at once in the axis of vision of both. On this case, the observations of Sir E. Home are interesting, who has made various reflections on the effect of an irregular action of the straight muscles of the eye in producing double vision. (*Phil. Trans.* 1797.) Perhaps, however, the cases adduced furnish no very conclusive evidence that the diplopia depended merely on the state of the muscles, independent of that of the brain. (See *Mackenzie, On Dis. of the Eye*, p. 344, ed. 4.)

Richter states, that, in the majority of cases, the irritation is seated in the gastric organs, though any other species of irritation may operate upon the eyes in a similar manner. This kind of diplopia is frequently attendant on other spasmodic diseases as a symptom. It often accompanies hypochondriasis. Sometimes it is the consequence of violent pain. Richter informs us of a man who saw double, and squinted, during a severe headach. He states, that another was affected in the same way during a toothach. Sometimes diplopia is owing to a paralysis of one of the muscles of the eye (*Morgagni de Sedibus et Causis Morborum*, epist. xiii. art. 20. *a paralysis of the abductor muscle*); sometimes to a tumor in the orbit. The diagnosis of this kind of diplopia is free from difficulty; the patient having been affected with squinting ever since things appeared double to him.

The views which Sir E. Home took of diplopia from irregular action, spasm, or weakness of any particular muscle of the eye, led him to propose a plan of treatment, the principle of which is to keep the muscle affected for a time perfectly at rest, which is easily done by covering the eye with a bandage, and not allowing the organ to be at all employed.

The fourth class of causes are such irritations as act upon the optic nerves, changing their sensibility in such a way, that objects do not make that sort of impression upon them which they ought to do. Thus, things sometimes have the appearance of being coloured, when they are really not so; immovable objects seem in motion, straight objects appear oblique, and in the cases which we are now treating of, single things seem to the eye double, treble, &c. This faulty kind of sensibility may also be produced by irritation in eyes which are perfectly sound; but it is most readily occasioned in eyes which are preternaturally weak and irritable. In these, very trivial irritations will often excite it. In the treatment, the common indication is to discover and remove whatever irritation conduces to this effect; but the attempt frequently fails. In irritable eyes, the disorder is often brought on by very slight irritations, which cannot always be diminished or removed. Here the grand indication is to cure the weakness and irritability of the organs.

According to Richter, the fourth class of causes of diplopia is the most frequent. The irritations are of various kinds, and generally seated in the abdominal viscera. Diplopia is sometimes the consequence of inebriety, foulness of the stomach, intermitting fevers, hypochondriasis, worms, &c. However, the complaint is occasionally excited by other sorts of irritation. It has frequently followed a violent fright. It may be connected with spasmodic and painful diseases of several kinds. Severe headachs and toothachs are sometimes joined with this affection of the sight. Richter mentions a boy, who, being in the woods, was struck by the bough of a tree over the eye; and, in consequence of the accident, became affected with diplopia. He informs us of a man who rode a journey on horseback along a snowy road on a very sunshiny day, and was affected in the same manner. This affection of the eyes is sometimes the effect of injuries of the head. (See *Hill's Cases in Surgery*, p. 108. *Schmucker*, *Med. Chir. Remerk*, b. i. No. 26. *Hennen's Military Surgery*, p. 345, ed. 2.) In University College Hospital there is at the present time (January, 1837) a woman, under my care, who was admitted on account of a blow on her head, whereby she was stunned. On recovering from this, she became affected with diplopia. At first, all objects appeared double, unless one eye were shut: afterwards, they were seen correctly with both eyes open, if within six or eight inches of these organs. In a still later stage, objects above the horizontal line were seen single; below it, double, except when one eye was shut.

Persons who have weak eyes are apt to become double-sighted, whenever they look attentively for a long while at any light shining objects. Patients in fevers are also sometimes double-sighted. (*Gooch's Cases*, &c. vol. ii.)

Diplopia frequently terminates in some other disorder of the eyes, and is often the forerunner of amaurosis.

The cure partly depends upon the nature of the remote cause, and partly upon the condition of the eye. Some causes are easy, others difficult, of removal.

The treatment consists in endeavouring to find out and remove the irritation occasioning the disorder. The majority of such irritations are of the same nature as those which give rise to gutta serena. (See Amaurosis.) Indeed, both the complaints are often only different effects of the same cause, and of course require a similar mode of treatment. The boy, whom Richter mentions as having become double-sighted in consequence of being struck over the eye with the bough of a tree, was cured by the external use of the infusum radicis valerianæ and spiritus vini crocatus, with which the eyelids and adjacent parts were rubbed several times a day. A diplopia which followed a violent fright, was cured by valerian, preceded by a few doses of bitartrate of potash. The case recorded by Dr. Hennen, as proceeding from a gunshot wound of the soft parts covering the root of the nose and right eyebrow, yielded to abstinence, occasional emetics, and cold collyria. (*Principles of Mil. Surgery*, p. 345, ed. 2.) The woman in University College Hospital, who had diplopia as a consequence of concussion of the brain, was materially benefited by cupping and purgative medicines, followed up by mercury, and blistering the nape of the neck; and latterly, by the exhibition of the carbonate of iron. A hypochondriacal patient got rid of the disorder by means of the warm bath. A diplopia, supposed to arise from disorder of the biliary secretion, was cured by means of pills made of gum galbanum, guaiacum, rhubarb, and Venice soap, assisted with emetics and purgatives.

When the irritation is only of temporary duration, as, for instance, that of looking at shining objects; when the disorder continues after the removal of the irritation; or, lastly, when the irritation cannot be well detected; the surgeon is to endeavour, by means of nervous and soothing medicines, either to remove the impression which the irritation has left upon the nerves, or to render the nerves insensible to the continuing irritation. The following remedies have proved useful in cases of diplopia: — Hartshorn dropped into the hand, and held before the eyes; the external use of the spiritus vini crocatus; warm bathing of the eye, particularly in a decoction of white poppy heads; bathing the eye in cold collyria; the internal administration of bark, valerian, small doses of ipecacuanha, oxide of zinc, and oleum cajeputi. (See *Richter's Anfangsgr. der Wundarzn.* b. iii. kap. 15.)

According to Beer, the diplopia which is not an effect of the continuance of another disease after inflammation of the eye, but probably depends upon injury of the retina, caused by such inflammation, usually diminishes, without the assistance of art, if the eye be not abused. (*Lehre von den Augenkr.* b. ii. p. 32.)

See *A. Vater* et *J. C. Heinicker*, Visus Vitia duo rarissima; alterum duplicati, alterum dimidiati, &c. Wittemb. 1723. (*Haller*, Diss ad Morb. t. i. p. 305.) *J. J. Klauhold*, De Visu duplicato, 4to. Argent. 1746. *Buchner*, De Visione simplici et duplice, 4to. Argent, 1753. *Euler*, Récherches Physiques sur la diverse Réfrangibilité des rayons de lumière; Mém. de l'Acad. des Sciences, &c. Berlin, p. 200. 1754. *Klinke*, De Diplopia, 4to. Gött. 1774. *B. Gooch*, Chir. Cases, &c. vol. ii. p. 42, &c. 8vo. Lond. 1792. *Sir E. Home's* Obs. on the Straight Muscles of the Eye, and the Structure of the Cornea, in Phil. Trans. for 1797. *Keghellini*, Lettera sopra l'offera della cista in una Donna, &c. 8vo. Venet, 1749; An instance of Diplopia from double pupil. Dict. des Sciences Méd. t. ix. p. 497. *J. Wardrop*, Essays on the Morbid Anatomy of the Human Eye, vol. ii. p. 216, &c. 8vo. Lond. 1818. *Robert G. Graves*, M.D. on Double and Single Vision, in Dubl. Journ. of Med. Sciences, vol. i. p. 255. 8vo. 1832. *Mackenzie*, on Dis. of the Eye, ed. 4. Airy, in Trans. of Cambridge Phil. Society.

DIRECTOR, an instrument in such common requisition that it is always contained in every pocket case. It ought to be made of silver, which qualifies it to be bent into any convenient shape. Its ordinary use is to direct the knife, and protect the parts underneath from its edge or point. The surgeon introduces the director under the parts which he means to divide, and then either cuts down, along the groove, with a common bistoury, or cuts upward with a narrow, curve-pointed bistoury, the point of which is turned upwards, and which he carefully introduces along the groove. This instrument and the probe-pointed bistoury are commonly employed for opening sinuses, for cutting fistulæ in ano, and fistulæ in other situations, and for dilating the stricture in hernia. The French employ the director very commonly in that stage of operations for aneurism, in which the artery is to be separated from the adjacent vein, or nerve: the director is put under the artery, which the surgeon then examines carefully, and even presses upon, to ascertain what effect is produced on the pulsations of the aneurism, and whether any of the consequences of pressing on a nerve are excited. If the experiment be satisfactory, the ligature is then introduced with an eye probe, which is passed along the groove of the director.

DISLOCATION (from *disloco*, to put out of place). *Luxation.* When the articular surfaces of the bones are forced out of their proper situation, the accident is termed a *dislocation* or *luxation.*

Sir Astley Cooper has justly remarked, that, of the various accidents which happen to the body, there are few which require more prompt assistance, or in which the reputation of the surgeon is more at stake, than cases of luxation; for, if much time be lost prior to the attempt at reduction, there is great additional difficulty in accomplishing it, and it is often entirely incapable of being effected. If it remains unknown, and consequently unreduced, the patient becomes a living memorial of the surgeon's ignorance or inattention. Hence, this experienced surgeon forcibly inculcates the careful study of anatomy; the want of an accurate knowledge of the structure of the joints being the chief cause of the many errors which happen in the diagnosis and treatment of dislocated bones. The following passage cannot be too deeply impressed upon the surgeon's mind: — "A considerable share of anatomical knowledge is required to detect the nature of these accidents, as well as to suggest the best means of reduction; and it is much to be lamented that students neglect to inform themselves sufficiently of the structure of the joints. They often dissect the muscles of a limb with great neatness and minuteness, and then throw it away, without any examination of the ligaments, the knowledge of which, in a surgical point of view, is of infinitely greater importance; and from hence arise the numerous errors of which they are guilty when they embark in the practice of their profession; for, the injuries of the hip, elbow, and shoulder are scarcely to be detected but by those who possess accurate anatomical information." (*Surgical Essays*, part. i. p. 2.)

General Remarks on Dislocation.

The most important points for consideration with respect to dislocations generally are: — 1. With respect to the articulation, in which these accidents take place; 2. The extent of the dislocation; 3. The direction in which the bone is displaced; 4. The length of time the displacement has continued; 5. The circumstances which accompany it, and which make it simple or compound; and lastly, 6. With respect to the causes of the accident.

1. Every kind of joint is not equally liable to dislocation. [In articulations with *contiguous* surfaces (*synarthroses*)—that is, in joints where there is no synovial cavity, but where ligamentous fibres pass from the entire surface of one bone to that of the other, as in the pelvic articulations, or in those between the bodies of the vertebræ—dislocations are most rarely met with.] Experience proves, for instance, that in the greater part of the vertebral column, luxations are almost impossible, unless there be also a fracture, the pieces of bone being articulated by extensive and numerous surfaces, varying in their form and direction, and so tied together by many powerful elastic means, that very little motion is allowed. Experience proves, also, that the strength of the articulations of the pelvic bones can scarcely be affected by enormous efforts, unless these bones be simultaneously fractured.

In articulations with *contiguous* surfaces (*diarthroses*), the facility with which dislocations happen, depends upon the extent and variety of motion in such joints. Thus, in the short bones of the carpus, and particularly of the tarsus, and at the carpal and tarsal extremities of the metacarpal and metatarsal bones, where flat broad surfaces are held together by ligaments, strong, numerous, and partly interarticular, and where only an obscure degree of motion can take place (*arthrodia*), dislocations are unfrequent, and can only be produced by uncommon violence. It is in the loose joints (*enarthrosis*), which admit of motion in every direction, that dislocations most frequently occur; as is exemplified in the joint of the humerus with the scapula. On the contrary, the *ginglymoid* joints, which allow motion only in two directions, are not so often dislocated. The articular surfaces of the latter are of great extent; and, consequently, the heads of the bones must be pushed a great way in order to be completely dislocated; and the ligaments are numerous and strong.

2. With respect to the extent of dislocation, luxations are either *complete* or *incomplete*. The latter term is applied when the articular surfaces still remain partially in contact. Incomplete dislocations are most frequently seen in ginglymoid articulations, as those of the ankle, knee, and elbow. In these, the luxation is generally incomplete; and very great violence must have operated when the bones are completely dislocated. In the elbow, the dislocation is sometimes partial, with respect to the ulna and radius. In the orbicular articulations, luxations are usually complete. However the os humeri sometimes rests upon the edge of the glenoid cavity, and readily returns into its socket. The lower jaw is sometimes partially dislocated in a manner different from what is commonly meant by this expression, viz. one of its condyles is luxated, while the other remains in its natural situation.

A partial dislocation sometimes occurs at the ankle-joint. "An ankle was dissected at Guy's, and given to the collection of St. Thomas's, which was partially dislocated: the end of the tibia rested still in part upon the astralagus; but a large portion of its surface was seated on the os naviculare, and the tibia, altered by this change of place, had formed two new articular surfaces, with their faces turned in opposite directions towards the two bones. The dislocation had not been reduced." (*Sir A. Cooper.*)

3. In the orbicular joints, the head of the bone may be dislocated at any point of their circumference; and the luxations are named accordingly *upward*, *downward*, *forward*, and *backward*. In the ginglymoid articulations, the bones may be dislocated either laterally, or forward, or backward.

4. The length of time a dislocation has existed makes a material difference. In general, recent dislocations may be easily reduced; but when the head of a bone has been out of its place several days, the reduction becomes exceedingly difficult; and, in older cases, often impossible. In these latter the soft parts, and the bone itself, have acquired a certain position; the muscles have adapted themselves in length to the altered situation of the bone to which they are attached, and, sometimes, cannot be lengthened sufficiently for it to be reduced. Indeed, I believe that Sir Astley Cooper's statement is quite correct, that the difficulty in the reduction, arising from the muscles, is proportioned to the length of time that has elapsed from the period of the accident. (*On Dislocations*, p. 26.)

Desault and Boyer suspected, that frequently the opening in the capsular ligament soon becomes closed, and resists the return of the head of the bone into its original situation. However, with regard to the doctrine of the reduction being at first ever prevented by this cause, I believe, with Sir Astley Cooper, that it is destitute of foundation. (*Surgical Essays*, part i. p. 18; and *Treatise, &c.*, p. 25.) Thus, in Mr. Thompson's dissection of a dislocated humerus, the capsular ligament was completely torn from the whole circumference of the humerus. In one of Mr. Crampton's cases, it was detached to the extent of more than half the circumference; and, in an instance of direct dislocation forwards, the rent was of sufficient extent, "but no more, to permit the head of the bone to pass easily through it." (See *Thompson, in Med. Obs. and Inq.* vol. ii. p. 349. *Ph. Crampton, in Dublin Journ. of Med. Science*, vol. iii. p. 47—49.)

5. The difference is immense, in regard to the danger of the case, arising from the circumstance of a dislocation being attended, or unattended, with a wound, communicating, internally with the joint, and externally with the air. When there is no wound of this kind, the danger is generally trivial, and the dislocation is termed *simple*: but should there be such a wound, together with the dislocation, the case is denominated *compound*, and is frequently accompanied with peril. Indeed, the latter kind of accident sometimes renders amputation necessary, and, in too many instances, has a fatal termination.

6. The causes of dislocations are external or internal. A predisposition to such accidents may depend on circumstances natural, or accidental. The great latitude of motion, which the joint admits of; the little extent of the articular surfaces; the looseness and fewness of the ligaments; the lowness of one side of the articular cavity, as the anterior and inferior part of the acetabulum; and the shallowness of the cavity, as of that of the scapula; are natural predisposing causes of luxations.

A paralytic affection of the muscles of a joint, and a looseness of its ligaments, are also predisposing causes. When the deltoid muscle has been paralytic, the mere weight of the arm has been known to cause such a lengthening of the capsular ligament of the shoulder-joint, that the head of the humerus descended two or three inches from the glenoid cavity.

Two cases, illustrative of the tendency to dislocation from a weakened, or paralytic state of the muscles, are recorded by Sir A. Cooper. The first is that of a junior officer of an India ship, who, for some trifling offence, had been placed with his foot upon a small projection on the deck, while his arm was kept forcibly drawn up to the yardarm for an hour. "When he returned to England, he had the power of readily throwing that arm from its socket, merely by raising it towards his head; but a very slight extension reduced it. The muscles were wasted, also, as in the case of paralysis." The other example happened to a young gentleman, troubled with a paralytic affection of his right side from dentition. "The muscles of the shoulder were wasted, and he had the power of throwing his os humeri over the posterior edge of the glenoid cavity of the scapula, from whence it became easily reduced." In these cases no laceration of the ligaments could have occurred, and the influence of the muscles in preventing dislocation, and in impeding reduction, is exemplified. (*Surgical Essays*, part i. p. 10.) Mr. Brindley, of Wink Hill, communicated to Sir A. Cooper an account of a dislocation of the os femoris, which the patient, a man of 50, is able to produce and reduce whenever he chooses. One of my pupils gave me an account of a similar case in another part of the country.

The looseness of the ligaments sometimes makes the occurrence of dislocations so easy, that the slightest causes produce them. Some persons cannot yawn, or laugh, without running the risk of their lower jaw being luxated. Collections of fluid within the knee, causing a relaxation of the ligament of the patella, are often followed by a dislocation of that bone. And, whenever a bone has been once dislocated, it ever afterwards has a tendency to be displaced again by a slighter cause than what was first necessary to produce the accident. This tendency likewise increases with every new displacement.

Diseases which destroy the cartilages, ligaments, and articular cavities of the bones, may give rise to a dislocation. The knee is sometimes, but not frequently, partially luxated in consequence of disease; and the thigh is now and then dislocated in consequence of the acetabulum and ligaments being more or less destroyed. Such dislocations are termed *spontaneous*, or *consecutive*.

At St. Thomas's Hospital, there is a preparation of a knee, dislocated in consequence of ulceration, and in the state of ankylosis, the leg forming a right angle with the femur directly forwards. (See *Sir A. Cooper's Surg. Essays*, part i. p. 11.)

An enarthrodial or ball and socket joint can only be dislocated by external violence; a blow, a fall, or the action of the muscles, when the axis of the bone is in a direction more or less oblique with respect to the surface with which it is articulated.

Any external force may occasion a dislocation of ginglymoid joints, in which case the displacement, as before mentioned, is generally incomplete; but in the ball and socket articulations, the action of the muscles sometimes has a share in producing the accident. So, when a person falls on his elbow, while his arm is raised outwards from his side, the force, thus applied, will undoubtedly contribute to push the head of the os brachii out of the glenoid cavity, at the lower and internal part. Still, the sudden action of the pectoralis major, lattissimus dorsi, and teres major, which always takes place from the alarm, will also aid in pulling the head of the bone downwards. Under certain circumstances, the action of the muscles alone may produce a dislocation, without the conjoint operation of any outward force, as is commonly exemplified in the lower jaw, and in some dislocations of the patella. But, in other cases, when the patient is aware in time of the violence which is about to operate, and his muscles are prepared for resistance, a dislocation cannot be produced without the greatest difficulty (*Sir A. Cooper*, op. cit. p. 15.), unless the posture of the member at the moment be such as to render the action of the strongest muscles conducive to the displacement, instead of preventive of it, as is frequently the case in luxations of the shoulder.

[In the above description, *indirect* force, that is to say, force operating at a distance from the joint, or at the opposite end of the bone to be displaced, is alone taken into consideration. This, however, though perhaps the most frequent way, is not the *only* way in which these accidents are occasioned, for they may be produced also by *direct* force applied immediately over the joint itself. Thus, for example, the humerus may be dislocated backwards by a blow or fall upon the front of the shoulder. In the latter class of cases there will probably be contusion and ecchymosis observable in the immediate neighbourhood of the injury; while in the former, if contusion is present, it will be situated at a distance.]

Dislocations are constantly attended with more or less laceration or elongation of the ligaments; and in the shoulder and hip, the capsules are always torn, when the accident is produced by violence. Some instances, in which the ligaments are only lengthened and relaxed, I have already quoted. Sometimes a dislocation is attended with a fracture: mostly when the ankle is luxated, the fibula is broken; and in dislocation at the hip, the acetabulum may be fractured. (*Sir A. Cooper*, op. cit. p. 15. *Wallace, in Dubl. Trans. of King's and Queen's College*, vol. v.)

Symptoms of Dislocations.

Every dislocation produces pain and incapacity in the limb or part; but, these are only equivocal symptoms, and cannot distinguish the case from a fracture, nor even from a simple contusion. A severe, but obtuse, pain arises from the pressure of the head of the bone upon the muscles; sometimes the pain is rendered more acute by the pressure being made upon a large nerve. (*Sir A. Cooper's Treatise*, p. 5.)

In order that a dislocation of the hip or shoulder may happen, there must be a particular attitude of the limb during the action of the external violence. Indeed, in the former, the displacement can hardly occur from the direct action of the cause on the articulation itself. The force always acts with greater effect the further it is from the joint, and the longer the lever is which it affects. Thus, in a fall on the side, when the arm, raised considerably from the trunk, has to sustain all the weight of the body on a point at its inner side, the probability of a dislocation is evident, and even that the head of the bone has been forced through the lower portion of the capsular ligament.

The symptoms, which Boyer terms positive, deserve to be well remembered.

1. In dislocations of orbicular joints, and complete luxations of ginglymoid joints, the articular surfaces are not at all in contact, and the point, where the dislocated bone is lodged, cannot be upon the same level with the centre of the cavity, from which it has been forced. Hence a change in the length of the limb. In the ginglymoid joints, such alteration can only be a shortening proportioned to the extent of the displacement. But, in the orbicular joints, the bone may be displaced and carried above, or below, the articular cavity, so that, in the first event, a shortening, in the second, an elongation of the limb, will be produced. But as the direction of the member is at the same time altered, it is not always practicable to place the limbs parallel together, nor to bring them near the trunk, for the purpose of judging whether they are lengthened or shortened. A

comparison, however, made without this advantage, will generally enable the surgeon to form a correct opinion. The proper length of a dislocated limb cannot be restored, except by putting the bone back into the cavity from which it has slipped. In general, this cannot be accomplished without considerable efforts, while a slight exertion is usually sufficient to restore the proper length of the limb in cases where the shortening depends upon a fracture. Also when once the natural length of the limb has been restored in dislocations, it remains; while, in fractures, the shortening recurs as soon as the extension is discontinued. As for elongation of the limb, it can never happen in cases of fracture, as it does in certain dislocations.

2. In many cases the direction of the axis of the limb is unavoidably altered. This circumstance arises from the resistance of that portion of the articular ligaments, which has not been ruptured, as well as from the action of the muscles. In dislocation of orbicular joints, the tension of certain muscles is a cause of a rotatory movement of the dislocated limb at the moment of the displacement, and which it afterwards retains. Thus in dislocations of the thigh bone at the hip, the toes and knee are turned outward or inward, according as the head of the bone happens to be situated at the inside or outside of the joint. The alteration in the length of the part, and in its position generally, is permanent when it depends upon a dislocation; whereas in fractures the same changes occur, but can be made to cease at once, without any particular effort.

3. The absolute immobility of a limb, or, at least, the inability of performing certain motions, is amongst the most characteristic symptoms of a dislocation. In complete luxations of some ginglymoid joints, the dislocated limb is absolutely, or very nearly, incapable of any motion. Thus, in the dislocation of the forearm backwards, the particular disposition of the bones, and the extreme tension of the extensor and flexor muscles, confine the limb in the half-bent state, and at the same time resist every spontaneous motion, and likewise almost every motion which is communicated. In the orbicular joints, the painful tension of the muscles, which surround the luxated bone, nearly impedes all spontaneous movements; but, in general, analogous motions to that by which the displacement was produced, can be communicated to the limb, though not without exciting pain. Thus, in the dislocation of the humerus downward, the elbow hardly admits of being put near the side, nor of being carried forward, and backward; but it can easily be raised up. In the dislocation of the acromial end of the clavicle, the patient can bring the arm towards the trunk, separate it a little from the side, or carry it forward or backward; but he cannot raise it in a direct way. Lastly, in complete lateral dislocations of such joints as have alternate motions, the patient has the power of performing no motion of the part; but the complete destruction of all the means of union allows the limb to obey every species of extraneous impulse.

Sometimes, as Sir. A. Cooper has remarked, a considerable degree of motion continues for a short time: thus, in a man, brought into Guy's Hospital, whose thigh-bone had just been dislocated into the foramen ovale, a great mobility of the femur still remained; but, "in less than three hours it became firmly fixed in its new situation by the contraction of the muscles." (*Surgical Essays*, part i. p. 3.)

4. In dislocations attended with elongation of the limb, the general and uniform tension of all the muscles arranged along it, gives to these organs an appearance as if they lay nearer the circumference of the bone, and the limb were smaller than its fellow. The muscles, however, which belong to the side, from which the dislocated bone has become more distant, appear tenser and harder. On the contrary, in dislocations, where the limb is shortened, the muscles are relaxed; but being irritated, they contract and accommodate themselves to the shortened state of the limb. Hence the extraordinary swelling of their fleshy part, and the manifestly increased diameter of the portion of the member to which they belong. We have a striking example of this in the dislocation of the thigh upward and outward, where the muscles at the inner side of the limb form a distinct oblong tumor. In dislocations of the thigh, the glutæus maximus on the same side is flattened if the bone is carried inward; but it is more prominent when the thigh-bone is carried outward; and its lower edge is situated higher, or lower, than in the natural state, according as the luxation may have taken place upward or downward. In the complete luxation of the forearm backward, the triceps is tense, and forms a cylindrical prominence, owing to the displacement of the olecranon backward.

The form of the joints principally depends upon the shape of the heads of the bones. Hence the natural relation of the bones to each other cannot be altered, without a change being immediately produced in the external form of the joint. The changes, which the muscles passing over the luxated joint undergo at the same time in their situation and direction, contribute likewise to destroy the harmony of the outlines of the limb.

When the head of a bone has slipped out of the articular cavity, it may often be felt in its new situation, while at the articulation itself may be remarked a flatness caused by one of the neighbouring muscles stretched over the articular cavity, and more deeply the outline and depression of this cavity itself can be perceived. The bony eminences, situated near the joint, and whose outlines were gradually effaced in the general form of the member, are sometimes rendered more apparent by the displacement, and project, in a stronger degree, than in the natural state, while, in other instances, they project less, and become more concealed. On this part of the subject, Sir. A. Cooper is particularly correct, when he observes, that the head of the bone can generally be felt in its new situation, excepting in some of the dislocations of the hip, and its rotation is often the best criterion of the accident. *The natural prominences of bone, near the joint, either disappear, or become less conspicuous, as the trochanter at the hip-joint. Sometimes the reverse occurs; for in dislocations of the shoulder, the acromion projects more than usual.* (*Surg. Essays*, part i. p. 4.)

The lines, made by the contour of the limb, and the natural relation of the bones, are so manifestly broken in dislocations of ginglymoid joints, that, when there is no inflammatory swelling, the case is at once manifest. More certain knowledge, however, and more correct information, respecting the kind of displacement, are to be obtained, by attentively examining the changes of position, which certain processes, or prominent points of the dislocated bone, or bones, have undergone, and which are the more obvious in these joints, inasmuch as they give attachment to the principal muscles. The natural relations of these processes being known, the least error of situation ought to strike the well-informed practitioner. Thus, in the elbow-joint, a considerable difference in the respective height, and in the distances between the olecranon and internal and external condyles, can be easily distinguished. But the thing is less easy when the surrounding parts are so swelled and tense as to make the bony projections deeper from the surface, and less obvious to examination. Even then, however, a good surgeon will at least find something to make him suspect the dislocation, and the suspicion will be confirmed when he again examines the part after the swelling has begun to subside. It is of the utmost consequence to make out what the case is as early as possible; for the unnatural state in which the soft parts are placed, keeps up the swelling a long while; and if the surgeon wait till this has entirely subsided before he ascertains that the bones are luxated, he may have waited till it is too late to succeed in reducing them, and the patient may remain for ever afterwards deprived of the free use of his limb. (*Boyer*, *Traité des Maladies Chir.* t. v. p. 45, &c.) It is not only the inflammatory swelling which may tend to conceal the ends of the bone; sometimes a quicker tumor arises from the effusion of blood in the cellular tissue, and causes an equal difficulty of feeling the exact position of the heads of the bones. (See *Sir A. Cooper, On Dislocations,* p. 5.)

Dislocations are sometimes attended with particular symptoms, arising altogether from the pressure caused by the head of the luxated bone on certain important organs. Thus, the sternal end of the clavicle may compress the trachea, and impede respiration; the head of the humerus may press upon the axillary plexus of nerves, and produce a paralytic affection of the whole arm. In one instance, cited by Sir A. Cooper, a dislocated clavicle pressed upon the œsophagus and endangered life. (*Surg. Essays,* part i. p. 4.)

As Kirkland has observed, some luxations are worse injuries than fractures: of this description, are dislocations of the vertebræ, cases which seldom happen without fracture, and are mostly fatal; dislocations of the long bones, attended with protrusion of their ends through the skin, and even a comminution of them, which may be followed by severe inflammation, extensive abscesses, necrosis, and not unfrequently gangrene.

According to Sir A. Cooper, young persons are rarely the subjects of dislocations from violence; but, he admits, that they do sometimes experience them, and relates an instance, which happened in a child seven years of age. In general, in them the bones break, or the epiphyses give way, much more frequently than the articular surfaces are displaced. (*Surg. Essays,* part i. p. 16; and *Treatise, &c.* p. 23.) Suspected luxations of the hip in children commonly turn out to be disease of the joint, one instance of which is given by the preceding author. For such examples I have also been sometimes consulted. Also, when a dislocation of the elbow is suspected in a child, because the bone appears readily to return into its place, but directly to slip out of it again, the case is always found to be an oblique fracture of the condyles of the humerus. Old persons are less liable to dislocation than individuals of middle age; a fact which is accounted for by the extremities of bones in old subjects being so softened, that the violence sooner breaks than luxates them. (*Sir Astley Cooper*, *On Disloc. &c.* p. 23.)

[This statement of Sir A. Cooper has been called in question by M. Malgaigne, who has shown, on the contrary, that beyond the age of 65, *if due regard is paid to the population*, the proportion of dislocations, instead of diminishing, becomes considerably *greater* than in adult age. He has also shown that beyond 60 years, the proportion of fractures, the comparison being made with reference to the population, *does not increase,* but tends rather to diminish; and his investigations led him to the unexpected result, that the tendency to fractures, as compared with dislocations, is even *less* in old age than at other periods of life. (*Traité des Fract. &c.* t. ii. p. 5; and *Etudes Statistiques sur les Luxations*, *Ann. de Chir.* 1841, p. 149.]

PROGNOSIS.

In general, every unreduced dislocation must deprive the patient more or less of the use of the limb or part; for nature cannot re-establish the natural relations which are lost. There is indeed an effort made to restore some of the motions, and the use of the limb in a certain degree; but it is always imperfectly accomplished, and, in the best cases, only a confined degree of motion is recovered. Nature cannot in any way alter the lengthened or shortened state of the limb; and she can only correct, in a very imperfect manner, its faulty direction. There are even some cases, in which little or no amendment can be effected. Generally, however, after a time, some degree of motion is regained, and the limb, or part, becomes to a certain extent more useful than at first. This statement applies even to dislocations of the hip, shoulder, lower jaw, elbow, thumb, &c.

If there are any exceptions to these observations, they are in young subjects, or in arthrodial joints, which are seldom extensively displaced; and as, in the natural state, their motions are but limited, the loss of these motions, in consequence of the natural relations not having been restored, is of less importance. Thus, the bones of the carpus, those of the tarsus, and the acromial end of the clavicle, may be dislocated, and be reduced either imperfectly, or not at all, without the functions of the limb being materially impaired. (*Boyer*, *Maladies Chir.* t. iv. p. 54.)

Dislocations of enarthrodial, are generally less dangerous than those of ginglymoid joints; for the action of the muscles has some share in producing them; the violence done to the external parts is less; and the injury of the soft parts is not so considerable. Even in the same kind of joints, the seriousness of the case materially depends on the extent of the articular surfaces, and the number and strength of the muscles and ligaments.

Dislocations of ginglymoid, however, are more easily reduced than those of enarthrodial joints, the muscles of which are powerful, and capable of making great resistance to the efforts of the surgeon.

This is frequently exemplified in luxations of the shoulder and thigh.

It may be said, however, of the luxations of enarthrodial joints, that although their reduction may require considerable efforts, yet it can be accomplished, and that the accident leaves no ill effects. On the contrary, in dislocations of ginglymoid joints, the same reason which renders them more unfrequent, makes them also more serious. The solidity of these joints prevents the uniting means from being destroyed, except by great violence; and the extent of the articular surfaces does not permit a considerable displacement, especially a complete one, without extensive injury of the ligaments and surrounding soft parts. It is for these reasons, no doubt, that compound luxations and protrusion of the ends of the bones are most commonly seen in ginglymoid articulations.

The more recent a luxation is, the more easy it is to reduce, and therefore, *cæteris paribus*, the less grave is the injury. In this point of view, dislocations of ginglymoid joints are the most serious, because they sooner become irreducible than those of enarthrodial articulations.

Simple dislocations are much less dangerous than those which are complicated with contusion, injury of a large nerve or blood-vessel, inflammatory swelling, fracture, wound, and, especially, a protrusion of the end of the bone. (*Boyer*, *Maladies Chir.* t. iv. p. 55, 56.)

Dislocations from disease of the parts of bones entering into the formation of the joints, termed *spontaneous* or *consecutive* luxations, cannot admit of reduction: when they arise from the hip-disease, it is not merely in consequence of the ligaments being destroyed, but because parts of the acetabulum itself are more or less absorbed. However, there are other *spontaneous* dislocations from preternatural looseness of the ligaments, where reduction may be accomplished with the greatest facility; though the displacement generally recurs from slight causes.

Mr. Wallace has made some interesting pathological remarks on dislocations, deduced from the dissection of an unreduced dislocation of the head of the femur on the dorsum ilii, accompanied by a fracture of the superior edge of the acetabulum, which formed part of the new articular surface. The case confirmed one point, which indeed was previously well known; namely, that when a bone is allowed to remain unreduced, and in such a situation that the natural movements of the limb are prevented or restricted, its muscles become diminished in size, or wasted. Mr. Wallace's case demonstrated further, however, that such atrophy affects the external rotator muscles in a greater degree than others, in consequence of their action having been rendered almost impossible by the existence of check-ligaments extended from the ilio-pubic symphysis to the lesser trochanter.

Mr. Wallace likewise notices the fact, that if, at the time of dislocation, a tendon be torn across at its junction with the muscle, the detached ends of the muscular fibres become connected with those parts with which they may be brought in contact. In the case adverted to this had happened to the pyriformis.

Mr. Wallace next explains, that, if the fleshy fibres of a muscle be torn through, they reunite by a tendinous tissue. This fact was exemplified in the gemelli and quadratus. If a muscle be so torn or injured as to render its reunion by tendon impracticable, its entire texture becomes changed, or rather the muscle is absorbed, and "there is deposited in its place a substance of a peculiar texture, resembling a mixture of adeps and fibro-cartilage." In the case referred to this had happened to the obturator internus.

Another circumstance exemplified in this instance was, that when the distance between the points of attachment of a muscle is either increased or diminished, the muscular fibre has the power of undergoing such changes of shortening or elongation as may be necessary to adapt itself to its new state. "The triceps femoris, and some others, were in this case shortened; and the quadratus and gemelli were elongated."

"When any of the ligaments of a joint have been torn during the act of dislocation, if the bone be allowed to remain in such a situation that the torn ligaments can no longer serve any useful purpose, they are completely absorbed, and disappear, or they are converted into cellular tissue, and become confounded with the surrounding parts. Thus, in the present case, there were not the slightest remains of the round ligament.

"In all complete dislocations of the enarthrodial joints, the capsular ligament must necessarily be ruptured. If the bone be returned into its natural situation, the laceration is quickly repaired; but if the displacement be allowed to continue, a perfect capsule will be formed round the new joint, and the original lacerated capsule will contribute to form a greater or a smaller portion of this new capsule, according to the situation of the parts." Mr. Wallace deems it probable that, in his case, the capsule was lacerated, although the dislocation was only partial, in consequence of a part of the acetabulum having been broken off. "Yet (says he) of this laceration there was not any appearance. The new capsule was remarkable for its great thickness; but it was not formed of those regular fibres which enter into the formation of the original capsule;" and, "although its inner surface had the power of secreting synovia, it did not exhibit the smooth, shining aspect of synovial membrane."

According to Mr. Wallace's investigations, nature does not possess the power of forming articular cartilage in those accidental joints which result from unreduced dislocations. "The new articular surfaces are always covered by a lamina of bone, which resembles in appearance that ivory-like substance sometimes found on natural articulating surfaces. As a cartilaginous surface cannot play easily on a bony surface, the original cartilage, which may have covered the head of the dislocated bone, becomes absorbed, and its situation occupied by the same kind of tissue as that which forms the new surface, upon which the head of the bone may be applied." Another thing noticed by Mr. Wallace is, the alteration of the articular cavity, in consequence of the removal of the head of the bone. It becomes contracted in size and altered in form; and "the cartilage, which formerly covered its surface, disappears, being replaced by ligamentous fibres, which grow at right angles from the surface of the bone, and these, extending outwards, become confounded with the surrounding parts."

Mr. Wallace finally adverts to the wonderful facility with which the osseous tissue, apparently unyielding as it is, adapts itself to varied states.

"At one time we find it so completely removed, that not a vestige of large masses of it remains; and, on other occasions, great additions are made to the original bone, to serve useful purposes. Again, without either increase or diminution of the quantity of osseous matter, we find the bone to be, as it were, so completely new modelled, that its acquired shape has scarcely any resemblance to its former figure. In the present dissection, the acetabulum was nearly removed; a new plate of bone for the formation of an articulating surface was deposited on the ilium, and the head of the femur was completely remodelled." (See *Wallace* in *Trans. of King's and Queen's College, Dublin*, vol. v. p. 250, &c.)

When the head of a bone is thrown and left for a certain time upon a thick stratum of muscular fibres, a new capsular ligament may form for its enclosure; but when it is thrown upon a thin layer of muscle, or upon the surface of a bone, the muscle may be absorbed, and a new bony socket or cavity be produced, as explained by Sir Astley Cooper. Even when the humerus has been thrown forwards on the ulna, new osseous deposits are sometimes arranged in such a manner on the latter as to constitute an articular cavity for the reception and support of the lower end of the humerus. Of this there is an interesting representation given by Cruveilhier. (See *Anat. Pathologique.*) Sometimes, when the head of the humerus remains dislocated in the axilla, a new articular cavity is formed for it below the neck of the scapula.

Treatment of Dislocations in general.

It was correctly explained by Pott, that the difficulty which attends the reduction of luxated joints principally arises from the resistance of the muscles. "The mere bones composing the articulations, or the mere connecting ligaments, would in general afford very little opposition; and the replacing the dislocation would require very little trouble or force, was it not for the resistance of the muscles and tendons attached to and connected with them: for, by examining the fresh joints of the human body, we shall find, that they not only are all moved by muscles and tendons, but also that although what are called the ligaments of the joints do really connect and hold them together in such manner as could not well be executed without them, yet, in many instances, they are, when stripped of all connection, so weak and lax, and so dilatable, that they do little more than connect the bones and retain the synovia; and that the strength, as well as the motion, of the joints depends, in great measure, on the muscles and tendons connected with and passing over them; especially in those articulations which are designed for the greatest quantity, as well as for celerity, of motion. Hence, muscles require our first and greatest regard, these being the parts whose resistance must be either eluded or overcome." (See *Pott's Chir. Works*, vol. i.)

That the muscles are the chief cause of resistance is proved by cases in which the dislocation is accompanied with injury of a vital organ; for then the bone may be reduced by a very slight force. Thus, in a man who had an injury of his jejunum and a dislocation of his hip, the bone was most easily replaced. (*Sir A. Cooper, Surgical Essays*, part i. p. 20.) In short, anything which produces faintness or weakness facilitates the reduction, as intoxication, nausea and sickness, paralysis, &c.

The following are some of the principles laid down by Pott:—

1. Although a joint may have been luxated by means of considerable violence, it does by no means follow that the same degree of violence is necessary for its reduction.

2. When a joint has been luxated, at least one of the bones of which it is composed is detained in that unnatural situation by the action of some of the muscular parts in connection with it; which action is not under the direction of the will of the patient.

3. That all the force used in reducing a luxated bone ought always to be applied to the other extremity of the said bone, and, as much as possible, to that only. Mr. Pott argues, that if the extending force were applied to a distant part of the limb, or to the bone below or adjoining, it would necessarily be lost in the articulation which is not luxated, owing to the yielding nature of the ligaments, and be of little or no service in that which is dislocated. This remark, though made by Pott, and generally received as true, is incorrect; for it tends to state, that if extension be made at the ankle or wrist, the force does not operate on the hip or shoulder.

4. That in order to make use of an extending force with all possible advantage, and to excite thereby the least pain and inconvenience, it is necessary that all parts serving to the motion of the dislocated joint, or in any degree connected with it, be put into such a state as to give the smallest possible degree of resistance.

5. That in the reduction of such joints as consist of a round head, moving in an acetabulum or socket, no attempt ought to be made for replacing the said head, until it has by extension been brought forth from the place where it is, and nearly to a level with the said socket.

6. That whatever kind or degree of force may be found necessary for the reduction of a luxated joint, that such force be employed gradually; that the lesser degree be always first tried, and that it be increased gradatim. (See *Pott's Chir. Works*, vol. i.)

The supposition of the reduction being sometimes prevented by the capsular ligaments, Sir A. Cooper considers erroneous; in dislocations from violence, those ligaments are always extensively lacerated; and the idea of the neck of the bone being girt, or confined by them, is altogether untrue. (*Surg. Essays*, part i. p. 18.) But, in addition to the resistance of the muscles, there are, in old dislocations, three circumstances pointed out by Sir A. Cooper as causes of the difficulty of reduction:—1. The extremity of the bone contracts adhesion to the surrounding parts, so that in dissection, even when the muscles are removed, the bone cannot be reduced. In this state, he found the head of a radius, which had been long dislocated upon the external condyle, and which is preserved in the collection of St. Thomas's Hospital. In a similar state, he has also seen the dislocated head of the humerus. (*On Dislocations*, p. 28.) 2. The socket is sometimes filled up with adhesive matter. 3. A new bony socket is sometimes formed, in which the head of the bone is so completely confined, that it could not be extricated without breaking its new lodgment. (*Surgical Essays*, part i. p. 21; and *Treatise, &c.* p. 10.)

Dislocations in general cannot be reduced without trouble; but, after the reduction is accomplished, it is easily maintained. On the contrary, fractures are for the most part easy of reduction; but cannot be kept in this desirable state without difficulty. The moment extension is remitted, the muscles act, the ends of the broken bone slip out of their proper situation with respect to each other, and the distortion of the limb recurs. As a modern writer has observed, the reduction is only a small part of the treatment of fractures: the most essential point of it is the almost daily care which a fracture demands, during the whole time requisite for its consolidation. The contrary is the case in luxations. Here, in fact, the reduction is every thing, if we put out of consideration the less frequent cases, in which the dislocation is complicated, and attended with such grave circumstances, as render it indispensably necessary to continue for a length of time the utmost surgical care. But, even then, the protracted treatment is less for the dislocation itself, than for the extraordinary circumstances with which it is accompanied. (See *Roux, Parallèle de la Chirurgie Anglaise avec la Chirurgie Française*, p. 207.)

All the ancient writers recommend the extending force to be applied to the luxated bone; for instance, above the knee in dislocations of the thigh-bone, and above the elbow in those of the humerus. We have stated, that Pott advised this plan, and the same practice which is approved by J. L. Petit, Duverney, and Callisen, is generally adopted in this country.

However, many of the best modern surgeons in France, for instance, Fabre, D'Apouy, Desault, Boyer, Richerand, Leveillé, and Dupuytren, advise the extending force not to be applied on the luxated bone, but, on that with which it is articulated, and as far as possible from it. It is said, that this plan has two most important advantages:—first, The muscles, which surround the dislocated bone, are not compressed, nor stimulated to spasmodic contractions, which would resist the reduction; secondly, The extending force is much more considerable than in the other mode; for, by using a long lever we obtain a greater degree of power.

In Pott's remarks, we find even him influenced against the latter practice, by the supposition that part of the extending force is lost on the joint, intervening between the dislocation, and the point at which the extension is made; a notion quite unfounded, as every man who reflects for one moment must soon perceive. When extension is made at the wrist, the ligaments, muscles, &c. which connect the bones of the forearm with the os brachii, have the whole of the extending force operating on them, and they must obviously transmit the same degree of extension, which they receive, to the bone above, to which they are attached. Indeed, this matter seems so plain, that I think it would be an insult to the reader's understanding to say any more about it, than that such eminent surgeons, as have contrary sentiments, can never have taken the trouble to reflect for themselves on this particular subject. Whether the force necessary to be exerted in some instances, would have a bad effect on the intervening joint, may yet be a question; but, as Desault's and Dupuytren's practice was extensive, and they did not find any objection of this kind, we have no right to conclude that such would exist.

If, however, the common objection to Desault's plan of applying the extending force be unfounded, the question still remains to be settled, whether this practice is most advantageous on the grounds above specified. This is a point, which, perhaps, cannot be at once peremptorily decided altogether in the negative, or the affirmative, since what may be best in one kind of dislocation, may not be so in another. Thus, Sir A. Cooper states, that, so far as he has had an opportunity of observing, it is generally best to apply the extension to the bone which is dislocated: but, that dislocations of the shoulder are exceptions, in which he mostly prefers to reduce the head of the bone by placing his heel in the axilla, and drawing the arm at the wrist, in a line with the side of the body, whereby the pectoralis major and latissimus dorsi are kept in a relaxed state. (*Surgical Essays*, part i. p. 25.)

Extension may either be made by means of assistants, who are to take hold of a napkin, tablecloth, or sheet, folded longitudinally, and put round the part at which it is judged proper to make the extension; or else a multiplied pulley may be used. In cases of difficulty, Sir A. Cooper deems the pulley preferable. "When assistants are employed, their exertions are sudden, violent, and often ill-directed, and the force is more likely to produce laceration of parts, than to restore the bone to its situation. Their efforts are also often uncombined, and their muscles are necessarily as fatigued as those of the patient whose resistance they are employed to overcome." In dislocations of the hip-joint, and in those of the shoulder which have been long unreduced, pulleys should always be employed. (*Surgical Essays*, part i. p. 24.) But, whether pulleys be used or not, nothing more need be added to what Mr. Pott has stated, concerning the propriety of using moderate force in the first instance, and increasing the extending power very gradually.

In order to measure the force used in the extension with pulleys, M. Malgaigne has invented and repeatedly used an instrument, termed a *dynamometer*. Mr. Weiss was kind enough to show me, some time ago, one which he has constructed; and Mr. Crosse informs us, that he has procured one, which seems to answer every purpose.

The extension should always be first made in the same direction in which the dislocated bone is thrown; but, in proportion as the muscles yield, the bone is to be gradually brought back into its natural position. Thus the head of the bone becomes disengaged from the parts, among which it has been placed, and is brought back to the articular cavity again by being made to follow the same course which it took in escaping from it.

Extension will prove quite unavailing, unless the bone, with which the dislocated head is naturally articulated, be kept motionless by *counter-extension*, or a force at least equal to the other, but made in a contrary direction.

The mode of fixing the scapula and pelvis, in luxations of the shoulder and thigh, will be hereafter described.

In partial dislocations of ginglymoid joints, extension and counter-extension are often made for the purpose of diminishing the friction of the surfaces of the joints, so that the reduction may be rendered more easy.

When the attempts at reduction fail, the want of success may be owing to the extension not being powerful enough, and the great muscular strength of the patient, which counteracts all efforts to replace the bone.

"The means to be employed for the reduction of dislocations (says Sir Astley Cooper) are both constitutional and mechanical. It is generally wrong to employ force only, as it becomes necessary to use it in such a degree as to occasion violence and injury; and it will be shown in the sequel, that the most powerful mechanical means fail, when unaided by constitutional remedies. The power of the muscles, in the first instance, is to be duly appreciated, as this forms the principal cause of resistance. The constitutional means to be employed for the purpose of reduction are those which produce a tendency to syncope, and this necessary state may be best induced by one or other of the following means, viz. by bleeding, warm bath, and nausea. Of these remedies, I consider bleeding the most powerful: and that the effect may be produced as quickly as possible, the blood should be drawn from a large orifice, and the patient kept in the erect position; for, by this mode of depletion, syncope is produced, before so large a quantity of blood as might injure the patient is lost. However, the activity of this practice must be regulated by the constitution of the person; for as the accident happens to all the varieties of constitution, it must not be laid down as a general rule; but when the patient is young, athletic, and muscular, the quantity removed should be considerable, and the method of taking it away that which I have described.

"Secondly, in those cases where the warm bath may be thought preferable, or where it may be considered improper to carry bleeding any farther, the bath should be employed at the temperature of 100° or 110°; and as the object is the same as in the application of the last remedy, the person should be kept in the bath at the same heat till the fainting effect is produced, when he should be immediately placed in a chair, wrapped in a blanket, and the mechanical means employed.

"Of late years, I have practised a third mode of lowering the action of the muscles, by exhibiting nauseating doses of tartarised antimony; but as its action is uncertain, frequently producing vomiting, which is unnecessary, I rather recommend its application, merely to keep up the state of syncope, already produced by the two preceding means, which its nauseating effects will most readily do, and so powerfully overcome the tone of the muscles, that dislocations may be reduced with much less effort, and at a much more distant period from the accident than can be effected in any other way." (*Sir A. Cooper on Dislocations, &c.* p. 29, 30. Also *Surgical Essays*, part i. p. 22.) In cases of unusual difficulty, the use of antimonium tartariz. together with the warm bath and bleeding, seems rational and judicious: but, except in cases of that description, I should prefer long continued, unremitting, not too violent, extension, which will at last overcome the muscles of the most athletic man. Sometimes the resistance made to reduction by muscles acting in obedience to the will, may be eluded by the patient's attention being suddenly taken from the injured part, at which moment the action of those muscles is suspended, and a very little effort on the part of the surgeon will reduce the bone. A case, illustrating this circumstance, is recorded by Sir A. Cooper. (*Surgical Essays*, part i. p. 25; and *Treatise, &c.* p. 34.) This principle was never neglected by Dupuytren, and it was partly by availing himself of it that he succeeded even without the pulley in reducing not less than thirty-three dislocations of the shoulder and hip, which had continued for periods varying from a fortnight to more than three months. (See *Dupuytren, Chir. Clin.* t. i. p. 126. Also, *M. Marx, in Répertoire Général d'Anat. et de Physiologie Pathol.* 1er. *Trimestre*, 1829.

[Since the introduction of anæsthetics, the above expedients for lessening the muscular resistance have been almost entirely superseded. We have in chloroform an agent, which, besides possessing the advantage of inducing insensibility to the pain necessarily occasioned by the attempts at reduction, causes a more complete relaxation of the muscles than can be obtained in any other way. In all dislocations, therefore, where any considerable force is likely to be required, chloroform should be administered, and persisted in until the muscles are in a perfectly passive and flaccid condition, before the extension is commenced.]

Sir Astley Cooper believes, that much mischief is produced by attempts to reduce dislocations of long standing in very muscular persons. He has seen great contusion of the integuments, laceration, and bruises of the muscles, and stretching of the nerves, leading to an insensibility and paralysis of the hand, follow an abortive attempt to reduce a dislocation of the shoulder. He is of opinion, that three months for the shoulder, and eight weeks for the hip, may be set down as the period from the accident, when it would be imprudent to make the attempt, except in persons of very relaxed fibre, or advanced age, (*On Dislocations, &c.* p. 35.)

Mr. Twining succeeded, however, in reducing a dislocation of the humerus in a robust healthy sailor, which had continued fifteen weeks. Gradually increased extension with the pulleys was maintained for fifty minutes, and, during that time nausea and faintness were induced by a large dose of tartar emetic, and the abstraction of lb. ij. of blood. (See *Trans. of Med. and Phys. Soc. of Calcutta*, vol. iv. art. 8, 1829.)

A case is mentioned by Mr. Lawrence, in which he succeeded in reducing the upper ends of the radius and ulna, when they had been displaced twenty-six days; one to the outside of the external condyle of the humerus, the other directly backward, with fracture of the coronoid process. (See *Lancet* for 1830, 31, p. 445.) Mr. Crosse refers to some dislocations of the radius and ulna backwards, which had been reduced at sixty-three and even seventy days; but, in one of these cases, the olecranon was fractured in the attempt, owing to the resistance of the triceps. In five weeks, however, the patient regained the use of the limb. (See *Prov. Med. and Surg. Trans.* vol. v.) In several instances, Desault succeeded in reducing dislocations of thirty or thirty-five days' standing, and even occasionally after an interval of two months and a half, or three months. (*Œuvres Chir. de Desault, par Bichat*, t. i.)

The practice of Desault then was encouraging, in relation to the reduction of old dislocations. But M. Flaubert, surgeon to the Hôtel Dieu at Rouen, published five cases of an opposite tendency; for his attempts at reduction of the shoulder after eleven and fifteen days, five weeks, and seven weeks, and at reduction of the elbow joint after twenty-seven days, were ineffectual. The first patient died of rupture of the axillary artery. The second and third were seized immediately after the operation with palsy of the arm, from which the former scarcely recovered at all, and the latter but very imperfectly; consequently, the brachial nerves must have been injured. The fourth was attacked with palsy of the entire side, and died of inflammation and softening of the spinal cord in the neck produced by the four lowest branches of nerves, which form the brachial plexus, being torn out of the spinal cord by the roots. And the fifth suffered laceration of all the soft parts around the elbow joint, and probably of the arteries also, and lost entirely the use of the forearm. (See *Flaubert*, in *Répertoire Général, &c.* t. iii.) One instance, in which a woman died from the violence used in attempting to reduce a dislocated shoulder, is recorded by Sir A. Cooper. (*On Dislocations*, p. 422.)

Professor Gibson has met with two instances, in which the axillary artery, which had become firmly adherent to the head of the bone, was torn across, and the patients lost their lives. One of the dislocations had existed nine weeks; the reduction took up an hour and three quarters; and, on the following day, a swelling of an aneurismal character was noticed. The subclavian artery was taken up; but the patient died. (See *Amer. Journ. of Med. Science*, No. 3, and *Amer. Ed. of this Dict. by Dr. Reese.*)

[Dr. Warren, of Boston, U.S., has recorded a case in which, after the reduction of a dislocated shoulder, the arm became greatly swollen, and a tumor formed in the axilla, which burst at the end of thirty-eight days, and gave rise to an alarming hæmorrhage. The subclavian artery was ligatured above the clavicle, and the patient recovered. (See *Med. Chir. Trans.* vol. xxix. p. 25, 1846.) Many other instances of serious and fatal mischiefs resulting from attempts to reduce dislocations might without difficulty be adduced. Suppuration in and around the joint, and even gangrene of the limb, have been known occasionally to occur. (See *Malgaigne, Traité des Fract. &c.* vol. ii. p. 143.)]

The experience of Dupuytren proves, after all, however, that old dislocations may frequently be reduced at so late a period as eighty-two days, and even more; that this may generally be accomplished without much torture to the patient; and that with proper precautionary measures, none of the serious accidents occur which M. Flaubert met with.

In seven of Dupuytren's cases, the dislocation had existed only for a week or less. In five, it had continued fifteen or eighteen days. In three, between twenty-one and twenty-six days. In three, between thirty-one and thirty-seven days. In five, between forty-one and fifty-two days. In four, between sixty and eighty-two days. In two, for three months; and in two, for two years. In one of the last, reduction was not attempted; and, in another of seventy-six days' standing, three attempts were unsuccessfully made to reduce a dislocation of the elbow; but, in all the rest the operation was completely successful. (See *M. Marx, in Répertoire Gén. d'Anat. &c.* 1829; also, *Dupuytren, Clin. Chir.* t. i. p. 121, &c.)

It deserves notice, that Dupuytren's own successful cases were twenty-three; that he never employed pulleys; and that, in attempting to reduce old dislocations of the shoulder, he made the extension considerably upwards, as first recommended by Charles White, of Manchester, afterwards by M. Mothe, and of late years by M. Malgaigne. He always availed himself of as long a lever as he could obtain, by applying the extending means as far from the dislocated joint as was practicable. Thus, in dislocations of the shoulder, the extension was made at the wrist; in those of the hip, it was made just above the ankle.

[*Prolonged extension* has sometimes been attended with advantage in old dislocations. In a dislocation of the elbow of six months' standing, Mr. Darke kept up extension with the pulleys for eight hours and a half, at the end of which time he was rewarded by the return of the bones to their proper situation. (*Prov. Med. Journ.* Dec. 1842, p. 250.) A dislocation of the shoulder was reduced by Mr. Mash in the Northampton Infirmary after extension at intervals with the pulleys for a period of eight hours. (*Lancet*, Sept. 1844, p. 773.) A less powerful, but frequently repeated, extension has also been practised. In this way, Dr. Stark succeeded in reducing a dislocation of the head of the radius forwards of twenty-five months' duration, in a child nine years old. He repeated the extension daily for twenty-two days consecutively, and the fibrous adhesions became gradually elongated, until at length, by pressure and flexion of the joint, the head of the bone could be restored to its place. (*Ed. Med. and Surg. Journ.* vol. lxix. 1848, p. 77.)

Subcutaneous section of resisting tendons, or of the new fibrous formations, has been practised to facilitate the reduction of old dislocations. Dieffenbach succeeded by this means in reducing a dislocated shoulder of two years' standing, (see Dislocations of Shoulder Joint,) and the practice has also been followed by success in other cases, and especially in old dislocations of the elbow. Sir Charles Bell advised the division of one of the lateral ligaments, in recent dislocations of the thumb. In one case of dislocation of the elbow, when all means, including the division of the muscles and ligaments, had proved unavailing, M. Blumhardt made a longitudinal incision on each side of the articulation, opened the capsule, freely divided the fibrous adhesions, and replaced the bones. The limb is said to have recovered its natural mobility, and the patient was able to resume his occupation as a carpenter. (*Gaz. Méd.* 1847, p. 238.)

Of late years, the ordinary extension and counter-extension has in some cases been dispensed with altogether, and reduction has been effected by manipulating the dislocated limb in different directions. This plan has been especially successful in dislocations of the hip joint, in many instances of which the reduction has been effected with astonishing facility by the unaided efforts of the surgeon. For a description of the mode of proceeding, the reader is referred to the portion of this article devoted to dislocations of the hip joint. It was in the first instance especially advocated and successfully practised by the surgeons of Guy's Hospital.]

The reduction of a dislocation is known by the limb recovering its natural length, shape, and direction, and being able to perform certain motions, not possible while the bone was out of its place. The patient experiences a great and sudden diminution of pain; and, very often, the head of the bone makes a noise at the moment when it returns into the cavity of the joint.

In order to keep the bone from slipping out of its place again, we have only to hinder the limb from moving. When splints will act powerfully in supporting the joint, they are often used, as in dislocations of the ankle, wrist, &c. As the humerus cannot be luxated, except when at some distance from the body, a return of its dislocation will be prevented by confining the arm close to the side in a sling. The spica bandage, applied after such an accident, is more satisfactory to the patient than really efficacious. Whatever bandage is used to keep the arm from moving, should be put on the lower end of the bone, as far as possible from the centre of motion. According to Sir Astley Cooper, the hip is rarely dislocated a second time ; but the humerus, and the lower jaw very frequently slip again from their sockets, which are shallow. Bandages for the prevention of this return of displacement are, therefore, in such cases, particularly necessary. Rest is required for some time after the reduction, in order that the ruptured ligaments may unite. The strength of the muscles, &c. will also be greatly promoted by friction, and pouring cold water over the limb. (*On Dislocations*, p. 35.)

[*Congenital dislocations* are occasionally met with in the hip, shoulder, wrist, and other joints ; they appear to be most frequent in the hip. On their mode of origin much has been written, and their occurrence has been variously explained by different surgeons. Breschet, Dupuytren, and others have looked upon them as the result of arrest of development of the bones and their sockets. Chelius and Cruveilhier ascribe them to the position of the fœtus in the womb. Guérin considers them as the product of an active or primary retraction of the muscles, the remote cause of which is to be sought in the affection of some central part of the nervous system, and that they result from the same causes as club-foot, wryneck, &c.; violence during parturition may be mentioned as another mode of their production. The examination after death in congenital dislocations has shown various alterations, such as distension and tearing of the capsular and other ligaments, diminution, flattening, distortion of the head of the bone, diminution of the socket, its filling up with a quantity of fat, flattening or entire disappearance, a more or less deep new cavity for the dislocated head ; the muscles surrounding the joint contracted, shortened, and variously altered in their substance ; considerable wasting in the affected limb.

The possibility of reducing congenital dislocations depends upon the changes which the muscles have undergone in their direction, dimensions, structure, and texture ; on the change in the ligaments and capsules, the head and surfaces of the joints; on the changes of the vessels and nerves, of the cellular tissue and skin, and of the bones in the neighbourhood of the dislocation. Reduction is to be effected by long-continued and gradually-increased extension by means of proper apparatus, and by properly fixing the head of the bone in the socket after it has been brought into it. If the shortened muscles will not lengthen, but project considerably, extension should be assisted by cutting them through beneath the skin. (*Chelius, Syst. of Surg. translated by South*, vol. i. p. 770.)

For further information on this subject, see *Palletta, Exercit. Pathol.* p. i. 1820. *Scarpa, Mémoire, sui. Piedi Torti Congeniti*, 1803. *Dupuytren, Mém. sur le Déplacement Orig. ou Congén. de la Tête des Fémurs ; Répert. Gén. d'Anat.* 1826, t. ii. *Chelius, Syst. of Surg. translated by South*, vol. i. p. 769, 1847. *Guérin ; Recherches sur les Lux. Congén., Gaz. Méd.* 1841. *R. W. Smith, On Fractures and Dislocations*, Dublin, 1847. *Cruveilhier, Traité d'Anat. Pathol.* t. i. 1849. *Robert, Des Vices Congén. de Conform. des Artic.; thèse de concours*, 1851. *Malgaigne, Traité des Fract. et des Lux.* t. ii. p. 260, 1855. *Parise, Archiv. Gén. de Méd.* 1842, t. xiv. p. 428.]

Dislocation with fracture.—[When a dislocation is complicated with fracture of the shaft of the dislocated bone, the difficulties in the treatment of the case are greatly increased, and the more so, in proportion as the fracture is situated near to the dislocation. In these cases, Sir A. Cooper advised that an endeavour should be made to reduce the dislocation without loss of time, taking care that the fractured part is strongly bandaged in splints, to prevent injury to the muscles ; for if the reduction be not accomplished at first, it cannot be afterwards attempted without danger of reproducing the fracture. (*On Dislocations, &c. ed. by B. Cooper,* p. 13.) Several cases are recorded of dislocation of the shoulder complicated with fracture of the neck of the humerus, where the head of the bone has been successfully replaced ; of dislocations of the hip which have been reduced notwithstanding fracture of the shaft of the femur ; of the elbow joint with fracture of the radius and ulna. Occasionally, however, when immediate reduction could not be obtained, it has been successfully accomplished after the fracture had united. Two cases of this kind, one at the shoulder, and the other at the elbow, are mentioned by Malgaigne. The advice given by this latter authority is, first to attempt immediate reduction of the dislocation; should the attempt fail, then to favour the consolidation of the fracture with a view to reduction at a later period; and lastly, should this be impossible, to endeavour to restore as far as possible the functions of the member by well-directed movements persevered in for a long period. (*Traité des Fract. &c.* t. ii. p. 211.) See DISLOCATIONS OF SHOULDER, HIP, AND ELBOW JOINTS.]

COMPOUND DISLOCATIONS

mean such as are attended with a wound communicating with the cavity of the injured joint. Some joints are more disposed than others to compound dislocations. The accident scarcely ever takes place at the hip. Sir Astley Cooper has known one instance of it at the shoulder, and he has seen one of the knee ; but the case is very frequent in the ankle. (*On Dislocations*, p. 19.) In most instances, the opening in the skin is caused by the protrusion of the bone, but sometimes by the part having struck against a hard or an irregular body. Cases of this description are frequently attended with great danger ; and the same nicety of judgment is requisite in determining whether amputation ought to be immediately performed, or an effort made to preserve the limb, as in compound fractures, and bad gunshot injuries ; and many of the observations which I shall have to offer upon the latter subjects will be applicable to the present.

When the dislocation of a large joint is conjoined with an external wound, leading into the capsular ligament, the latter circumstance has a particular tendency to increase the danger. In many cases, injuries of this description are followed by violent and extensive inflammation, abscesses, mortification, fever, delirium, and death. When the patient is advanced in years, much debilitated, or of an unhealthy irritable constitution, a compound luxation, especially if attended with severe contusion and other injury of the soft parts, often has a fatal termination. A man, above the age of seventy, and much addicted to drinking, was brought into University College Hospital with a compound dislocation of the first phalanx of his right thumb. The dislocation was reduced; but considerable swelling and a livid redness of the hand ensued, with a small irregular pulse; and death occurred in about a week from the time of the accident. This, however, is not the general event of compound dislocations; and whatever may have happened in former times, we now know, that, in the present improved state of surgery, and in moderately good constitutions, these accidents mostly admit of cure. This statement may be made, without any censure being cast upon every instance of amputation performed in such cases. I know that this operation is sometimes indispensable directly after the accident, and I am equally aware, that it may become necessary in a future stage, when extensive abscesses, or sloughing, joined with threatening constitutional symptoms, have taken place. My only design is to recommend the endeavour to cure the generality of compound luxations. But, if a case were to present itself, attended with serious contusion and laceration of the soft parts, I should be as earnest an advocate for amputation as any surgeon.

Sir Stephen Love Hammick, in speaking of compound dislocations of the ankle, advises amputation, "where the lower heads of the tibia and fibula are very much shattered; where, together with the compound dislocations of these bones, some of the tarsal bones are displaced and injured; where any large vessels are divided, and cannot be secured without extensive enlargement of the wound, and disturbance of the soft parts; where the common integuments, with the neighbouring tendons and muscles, are considerably torn; where the protruded tibia cannot by any means be reduced; and where the constitution is enfeebled at the time of the accident, and not likely to endure pain, discharge, and length of confinement." (*A. Cooper's Surgical Essays*, part ii. p. 146.) Perhaps, as general remarks, these may not be inaccurate; but there are exceptions to them. Thus we find in Sir A. Cooper's publication, several cases, in which compound dislocations of the ankle terminated well, notwithstanding the displacement and removal of the astragalus, other instances of which kind of success are to be found in the records of surgery. (See *Laumonier*, in *Fourcroy Méd. Eclairée*; *Percy*, in *Journ. de Méd. continué*, Nov. 1811, p. 348; *Professor Stevens, of New York*, see *Reese's American ed. of this Dict.*) However, if the ends of the tibia and tarsal bones, especially the astragalus and os calcis, are broken, the operation of amputation is recommended on high authority. (*Sir A. Cooper's Surg. Essays*, part ii. p. 181.) But, with regard to the division of large blood-vessels, Sir A. Cooper states that he would not at once proceed to amputation on that account. "The case from Mr. Sandford, of Worcester, sent me by Mr. Carden, clearly shows, that the division of the anterior tibial artery does not, if it be well secured, prevent the patient's recovery. I also once saw a compound fracture, close to the ankle-joint, accompanied by a division of that artery; and, although the patient was in the hospital, and a brewer's servant, who possessed the worst constitution to struggle against severe injuries, yet this man recovered without amputation." Nor, in Sir A. Cooper's opinion, would all hope be precluded, even if the posterior tibial artery were injured. (Vol. cit. p. 186.) For the method of securing these vessels, see ARTERIES.

The following are the circumstances, which Sir A. Cooper has known give rise to the necessity for amputation in compound dislocations of the ankle. 1. The advanced age of the patient. 2. A very extensive lacerated wound. 3. Difficulty of reducing the ends of the bones he considers rather as a reason for sawing them off, than for amputation. 4. The extremely shattered state of the bones. 5. Dislocations of the tibia outwards cause greater injury of the bones and soft parts, than those inwards, and more frequently require amputation. 6. Sometimes the bone cannot be kept reduced owing to the tibia in the dislocation outwards being obliquely fractured. 7. Division of a large blood-vessel, attended with extensive wound of the soft parts. 8. Mortification. 9. Excessive contusion. 10. Extensive suppuration. 11. Necrosis, where the sequestra do not admit of removal. 12. Very great and permanent deformity of the foot. 13. When tetanus comes on, Sir A. Cooper does not approve of the operation. 14. A very irritable state of constitution, such as is often met with in very fat subjects, who take no exercise. (*On Dislocations, &c.* p. 332, &c.)

The treatment of a compound dislocation requires the reduction to be effected without delay, and with as little violence and disturbance as possible. When the extremity of the bone protrudes, and is smeared with sand or dirt, as frequently happens from its having touched the ground, "it should be washed with warm water, as the least extraneous matter admitted into the joint will produce and support a suppurative process, and the utmost care should be taken to remove every portion of it adhering to the end of the bone. If the bone be shattered, the finger is to be passed into the joint, and the detached pieces are to be removed, but this is to be done in the most gentle manner possible, so as not to occasion unnecessary irritation; and if the wound be so small as to admit the finger with difficulty, and small loose pieces of bone can be felt, the integuments should be divided with a scalpel, to allow of such portions being removed without violence." (*Sir A. Cooper, On Dislocations*, p. 254.) If any difficulty of reduction should arise from the bone being girt by the integuments, the opening in them should be dilated with a scalpel, and the limb is then to be placed in splints, with the necessary pads, eighteen-tailed bandage, &c. Sir A. Cooper judiciously recommends the portions of this bandage not to be sewn together, "but passed under the leg, so that one piece may be removed when it becomes stiff;" and by fixing another to its end, before it is withdrawn, the fresh piece may be applied, without any disturbance to the limb. (*Surg. Essays*, part ii. p. 120.) Or the limb may be laid on M'Intyre's apparatus, with which a common roller will answer even better than the eighteen-tailed bandage. The wound is to be freed from any dirt, clots of blood, or other extraneous matter, and its lips are to be accurately brought together with strips of adhesive plaster. The joint is to be covered with linen, kept constantly wet with the liquor plumbi acetatis dilutus, or, with what is better, spirit of wine and water; the bandage is to be loosely laid down, and the splints fastened on the limb with their proper straps, or pieces of tape, and the limb is to be kept perfectly at rest in an eligible posture. The patient, if strong and young, is to be bled. An anodyne, the first night or two, will be highly proper. Saline draughts and a low regimen are also indicated during the first few days of the symptomatic fever, which commonly follows.

According to Sir A. Cooper, purgatives should be used with the utmost caution; "for (says he) there cannot be a worse practice, when a limb has been placed in a good position, and adhesion is proceeding, than to disturb the processes of nature by the frequent changes of position which purges produce; and I am quite sure, that, in cases of compound fracture, I have seen patients destroyed by their frequent administration."

If the case take a favourable course, the constitutional fever will not be excessive, nor will the pain and inflammation of the limb be immoderate. Sometimes the wound will unite, more or less, without suppuration; a circumstance particularly desirable, as tending more than anything else to lessen the danger, by changing the case, as it were, from a compound into a simple one. In other cases, the wound is not united, but the inflammation and suppuration are not violent or extensive, the constitution is not dangerously disturbed, and hopes of ultimate success may be reasonably entertained. When the wound is disposed to heal favourably, adhesive plaster, with or without lint, or a pledget of soft soap cerate, is the best dressing. In other instances, while the suppuration is copious, and the parts are tense and painful, emollient poultices are the most eligible.

When the symptomatic fever and first inflammatory symptoms are over, and much discharge prevails, attended with marks of approaching weakness, the patient is to be allowed more food, and directed to take bark, cordials, porter, wine, &c. If his nights are restless, he must have opiates; if he sweats profusely, sulphuric acid; and, in short, all such medicines as his particular complaints may require, are to be prescribed.

When the inflammation of a compound dislocation is violent or extensive, general bleeding, the application of leeches, and the use of fomentations and poultices, are the most likely means of lessening the mischief. Yet, it is only in strong habits that venesection to any extent can be prudently practised in large cities, or crowded hospitals.

In certain examples, the most skilful treatment is unavailing. The joint and limb become affected with considerable pain and swelling; the fever runs high; delirium comes on; and the patient may even perish from the violence of the first symptoms, the limb being generally at the same time attacked by gangrene. If these first dangers are avoided, the wound may yet not heal favourably; the inflammation may be considerable, or of an erysipelatous nature; large abscesses under the fascia may be formed; the bones may be affected with necrosis; and the hectic symptoms and sinking state of the patient may make the only chance of recovery depend upon amputation. But even this operation is sometimes deferred till too late, and the patient must be left to his fate.

Whoever gives the smallest reflection to the nature of compound luxations, will perceive, that it is often a matter of the highest importance to make a right decision at the very beginning, whether amputation should be immediately done, or an attempt made to save the limb. In some instances, the patient's sole chance depends upon the operation being performed at once, without the least delay, and the opportunity of doing it never returns. The surgeon should take off the limb as soon as he has seen the nature of the injury, and not wait till a general tendency to swelling and gangrene has spread through the member, and every action in the system is disturbed. Amputation, under the latter circumstances, is sometimes unadvisable, the system not being in a condition to bear it, and every surgeon knows, that when the operation is performed for a spreading gangrene, it is always performed with a very diminished chance of success. Indeed, until certain facts were adduced by Baron Larrey, Mr. Lawrence, Mr. A. C. Hutchison, and others, it was not long ago altogether prohibited. (See AMPUTATION and MORTIFICATION.)

But, besides this first critical period, the surgeon often has to exercise a nice degree of judgment in a future stage of the case; I mean when the suppuration is copious, the wound open, the bones affected with necrosis, and the health impaired. Here the practitioner may sometimes err, in taking off a limb that might be saved; or, he may commit a worse fault, and make the patient lose his life in a fruitless attempt to save the member. No general precepts can guide the practitioner aright in this delicate part of surgery; genius alone cannot do it; the opportunity of making observations, and the talent of profiting by them, are here the things which make the consummate surgeon.

It should ever be recollected, in regard to bad compound dislocations, that in young subjects, and in a salubrious air, many cases will do well, which, in old persons, and in the polluted atmosphere of London, and crowded hospitals, would be fatal without amputation.

The constitutions of some individuals are so irritable, that whether an attempt be made to save the limb, or amputation be at once performed, the case has a rapid and fatal termination. According to Sir A. Cooper, persons who are much loaded with fat, "are generally irritable, and bear important accidents very ill; indeed," says he, "they generally die, whichever plan of treatment be pursued." However, he adds, that such corpulent people as take a great deal of exercise, form exceptions to the foregoing remark. (*Surgical Essays*, part ii. p. 195.)

There is a practice in regard to compound dislocations, which I think ought at all events to be adopted only in a few cases: I mean the plan of sawing off the head of the luxated bone. According to Leveillé, this method is recommended by Hippocrates, as a means of accelerating and perfecting the cure. (*Nouvelle Doctrine Chirurgicale*, t. ii. p. 44.) However, it seems not to have done sufficient good in ancient times to have obtained a lasting reputation. In fact, when it was mentioned by the late Mr. Gooch, it had sunk into such oblivion, that it was received as an entirely new proposal. "Compound luxations" (says this author) "are of a more dangerous nature than compound fractures, for very plain reasons; but if a surgeon should judge it advisable to attempt saving a limb under such threatening circumstances, *I am inclined to think, from what I have observed, he will be more likely to succeed by sawing off the head of the bone, especially if it has long been quite out, and exposed to the air.*"

Mr. Gooch afterwards takes notice of a case in which Mr. Cooper of Bungay sawed off the ends of the tibia and fibula, and preserved the limb, the patient being able to walk and work for his bread for many years afterwards. Other examples are also briefly mentioned, in which the lower end of the radius was sawn off, and the head of the second bone of the thumb.

The late Mr. Hey of Leeds was induced to make trial of this plan in a compound luxation of the ankle. The example, however, which he published, is decidedly unfavourable to the practice, as the following passage will show: — "I was in hopes that this patient would have been able to walk stoutly, but in this I was disappointed. He walked indeed without a crutch; but his gait was slow, his leg remaining weak, and his toes turning outwards, which rather surprised me, as his leg was very straight when I ceased attending him.

Mr. Hey did not recite this case with the view of recommending a similar practice in all cases of this accident; for he had not always adopted it, nor was he of opinion that the same mode of treatment, whether by replacing the bones, sawing off their extremities, or amputating the limb, ought to be universally practised. When the laceration of the capsular ligament and integuments is not greater than is sufficient to permit the end of the tibia to pass through them; and when, at the same time, the joint or contiguous parts have suffered no other injury, Mr. Hey recommends the replacing of the bone, and a union of the integuments by suture, with the treatment adapted to wounds of the joints. (*Practical Obs. in Surgery*, chap. xi. ed. 2.)

The most ingenious arguments, which have yet been urged in behalf of the practice of sawing off the ends of the bones, in compound dislocations of the ankle, are those recently published by Sir A. Cooper. However, he does not advise the plan without restrictions. If the dislocation (says he) can be easily reduced, without sawing off the end of the bone; if it be not too obliquely broken to remain firmly upon the astragalus after being reduced; if the end of the bone be not shattered, for then the small loose pieces of bone should be removed, and the surface of the bone be smoothed by the saw; if the patient be not excessively irritable, and the muscles affected with violent spasms, impeding reduction, and causing a displacement of the bones after they have been reduced; he advises the immediate reduction of the parts, and uniting the wound by adhesion. In the opposite circumstances, rather than amputate the limb, he would saw off the ends of the bones. (*Surgical Essays*, part i. p. 154; and *Treatises*, p. 302.)

M. Roux gives much praise to the English surgeons for the judicious boldness which they have evinced in cases of this description. Although Fabricius Hildanus, Ferrand, Desault, Laumonier, and several other French surgeons, have, like many British practitioners, ventured to remove the whole of the astragalus, when this bone was totally separated from the scaphoid, and protruded in compound luxations; yet M. Roux acknowledges, that the bold practice of sawing off the lower end of the humerus, the lower end of the radius, the lower end of the tibia, and also of the fibula at the same time, originated with, and was first executed by, English surgeons. (*Parallèle de la Chirurgie Anglaise avec la Chirurgie Française*, p. 208, 209.)

The foregoing general observations will now enable us to enter upon the dislocations of each particular joint.

DISLOCATIONS OF THE LOWER JAW.

The lower jaw can only be luxated forward, and either one or both of its condyles may become displaced in this direction. [The dislocation of both condyles together is more frequent than that of one condyle singly; out of seventy-six cases collected by Malgaigne, he found that in fifty-four both condyles were implicated. (*Traité des Fract. &c.* t. ii. p. 288.)]

Every dislocation, except that forward, is rendered impossible by the formation of the parts. [One exception only has been recorded, in which the condyle was dislocated *outwards*, and rested against the external surface of the zygomatic process, but in this case there was also a fracture of the bone a little anterior to its ramus. (See *Robert, Journ. de Chir.* 1844, p. 265, and *Malgaigne*, loc. cit. p. 317.)]

The lower jaw cannot even be dislocated forward, unless the mouth, just before the occurrence of the accident, be very much open. Whenever the chin is considerably depressed, the condyles slide from behind forward, under the transverse root of the zygomatic processes. The cartilaginous caps which envelop the condyles, and follow them in all their motions, still afford them an articular cavity; but, the depression of the bone continuing, the ligaments give way, the condyles glide before the *eminentiæ articulares*, and slip under the zygomatic arches. Hence a dislocation mostly happens while the patient is laughing, gaping, &c. A blow on the jaw, a spasm, or any irregular action of the muscles, when the mouth is wide open, may easily cause the accident. It has occasionally arisen from the exercise of great force in drawing out the teeth. Sir Astley Cooper has known a luxation of both condyles, produced by a boy suddenly putting an apple into his mouth, to keep it from the reach of a playfellow. (*On Dislocations*, p. 389.) Whenever the jaw has once been dislocated, the same causes more easily reproduce the occurrence. In certain individuals, the ligaments are so loose, that a dislocation is produced by any slight attempt to yawn, laugh, or (as Lamotte has observed) to bite any substance which is rather large. (*Leveillé, Nouvelle Doctrine Chir.* t. ii. p. 54.) There have been persons, who could scarcely ever laugh heartily, without their lower jaws being luxated. But, of all the causes of this occurrence, yawning alone, even without the combination of any external force, is by far the most common.

When the jaw is depressed, if the muscles contract, the anterior fibres of the masseter tend to bring the condyles under the zygoma. The external pterygoid muscle will also contribute to produce the same effect.

Dislocations of the lower jaw are attended with a great deal of pain, which may be imputed to the pressure produced by the condyles on some of the branches of the third division of the fifth nerve, and to the tension to which its inferior dental branch is subjected. The mouth is wide open, and cannot be shut. It is more open in recent dislocations than in those which have continued for some time. An empty space is felt before the ear, in the natural situation of the condyles. The coronoid process forms under the cheek-bone a prominence, which may be felt through the cheek or from within the mouth. [When an attempt is made to close the mouth, the coronoid process comes in contact with the lower margin of the malar bone, close to its junction with the superior maxilla, and further approximation is thus effectually prevented. M. Nélaton considers the contact of these two points of bone to be an indispensable condition of true dislocation, that is to say, of a *permanent* displacement, and that without it, the reduction would take place almost spontaneously. Hence he thinks this accident will necessarily be rare, because in all subjects the coronoid process is not of sufficient length to come in contact with the malar tuberosity. In children, for instance, in whom this process is very short, and in old persons, in whom it is directed obliquely backwards, the accident is almost unknown. (See *Elem. de Pathol. Chir.* t. ii. p. 313.)] The cheeks are flattened by the lengthening of the masseter and buccinator muscles. The saliva flows in large quantities from the mouth, the secretion of which fluid is greatly increased by the irritation of the parotid gland. The arch, formed by the teeth of the lower jaw, is situated more forward than that formed by the teeth of the upper jaw, and the axis of the teeth is directed obliquely forwards instead of vertically upwards. During the first few days after the accident, the patient cannot speak, and, according to Boyer, he cannot swallow. When only one condyle is dislocated, the mouth is distorted, and turned towards the opposite side, while the fellow-teeth of the jaws do not correspond. However, Mr. Hey asserts, that frequently the position of the chin is not perceptibly altered. (*Practical Obs.* p. 322.) The mouth cannot be shut; but it is not so widely open as in the complete luxation. (*Sir A. Cooper, On Dislocations*, p. 392.)

When a dislocated jaw has remained unreduced for several days or weeks, the symptoms are not so well marked. In such instances, the chin becomes gradually approximated to the upper jaw; the patient recovers by degrees the faculty of speaking and swallowing; but he stammers, and the saliva dribbles from his mouth. The sufferings induced by a dislocated jaw, it is said, may even prove fatal, if the case continue unrectified; but we are not to believe Hippocrates when he positively declares the accident mortal, if not reduced before the tenth day. Indeed, Sir Astley Cooper, in noticing the severity of the pain, assures us that he has never seen any dangerous effect produced; on the contrary, that in time the jaw becomes more closed, and a considerable degree of its motion is restored. (*On Dislocations*, p. 389.)

Dislocations of the lower jaw may be reduced in the following manner: — The surgeon is first to wrap some linen round his thumbs, to keep them from being hurt by the patient's teeth, and then introduce them into the mouth, as far as possible along the grinding teeth. At the same time he is to place his fingers under the chin and base of the jaw; and while he depresses the molares with his thumbs, he raises the chin with his fingers, by which means the condyles become disengaged from their situation under the zygomas; at which instant the muscles draw the condyles so rapidly back into the articular cavities again, that the surgeon's thumbs might sometimes be hurt, did he not immediately move them outward between the cheek and the jaw.

The ancients used to place between the grinding teeth two pieces of stick; and while they used them as levers to depress the back part of the bone, they raised the chin by means of a bandage. The late Mr. Fox, the dentist, had a patient, whose jaw had been dislocated on both sides, in the extraction of a tooth: the reduction was first effected on one side, by placing a piece of wood, a foot long, upon the grinders, and then raising the part of it that was held in the hand. Mr. Fox next reduced the other condyle in the same manner. Sir Astley Cooper, in reducing a complete luxation of the lower jaw, prefers putting the patient in the recumbent posture, introducing two corks behind the molar teeth, and then elevating the chin. (*On Dislocations*, p. 391.) When only one condyle is dislocated, whatever method of reduction be followed, it need only be applied to the side affected.

The reduction having been accomplished, a fresh displacement is to be prevented by applying a four-tailed bandage, as recommended for fracture of the jaw. For a few days, the patient should avoid all food requiring much mastication.

[M. Nélaton does not consider it necessary to elevate the chin; on the contrary, he directs the patient to open his mouth as widely as possible; the sole indications, according to him, being, first to disengage the coronoid process from the malar bone, and then to press it backwards, when the action of the muscles will accomplish the rest. In a case in which repeated attempts at reduction had been made by other surgeons without success, M. Nélaton proceeded in the following manner. He ordered the patient (a female) *to open her mouth as much as possible*, and while she executed this movement, he placed his two thumbs on the coronoid processes, and without even embracing the jaw or taking any other point of support, a simple pressure in the backward direction caused the condyles to return suddenly into their cavities; the reduction was complete, and all the symptoms disappeared. Two other cases of the successful application of this process are recorded by M. Nélaton. The pressure may be made either from within the mouth, or from without through the cheek; and the coronoid process should be pushed downwards and backwards at the same time that the patient opens his mouth. In ordinary cases, a light pressure is sufficient, but if more force is required, the head may be supported by an assistant, or a band looped at each end may be passed around it, in which the operator can engage his fingers, while the thumb is brought to bear upon the coronoid process. (See *Dublin Quart. Jour.* vol. x. p. 114, 1850.)

An interesting account of the dissection of a remarkable case of *congenital dislocation* of the lower jaw has been given by Mr. R. W. Smith (*On Fractures and Dislocations*, p. 273)].

DISLOCATIONS OF THE SPINE.

[Dislocations of the vertebræ are less frequent than fractures of these bones; indeed, a dislocation, pure and simple, uncomplicated by fracture of any of the processes, is exceedingly rare. The liability to dislocation varies in the different regions of the spine; it is most common in the articulation between the atlas and axis, but throughout the cervical portion of the spinal column, in consequence of the greater mobility there permitted, and the oblique direction of the articular surfaces, it is much more likely to occur than in the dorsal or lumbar regions; in these latter situations it has often been described as absolutely impossible unless accompanied by fracture. Facts, however, have been placed on record which show that even here it is now not altogether unknown.

Dislocations of the spine will require a separate consideration according to the situation in which they occur. They will be treated of in the following order.

1. Dislocation of the head from the first vertebra or atlas.
2. Dislocation of the first cervical vertebra from the second.
3. Dislocation of the six inferior cervical vertebræ.
4. Dislocation of the dorsal and lumbar vertebræ.]

[1. *Dislocation of the head from the first cervical vertebra.* — Only three examples of this dislocation have been met with. The first was observed by M. Lassus. A bundle of hay fell from a height of fifteen or sixteen feet on the posterior part of the neck of a man whose head was at the moment bent forwards. He immediately lost speech and consciousness. The head remained inclined forwards and a little to the left. The mouth was half open, and the upper extremities convulsed. He died in five or six hours. "The condyles of the occipital bone were disunited and separated about three or four lines from the apophyses of the first vertebra of the neck." The right vertebral artery and vein were ruptured.

The second was published by M. Palletta. A man fell from a tree, head first. The fourth day he was brought to the hospital, being perfectly conscious, but pulseless, and in a state of extreme debility, the bladder and lower extremities paralysed. He died the next day. The atlas was found to be "displaced, and its articulation with the occipital bone loosened." There was also a fracture of the fourth cervical vertebra, but without displacement.

The third case was recorded by M. Bouisson. A youth of sixteen had his neck crushed by the overturning of a cart, from beneath which he was extricated lifeless. "The atlas, and especially its right lateral mass, had undergone a movement of projection forwards, which had carried the right articular surface in front of the occipital condyle. The right occipito-odontoid ligament was ruptured; but the left remained entire, and prevented the luxation taking place on this side. In consequence of the displacement of the atlas forwards and to the right, its posterior arch encroached upon the occipital foramen, and compressed the medulla oblongata. There was no fracture either of the atlas, axis, or occipital bone. The articulation between the atlas and axis was uninjured. (See *Lassus, Pathol. Chir.* t. ii. p. 196; *Palletta, Exercit. Pathol.* 1820, p. 234; *Bouisson, Revue Méd. Chir. de Paris*, t. ii. p. 355, and *Malgaigne, Traité des Fractures, &c.* t. ii. p. 320.)]

Dislocations from Disease.—Five examples of *displacement of the atlas by disease* are in the museum at Leyden, and are described by Sandifort. Boyer has seen one at La Charité; and an interesting description of a similar case, illustrated by engravings, has been recently published by Schupke, (*De Luxatione Spontaneâ Atlantis et Epistrophei*, 4to. Berol. 1816.) In this tract is collected, from the writings of J. P. Frank (*Delect. Opusc.* vol. v.), from those of Reil (*Fieberlehre*, b. ii. § 102), and of Rust, &c. an exact detail of the symptoms of the disease; an important topic, on which Boyer confesses his inability to give any information. The symptoms have been described by Mr. Lawrence as follows:—"Pain in the neck, becoming more severe at night, or in swallowing a large mouthful, or drawing a deep breath, is the first symptom. This pain affects one side of the neck, especially when the head is moved towards the shoulder; it extends from the larynx towards the nape, and often to the scapula of the pained side. No external alteration is perceptible; but firm pressure on the region of the first and second vertebræ produces considerable pain, and thus points out the seat of disease. The difficulty of swallowing and breathing, and hoarseness, increase, alternating with pain in the neck, which seems to fix about the back of the head, and becomes intolerable on moving that part. The head sinks towards one shoulder, the face being turned a little down; for, in general, the articulations are affected on one side only, and that was the left in seven out of nine examinations after death. If both sides are affected, the head will incline directly forwards. In this state things continue for several weeks or months; and before worse symptoms come on, there is often apparent improvement, freer motion, and more natural situation of the head. But, the uneasiness in speaking and swallowing returns; the pain becomes more severe and extensive; the head falls a little backwards, and shrinks towards the opposite side. The patient feels as if the head were too heavy, and he carefully supports it with his hands, when he moves from the sitting to the lying position, or *vice versâ*. This may be considered a pathognomonic symptom of the affection. Another symptom, which, at this period, shows the true nature of the disease, is a peculiar expression of pain in the countenance, which, combined with the position and stiffness of the head, constitutes so characteristic an assemblage of appearances, that it is enough to have seen it once, in order to recognise it again immediately. In the further progress of the case, noise in the head, deafness, giddiness, cramps, and convulsions, partial paralysis, particularly of the upper limbs, loss of voice, purulent expectorations, and hectic symptoms supervene. Generally no external change is observable, either in the neck, or in the nape; and Rust observed, in one case only, swelling of the affected side, which broke and left fistulous ulcers. But the slightest pressure in the region of the three upper vertebræ is acutely painful, and sometimes, in the advanced period of the disease, a grating of rough surfaces is distinctly perceptible when the head is turned. The patient may continue for months in this helpless and painful state, and then dies, either from exhaustion and debility, or, which is more frequent, suddenly and unexpectedly."

(*Lawrence*, in *Med. Chir. Trans.* vol. xiii. p. 406.) These spontaneous displacements of the atlas may depend upon caries and scrofulous disease of its articular surfaces, or upon an exostosis of its transverse process, or a similar tumour growing from the neighbouring portion of the os occipitis, or petrous portion of the temporal bone. By these causes, the anterior, or posterior arch, or one of the sides of the atlas, has been made to intercept a third, the half, and even two-thirds, of the diameter of the foramen magnum. Notwithstanding these changes, life may be carried on, and the nutritive functions performed sufficiently well to afford time enough either for the exostoses to attain a large size, or for the ankylosis, binding together the head and most of the cervical vertebræ, to acquire great solidity. The size of the foramen magnum, and the dimensions of the vertebral canal in the neck, are considerably beyond what would be necessary for simply containing the spinal marrow, so that the free lateral movements of the head and atlas can be executed without any risk of pressure on that important part. Hence spontaneous displacement can occur in these cases to a considerable degree, without impairing the functions of the spinal cord. (*Lawrence*, in *Med. Chir. Trans.* vol. xiii. p. 411.) According to Boyer, the atlas is never found free and distinct, when thus displaced; but is confounded at least with the os occipitis, and mostly with five or six of the subjacent vertebræ. And, another interesting fact is, that, in cases of this description, the joint between the atlas and occiput is never the only one which is displaced and deformed, unless the disease be very slightly advanced; for, the articulation of the processus dentatus with the atlas, and sometimes that of the point of the same process with the occiput, are considerably affected. Sometimes the processus dentatus and the occiput retain their natural position with respect to each other, and the atlas alone seems to be displaced between them. Sometimes the second vertebra is out of its place with respect to the os occipitis, in the same direction as the atlas, but not in quite so great a degree. Lastly, in some other instances, the two vertebræ are twisted in opposite directions; as, for instance, one to the left, the other to the right; or *vice versâ*. In one of the cases, recorded by Sandifort, this kind of lateral displacement in opposite directions was so extensive, that an interspace, only six lines in breadth, was left between their approximated annular margins. An instance was seen by Duverney, where the displacement of the two vertebræ was from before backward, and where the processus dentatus was approximated to the posterior arch of the atlas to the extent of two-thirds of the annular opening in this vertebra. In these cases, nothing can be more obvious, than that there must be a destruction, or, at all events, a thoroughly diseased state of the ligaments between the atlas and dentata, and of those connecting the dental process to the occiput. (*Boyer*, vol. cit. p. 105.)

As for the treatment of the preceding forms of disease, experience has hitherto furnished little satisfactory knowledge. But, as an analogy is seen between these cases and the scrofulous and carious affections of other joints, blisters, setons, and issues, have been proposed and tried. Rust found these remedies only capable of retarding the progress of the disease, and of producing an abatement of the symptoms. The pain often reaching from the back of the head to the forehead, was rendered less severe; and the difficulty of swallowing was considerably lessened. But the means here specified were not found adequate to arrest the morbid change in the bones. However, Rust thinks that greater benefit might be expected, if a case were to present itself arising altogether from a local cause, without its origin being connected with constitutional disease. (*Salzburger*, *Med. Chir. Zeitung*, *jahrgang*, 1813, b. ii. p. 108.) In a later work, he adverts to some examples, in which a cure was effected by nature. Indeed, the occasional termination of the disease by ankylosis is a full proof of this fact. (*Arthrokakologie*, § 118.)

2. *Dislocation of the first cervical vertebra from the second.* — The rotatory motion of the head is chiefly performed by the first vertebra moving on the second. When this motion is forced beyond its proper limits, the ligaments which tie the processus dentatus to the edge of the foramen magnum are torn; and, supposing the head to be forced from the left to the right, the left side of the body of the second vertebra is carried before its corresponding articulating surface, while the right side falls behind its corresponding surface. Sometimes the processus dentatus, whose ligaments are ruptured, quits the foramen formed for it by the transverse ligament and the anterior arch of the first vertebra, and presses on the medulla oblongata. But, according to Boyer, the processus dentatus may be displaced in two ways: 1st, It may be carried directly backwards, the transverse and other ligaments being broken. This mode of displacement Boyer considers as the most difficult and uncommon, as it can hardly take place except from a fall from a great height upon the back of the head, while the spine is bent forwards. (*Traité des Mal. Chir.* t. iv. p. 109.) However, the accident may happen in another manner, as in Sir C. Bell's instance, where it occurred from the chin striking against a curb-stone. (*Surg. Obs.* vol. i. p. 150.) 2ndly, In a violent rotation, in which the face is carried sideways beyond the proper limits, the lateral and accessory ligaments of the processus dentatus may be stretched and twisted spirally round this process. The force operates entirely upon them, and not at all upon the transverse ligament. Now when the lateral and accessory ligaments of the processus dentatus have given way, and an effort to incline the head to one side is kept up, one of the sides of the space, bounded by the transverse ligament, may present itself near the point of the processus dentatus, which may then pass below the transverse ligament without rupturing it.

In children, where the processus dentatus is not fully developed, and the ligaments are weaker than in the adult, a perpendicular impulse may break the lateral and accessory ligaments, and then force the processus dentatus under the transverse ligament, without rupturing this latter part; as Boyer conceives must have been the case in the child, which J. L. Petit mentions as having been instantaneously killed by being lifted up by the head.

[M. Malgaigne mentions a case in which the odontoid process was displaced behind the transverse ligament, although only one of the odontoid ligaments had given way A man, æt. 60, fell from a considerable height upon his head. The fall caused symptoms of severe " cerebral commotion."

The head was bent backwards, but no dislocation appears to have been suspected. He died in 20 hours. At the post-mortem examination, the odontoid process was found displaced behind the transverse ligament, and compressing the medulla oblongata. The right odontoid ligament was ruptured, but the left was entire, and was drawn under the transverse ligament. The odontoid process was not displaced backwards to so great an extent as when both odontoid ligaments are torn through, and did not exercise so great an amount of compression upon the medulla. This slighter degree of compression would explain the fact of death not having been, as usual, instantaneous.]

Lastly, when the transverse, lateral, and other ligaments are capable of making very great resistance to a force tending to rupture them all, and to throw the processus dentatus directly backwards, this process, if more slender than common, may be broken near its base, and this portion of it forced back upon the spinal marrow. A case, exemplifying the occurrence, used to be related by Mr. Else in his lectures, and is recorded by Sir Astley Cooper. (*On Dislocations*, p. 348; *Boyer*, vol. cit. p. 110.)

Patients can hardly be expected to survive mischief of this kind in so high a situation; when the transverse ligament is broken, and the processus dentatus is thrown directly backward against the medulla oblongata, the effect must be instant death, as happened in the case recorded by Sir C. Bell (*Surg. Obs.* vol. i. p. 150), and in that mentioned by Mr. Else.

The causes of this formidable accident are various: a fall on the head from a high place; the fall of a heavy body against the back of the neck; a violent blow; a forcible twist of the neck; tumbling; standing upon the head; the rash custom of lifting children up by the head, &c. Louis believed, that the first vertebra was dislocated from the second in the malefactors hanged at Lyons, at which place the executioner used *to give a sudden twist* to the body at the moment of its suspension, and then bear with all his weight upon it. Under such circumstances, Boyer conceives that the processus dentatus might pass under the transverse ligament, without any rupture of the latter.

Perhaps, the only recorded instances of luxation of the processus dentatus, independently of external violence or previous disease, are two; one noticed by Mr. Cruikshank (See *Lond. Med. Gaz.* vol. iii.); the other by Dr. Wm. Thompson (*Edin. Med. and Surgical Journ.* vol. xlii. p. 279.)

With regard to the prognosis of all luxations in which the processus dentatus is displaced suddenly and not gradually by disease, I may observe, that such cases are mostly fatal. Mistaken notions have been entertained upon this point, in consequence of particular dislocations of the neck having been successfully treated. [The diagnosis of such cases is always attended with great difficulty; indeed, it is only when they have terminated fatally, and the parts are examined, that positive information as to the nature of the injury can be obtained. Great uncertainty, therefore, must always attach to those instances in which reduction is supposed to have been effected.]

A child was brought to Desault, with its neck bent, and its chin turned towards the right shoulder. The accident had been a consequence of the head having been fixed on the ground, while the feet were up in the air. A surgeon happened to be with Desault at the time, and they agreed to make an attempt to reduce the luxation, and to apprise the mother, that though the child might be cured, there was a possibility of its perishing under their hands. Being permitted to do what they judged proper, they fixed the shoulders, and the head was gently raised, and gradually turned into its natural position. The child could now move freely; the pain ceased; and a considerable swelling in the situation of the luxation, yet left, was dispersed by the application of emollient poultices. (*Leveillé, Nouvelle Doctrine Chir.* t. ii. p. 62.)

Another alleged instance of the reduction of a dislocation of the neck is recorded. (*Schmucker's Vermischte Chir. Schriften*, b. i.) However, both in this case and that related by Desault, it seems probable, that the accident was not a dislocation of the dentata from the atlas, but a luxation of one of the articular processes of a cervical vertebra lower down.

[M. Malgaigne relates a case under his father's care, where symptoms of this dislocation were present, but in which reduction was successfully effected by making extension from the head, counter-extension being made from the shoulders. The patient recovered, but remained unable to perform the rotatory movements of the head.

Another case of successful reduction has been recorded by M. Ehrlich. In this case the atlas and head were dislocated *backwards*, a most unusual occurrence, of which only one other example has been met with. The head was bent backwards, and is stated to have rested against the right scapula. On the anterior part of the neck, on the left side, was a projection, supposed to be formed by the axis. The patient was paralysed. One assistant was directed to fix the shoulders, while another made extension upon the head. The surgeon, M. Ehrlich, placed the palms of his hands upon the occiput, and, at the same time, pressed with his two thumbs in front upon the projection formed by the axis. After several fruitless attempts, the reduction took place with a distinct noise, the head resumed its usual solidity, and the arms commenced to move. This patient recovered, with some slight stiffness of the neck. (*Ehrlich, Journ. Complément.* t. xxxvi. p. 56, and *Malgaigne*, loc. cit. p. 334.]

When the processus dentatus is fractured, the effects on the medulla spinalis are almost invariably fatal. A case, however, was attended by Mr. Cline, in which the processus dentatus had lost a part of its natural support, in consequence of a transverse fracture of the first vertebra, and in which the child survived the accident a year. (See *Sir A. Cooper, On Dislocations*, p. 549.)

My friend, Mr. Benjamin Phillips, has favoured me with the following very remarkable case, a more particular account of which has been inserted in the Transactions of the Royal Med. Chir. Society of London, vol. xx.:—"Wm. Cross fell from a hayrick to the ground, the occiput first coming in contact with the soil; he was stunned by the accident; but, in a few minutes, was able to walk to the residence of the parish surgeon, by whom he was bled and purged. In two or three days he was enabled to resume his usual avocations.

"The only inconvenience which succeeded to the accident, was inability to rotate the head; and for this symptom, three weeks after the accident, I saw him.

"He complained of a slight tenderness over the superior cervical region, which was a little painful upon pressure, and presented a very inconsiderable tumefaction.

"The conclusion come to was, that either chronic inflammation or caries affected the atloido-axal articulation. Under this impression, leeches were applied every two days for three weeks, without any other benefit than the lessening of the tenderness. By means of caustic potash, an issue was maintained over the point for nearly four months; but rotation of the head was still impracticable.

"After the drying up of the issues, or in about six months from the receipt of the injury, he had an attack of pleurisy, for which it was necessary to resort to very active depletion.

"When he had become convalescent from the pleurisy, symptoms of anasarca were manifested, under which he ultimately sunk, eleven months after the receipt of the injury.

"Sensation and motion, with the exception I have named, were in no degree impaired, and about this there could be no fallacy; for he was accustomed to feed himself while lying on his back, and to walk to the water-closet daily. During the last three months of his life, he had complained of some difficulty in swallowing, and his voice was observed to be rather thick; but, upon looking into the throat, there was no obvious cause for these symptoms.

"After death the cervical region was examined, and, at first sight, no very particular lesion was evident; but, upon more careful examination, it was found that a complete transverse fracture of the atlas had occurred. The anterior moiety of the ring, including the joints of articulation with the occiput, had been carried downwards and forwards in front of the axis, had arrived on the same plane with it, and had become connected to it by perfect bony union. The strength of the transverse ligament, which embraces the neck of the processus dentatus, had been sufficient to retain that organ in its grasp, and, consequently, the latter had been fractured and carried down with it; and to this circumstance the patient, no doubt, owed his life; for had the ligament given way, the process would inevitably have lacerated the spinal cord.

"The morbid specimen is in the possession of Sir C. Bell. The importance of this case arises from its invalidating the principle, so confidently laid down, that such an injury in this region must necessarily be fatal."

[The following case was observed by M. Costes, of Bordeaux:—A boy, æt. 15, was struck on the back of the neck, and thrown to the ground. He experienced some pain in moving his neck, and his head was inclined forwards, but nothing material occurred till four months after the accident, when he was suddenly seized with pain in the right arm and leg, and eight days later all the limbs became paralysed. He was then taken to the hospital; a hard tumour was felt at the back of the neck, towards the right side, while the chin was directed towards the left, and approximated to the sternum. In spite of treatment, he died in a few days. The examination showed that the atlas had been dislocated from the axis forward and towards the left side. The odontoid process had been fractured at its base, and carried forward with the atlas. Its direction was nearly horizontal, and it had become united by bone with the body of the axis. The posterior arch of the atlas was approximated to the body of the axis, so as to leave between them only a sort of transverse cleft. (See *Revue Méd. Chir.* t. xii. p. 303.)]

3. *Dislocation of the six lower cervical vertebræ.*—[Luxations of the cervical vertebræ below the atlo-axoid articulation are occasionally met with. They may take place at any of the articulations between the six lower cervical vertebræ.]

We learn from Mr. Lawrence, that the museum of St. Bartholomew's Hospital contains specimens of luxated cervical vertebræ. In one of these, the right inferior articular process of the fifth vertebra is dislocated forwards. The portion of the vertebral column above the seat of the injury is twisted to the left, and the body of the fifth, having been partially displaced, projects beyond that of the sixth vertebra. This displacement could not have been effected without considerable injury of the fibro-cartilage. The upper and anterior part of the bodies of the sixth and seventh vertebræ has been slightly fractured on the left side. In another case, the inferior articular processes of the fifth cervical vertebra are partially separated from those of the sixth. The bodies of the same bones are partially separated behind. A third specimen exhibits a dislocation of the sixth from the seventh cervical vertebra. The inferior articular processes of the sixth are completely dislocated forwards, and its body projects over that of the seventh. Mr. Lawrence has recorded one case, proving that complete dislocation both of the articular processes and body, without fracture, may occur in the cervical region of the spine. (See *Med. Chir. Trans.* vol. xiii. p. 391—394.) A gentleman, attending my lectures, lent me a specimen of a complete dislocation of the middle cervical vertebræ without fracture. The accident befel a person, who was sitting upon an omnibus as it passed rapidly under a gateway, the upper part of which struck against him with immense violence. Baron Dupuytren has also recorded an instance of a dislocation of the sixth from the seventh cervical vertebræ, without any previous fracture. The patient, a woman fifty-six years old, lived thirty-four hours after the accident. There was total loss of sensibility in the lower extremities and the rectum, bladder, parietes of the abdomen, and all parts below the diaphragm, seemed, as it were, dead. Above this point, the upper extremities were also in a state of incomplete paralysis, with respect both to motion and feeling. Respiration was frequent and laborious; but the speech, senses, motions of the countenance, and intellectual faculties, were not affected, and seemed to belong to another individual. The pulse was full and soft; the tongue dry and brownish; and the skin natural in point of temperature and exhalation. (See *Dupuytren, Clin. Chir.* t. i. p. 390.)

[From the records which we now possess of these dislocations, it appears that the upper part of the spine is most frequently displaced *forwards* upon the lower part. M. Malgaigne, who has carefully investigated the subject, refers to as many as forty-one examples of dislocation forwards, verified by post-mortem examination, while he could only meet with four in which the vertebræ above the point injured had been displaced backwards. The dislocation *forwards* may be considered as presenting two varieties; the *bilateral*, affecting both articular processes; and the *unilateral*, in which only one articular process is displaced. The bilateral, again, according to M. Malgaigne, may be *complete* or *incomplete*. The cases described by Mr. Lawrence, it may be observed, afford examples of each of these three varieties.

In the *complete bilateral* dislocation, of which Malgaigne refers to twenty-three examples, the inferior articular processes of the vertebra above are situated altogether in front of the superior articular processes of the vertebra below, to the notches of which they correspond. The intervertebral fibro-cartilage, and most of the ligaments are torn through, but the anterior common ligament often remains entire, being peeled off from the anterior surface of the vertebræ below. The spinal marrow must, of course, suffer more or less from compression, stretching, or laceration. In one case, seen by Dupuytren, the pharynx was ruptured. Strange to say, the vertebral artery has always been found uninjured. Of the twenty-three cases referred to, two were dislocations of the second vertebra, four of the fourth, six of the fifth, nine of the sixth, and two of the seventh on the first dorsal. Fifteen of these were unaccompanied by any fracture whatever; but in the remaining eight, the articular or some other processes were broken.

A fall or a blow, or any external violence operating in such a manner as to bend the head and neck suddenly and forcibly forwards, may produce this dislocation; the causes, are in fact, very similar to those which have already been mentioned as producing dislocation of the atlas and axis.

The symptoms are, pain at the back of the neck, a bent position of the head forwards, and probably a depression felt posteriorly opposite to the seat of the injury, with a projection just beneath, caused by the spinous process of the succeeding vertebra. Sometimes, by exploration of the pharynx with the finger, a corresponding inequality upon the anterior aspect of the spine may be detected. Complete paralysis of the trunk and lower extremities is the immediate result of the accident, and complete or partial paralysis of the upper extremities according to the level at which it has taken place. All these symptoms, however, equally belong to a fracture of the spine in the like situation, and any degree of accuracy of diagnosis between these two injuries is obviously unattainable.

These dislocations are almost inevitably fatal. Death has usually taken place in from twenty-four to forty-eight hours; but the higher the level of the injury, the sooner may the fatal result be expected. A patient under the care of Mr. Jordan in the Manchester Infirmary, with dislocation of the seventh cervical vertebra, survived for six days. (See *Drew, Lancet*, 1850, vol. i. p. 599.) Another, under the care of M. Roux, lived till the eighth day.

The important question arises, should any attempts at reduction be made. Fear of increasing the mischief and of accelerating the fatal termination, appears for the most part to have deterred surgeons hitherto from making the attempt. Considering, however, that all but certain death must result from non-interference, it appears scarcely consistent with sound surgery not to use every endeavour to remedy what we know to be the principal mischief,—the compression of the spinal marrow by the displaced bone — since it is certainly *possible*, that by judiciously directed efforts, whether the case be one of fracture or of dislocation, this most desirable result may be accomplished. Mr. Gaitskill made the attempt, but without success. (*Lond. Med. Repos.* vol. xv. p. 282.) A case, however, of supposed dislocation of the fifth cervical vertebra, under the care of M. Vrignonneau, terminated more fortunately. On the second day after the accident, death appeared to be imminent, it was therefore resolved to make an effort at reduction. The attempt was successful, and the reduction took place with a sensible crackling noise. The paralysis, and other symptoms, disappeared as if by magic, and two months afterwards the patient was perfectly well, with the exception of some slight stiffness of the neck, and inability to perform lateral movements. (See *Malgaigne*, loc. cit. p. 363.) The attempts at reduction should consist, according to M. Malgaigne, in making extension upon the head, while the trunk is held fixed by the shoulders, (the patient being raised to the sitting position,) and when sufficient extension has been made, the head should be drawn backwards, while the surgeon may with his knee make pressure forwards upon the spine below the seat of the injury.]

[*Incomplete bilateral dislocation.*—One case of this kind is recorded by Mr. Lawrence, and has been already alluded to in this article. M. Malgaigne refers to nine examples of incomplete displacement in the cervical region, where the articular surfaces of the vertebra above were displaced upwards upon those of the vertebra below, but without complete separation. Mr. Lawrence's case is included in the number. When this accident happens, the intervertebral cartilage, ligamenta subflava, and other ligaments, are ruptured to a greater or less extent; there is an increased interval between the spinous processes opposite to the seat of injury, but the body of the vertebra above does not project forward to the same extent as in the complete dislocation. The spinal marrow, it might be expected, would not suffer injury to the same extent as in a complete dislocation; these cases, however, have not been less fatal than the others, for four died within twenty-four hours, and one only lived till the twelfth day. The symptoms of this injury are necessarily obscure. Should its existence be suspected, an attempt at reduction might be made, and it would be more likely to be attended with success than where the dislocation is complete. M. Malgaigne thinks that the incomplete dislocation may sometimes occur, but may undergo immediate and spontaneous reduction without causing any serious injury to the spinal cord.]

Unilateral dislocation. — When dislocations of the cervical vertebræ occur at the third, fourth, fifth, or sixth of these bones, and only one articular process is luxated, the accident is not always fatal. In these instances, the vertebral canal is not so much lessened as to compress the spinal marrow, and occasion immediate death.

According to Boyer, many examples have happened, in which one of the inferior oblique or articular processes of a cervical vertebra, has been dislocated, so as to cause a permanent inclination of the neck towards the side opposite to that of the displacement. (*Mal. Chir.* t. iv. p. 114.)

[M. Malgaigne has collected records of nine fatal cases of this dislocation, and of seventeen in which recovery took place. On referring to the fatal cases, it appears that death does not always follow so immediately as in the complete dislocation: thus, one patient survived forty days, and another as long as a hundred and one days. The paralysis is not always immediate, but may appear at some considerable period after the accident, arising probably from effusion, or consecutive inflammation, rather than from immediate compression.

In some of the cases which recovered, the accident was produced by very slight violence; thus in six it was caused by a sudden turn of the head for the purpose of looking round. The leading symptoms are, according to Boyer, an inclination of the head and rotation of the face to the opposite side; inability to restore the neck to its proper position, and deviation towards the same side of the spinous processes above the seat of dislocation. To these signs may be added, says Malgaigne, the projection of the body of the vertebra forward, recognisable by exploration from the pharynx. If these two latter signs are present, there is not much doubt about the nature of the injury; in some of the cases of alleged recovery, however, the symptoms are scarcely stated with sufficient accuracy to render it certain that a dislocation had really taken place.

Boyer condemned any attempt at reduction, fearing that the mischief to the cord might be thereby increased. Several successful cases, however, are now recorded, and it does not appear that when the attempt was unsuccessful, any harm has resulted. Indeed, in several, the paralysis, which had been previously present, disappeared as soon as the bones were restored to their natural position. M. Malgaigne mentions, amongst these, two which were under his own care, one a girl æt. 13, the other a man æt. 31. In these the reduction, he says, took place with an audible snap, and the neck at once resumed its proper position and liberty of movement. Both were perfectly well in a few days. The proper proceeding is, for the surgeon to place his knees upon the patient's shoulders to make counter-extension, to take the chin in his two hands in order to draw the head upwards first, then towards the side opposite to the dislocation, and the articular process being thus disengaged, to bring it into its place by a movement of rotation.

Dislocations in which the upper part of the spine is displaced *backwards* are, as already stated, much less common than the displacement in the opposite direction. One case of complete dislocation backwards without any fracture, was met with in Haslar Hospital, and has been related by Mr. S. S. Stanley. The subject of the accident was a sailor, who lost his footing, and fell backwards on his head on the deck of his ship. Paralysis ensued, and he died in two days. The dissection exposed a considerable displacement backwards of the 5th from the 6th cervical vertebra. The body of the fifth pressed severely on the spinal cord, and rested on the laminæ and spinous process of the sixth vertebra. Further examination displayed complete ankylosis of the cervical vertebræ from the atlas down to the seat of the injury. (See *Ed. Med.* and *Surg. Jour.* vol. lvi. 1841, p. 404.) Three cases of incomplete dislocation backwards, all terminating fatally, are mentioned by M. Malgnigne; who also relates two cases of supposed dislocation backwards, in which reduction was effected, and the patients recovered. (*Traité des Fract. &c.* t. ii. p. 381.)]

4. *Dislocations of the Dorsal and Lumbar Vertebræ.*—The large surfaces with which these vertebræ support each other; the number and thickness of their ligaments; the strength of their muscles; the little degree of motion which each vertebra naturally has; and the vertical or slightly oblique direction of the articular processes, are generally supposed to make dislocations of the dorsal and lumbar vertebræ impossible, unless there be also a fracture of the above-mentioned processes. Thus, Sir Astley Cooper, in his very extensive experience, had never witnessed a separation of one vertebra from another through the intervertebral substance, without fracture of the articular processes; or, if those processes remained unbroken, without a fracture through the bodies of the vertebræ.

Rust declares, however, that even the lumbar and dorsal vertebræ may be dislocated. (*Arthrokakologie*, p. 71.) Sir C. Bell also describes a case of complete dislocation of the last dorsal from the first lumbar vertebra, with entire division of the spinal cord. A small portion of bone was broken off. (*On Injuries of the Spine and Thigh-bone*, p. 25, pl. 2, fig. 2 and 3.)

In three cases, recorded by Dupuytren, the intervertebral substance was lacerated, and the bodies of the vertebræ were uninjured; but in two of them the spinous, transverse, and articular processes were broken off; while in the third, all these parts were not hurt. (*Clin. Chir.* t. i. p. 395.) These cases can only result from immense violence. The symptoms would be, an irregularity in the disposition of the spinous processes, retention or incontinence of the urine and fæces, paralysis and a motionless state of the lower extremities, and other circumstances, the effects of the pressure or other injury to which the spinal marrow would be subjected. Similar symptoms may also arise when the spinal marrow has merely undergone a violent concussion, without any fracture or dislocation whatever; and there is no doubt that many of the cases mentioned by authors as dislocations of the lumbar and dorsal vertebræ, have only been concussions of the spinal marrow, or displacement with fracture.

[M. Malgaigne enumerates thirteen cases of dislocation in the dorsal and lumbar regions, verified by post-mortem examination; some of those above alluded to are included in the number. They appear to be most frequent in the lower part of the dorsal and upper part of the lumbar region. Thus, of the thirteen: one was at the sixth dorsal; one at the ninth; two at the tenth; five at the twelfth; three at the first lumbar; and one at the second. Out of ten, in which the direction of the displacement is recorded, in six the upper part of the column was dislocated forwards, in two backwards, and in two laterally. The greater number were complicated with fracture of the body or processes, varying in extent; but in three the dislocation seems to have been complete, although unaccompanied by any fracture whatever. These latter, from their extreme rarity, seem deserving of notice. In one, there was a complete dislocation forwards at the tenth dorsal vertebra, in such a manner that the inferior articular processes were in contact with the posterior surface of the body of the eleventh, and the spinal marrow was divided across. In a second, the dislocation was at the sixth dorsal vertebra, the inferior articular processes of which were placed in front of those of the seventh. The spinal marrow was bent and compressed, but not otherwise altered. In a third, the ninth dorsal vertebra was displaced backwards upon the tenth. The superior articular processes of the tenth could be brought into contact with the body of the ninth vertebra. (See *Malgaigne, Traité des Fract. &c.* vol. ii. p. 384.)]

DISLOCATIONS OF THE RIBS.

Dislocation of the Ribs from the Vertebræ.—J. L. Petit believed such a case never occurred. Buttet related an instance, which he supposed to be a dislocation of the posterior extremity of the rib from the vertebræ; but Boyer clearly proved that no true reasons existed for this opinion, and that the case was only a fracture of the bone, near the spine. (*Mal. Chir.* t. iv. p. 123.) Paré, Barbette, Juncker, Platner, and Heister, not only admit the occurrence of luxations of the ribs, but describe different species of them. Lieutaud extended the term luxations to cases in which the head of the rib is separated by disease, the pressure of aneurisms, &c.

[Sir A. Cooper mentions the case of a patient who had died of fever, in whom, at the post-mortem examination, the head of the seventh rib was found thrown upon the front part of the corresponding vertebra, and there ankylosed. Several years before, this gentleman had been thrown from his horse across a gate, for which accident he had been subjected to the treatment usually followed in fractures of the ribs, and there is every reason to believe that it was at this time that the dislocation occurred. (*On Dislocations, &c. edited by B. Cooper*, p. 521.)

The following case came under the observation of Dr. Kennedy of Dublin. A gentleman, æt. 20, while standing on a scaffold, felt it suddenly give way. He fell through, and a portion of the scaffold then fell down upon him. On examining the back, there was extensive ecchymosis in the lumbar region, and it was found that the two last ribs of the left side were displaced downwards and forwards; there was a distinct hollow where their heads should have been, and pressure on their sternal extremities caused the vertebral ends to move distinctly. There was no crepitus, or other evidence of fracture. A bandage was applied, and the dislocated ribs, it is said, came back to their natural position in about three weeks. (See *Dublin Medical Press*, vol. v. 1841, p. 30.)

Several other cases are recorded in the same journal. In one, the patient, a boy æt. 11, received a heavy blow on the back from a lump of turf. He was admitted ten days afterwards to the Queen's County Infirmary, under the care of Dr. Jacob, with paralysis and retention of urine, and on examination a tumor was discerned at the left of the spine, extending over the heads and necks of the three or four last ribs. The tenth and eleventh ribs admitted of more depression than the others, and led to the suspicion of fracture or dislocation, but the tumor interfered with the examination of the ribs posteriorly. The boy died six days later from suppuration around the seat of the injury, and it was found that there was complete dislocation forwards of the tenth, and partial dislocation of the eleventh ribs from their vertebral articulations. The separation of the tenth rib was sufficient to admit the insertion of the point of the little finger between the head of the bone and the articulating surface on the vertebræ. (p. 70.)

In another case, seen by Dr. Finucane, the patient, a girl, æt. 15, was killed by the falling in of the roof of a cottage. One of the beams that had fallen in had fractured her skull, and another beam was found with one end resting on her back. On examination, there was found to be a complete dislocation of the two last ribs of the left side; the ligaments were ruptured, and the heads of the ribs easily moved inwards to some extent, by grasping the anterior ends of these bones. (p. 145.)

In a third case, a youth, æt. 17, fell from the top of a high tree, striking his back on one of the roots, which was above the surface of the ground. There was an indentation at the place of the junction of the two last ribs of the right side with the spine, and these bones were therefore supposed to have been dislocated, but the description of the case is not very conclusive, as the boy rapidly recovered, and ten days afterwards no depression could be discerned. (p. 229.)

From these cases it would appear that direct violence applied over their spinal articulations does occasionally produce dislocation of the ribs, and that the two or three last ribs are most liable to the accident, doubtless on account of the greater looseness of their ligaments and of their greater exposure, consequent upon the slight development of the transverse processes of the vertebræ in the lower part of the dorsal region.

Dislocations of the Cartilages of the Ribs.—In a modern work may be read the particulars of a case, where all the ribs were dislocated from their cartilages, in consequence of the chest being violently compressed between the beam of a mill and the wall. In such a case there is no means of reduction, except the effect produced by forcible inspirations; nor are there any modes of relief, but bleeding, and the application of a roller round the chest. (See *C. Bell's Surg. Obs.* p. 171.)

[M. Bouisson met with a case in which the cartilage of the fourth rib was separated and displaced backwards. The patient had been thrown from a donkey, and the animal had stepped upon his chest. M. de Kimpe has recorded a case of a person who was thrown from a horse, and struck the front of his chest against the corner of a milestone. The cartilage of the fifth rib was separated from the bone and driven inwards. (*Malgaigne, Traité des Fract.* vol. ii. p. 397. See also *Mémoire sur les Luxations des Cartilages Costaux*, 1854, *par L. Saurel*, and *Dublin Quart. Journ. of Med. Science* vol. xix. p. 201, 1855.) The treatment of such a case would be the same as in fracture of the rib or of its cartilage. It is, in fact, very difficult to determine whether the injury is really a fracture or a dislocation, since either the rib or the cartilage may have been broken close to their line of junction.

There are examples also recorded in which violent and sudden movements of the body have produced a *separation of the cartilages of the false ribs* at their articulations with each others. The separated ribs have then been found depressed below the level of the others. (*Malgaigne*, loc. cit. p. 398.)

Again, the cartilages of the ribs may be dislocated at their *sternal* articulations. Sir C. Bell records the case of a young man, who while exercising with dumb bells, suddenly felt something give way, and one of the costal cartilages was found dislocated forwards upon the sternum. It was replaced by pressure with the fingers, and retained in position by a compress and bandage. Other instances are mentioned by Malgaigne. In one the fourth cartilage was dislocated forwards on the sternum; in another the fourth, fifth, and sixth underwent a similar displacement. In the latter case, reduction was effected and maintained by placing pillows under the back, so as to curve the trunk backwards. (Loc. cit. p. 399.)]

[DISLOCATIONS OF THE STERNUM.]

[Dislocations of the sternum are rare. Occasionally, however, a separation of the first from the second piece has been met with. M. Malgaigne has collected ten examples of this accident. In some of these it was produced by direct force, such as a blow, or severe pressure, applied to the sternum itself; but more frequently it was caused by a fall from a considerable height, in which the spine was forcibly bent forwards, and the two pieces of bone being pressed together, the lower became displaced in front of the upper. A dislocation in the opposite direction, *i. e.* of the lower piece behind the upper, has not yet been met with. In one case the displacement occurred in consequence of a forcible bending *backwards* of the spine, and the two pieces of bone were torn away, and separated by an interval, from each other. Dislocation of the sternum requires extreme violence for its production, and it is therefore likely to be accompanied by other complications, as fracture of some part of the spine, or injury to internal organs: of the ten cases alluded to, five terminated fatally from other complications, but those in which the dislocation of the sternum was the only mischief, no very serious consequences appear to have resulted. The reduction, however, has been attended with great difficulty, and has sometimes been impossible. Where there is much overlapping of the first piece by the second, a firm bolster placed under the back to produce extension of the spine appears the most likely to be attended with advantage.

Displacement of the Ensiform Cartilage.—Two observations are recorded. In one the cartilage was driven inwards by a blow on the epigastrium. Frequent vomiting followed the accident, and continued until the cartilage was restored to its normal position. This was accomplished by the surgeon pressing his fingers beneath it, and elevating it into its place. The subject of the second case was a sailor, who fell upon the seat of a boat, and struck his epigastrium. He had violent pains in the stomach, dyspnœa, and vomiting, and for five and twenty days was unable to swallow the smallest quantity of fluid without immediately rejecting it. At length, his death being imminent, it was resolved to attempt to relieve him by an operation. An incision was made on one side of the depressed cartilage, extending through the peritoneum. An instrument was then passed beneath it, and it was raised into its place. The patient immediately expressed himself relieved, the vomiting ceased, and he rapidly recovered. (See *Malguigne*, loc. cit. p. 409.)]

DISLOCATIONS OF THE STERNO CLAVICULAR ARTICULATION.

The clavicle may be luxated at its sternal extremity, *forwards*, *backwards*, or *upwards*; but never *downwards*, on account of the situation of the cartilage of the first rib. The luxation forwards is the most frequent; that backwards is unusual; and the one upwards is still more rare.

Dislocation forwards.—In this dislocation a hard circumscribed tumor is felt, or even seen, on the front and upper part of the sternum. According to Boyer, when the shoulder is carried forward and outward, the tumor disappears; but, in Sir Astley Cooper's account, it is said, that the projection on the sternum will subside, if the shoulder be drawn backward. The shoulder being elevated, the projection descends; if it be drawn downwards, the dislocated extremity of the bone becomes elevated to the neck. The motions of the clavicle are painful, and the patient moves the shoulder with difficulty. The point of the acromion is less distant from the central line of the sternum than usual. The dislocation forwards is generally produced by a fall upon the point of the shoulder, when the force pushes the clavicle inwards and forwards; but it also happens, from falls upon the elbow when this is separated from the side, and thus the clavicle is propelled violently inwards and forwards against the anterior portion of the capsular ligament. (See *A. Cooper*, *On Dislocations*, p. 399.)

[The dislocation forwards is sometimes incomplete, only the front of the capsular ligament being torn; and in this case, as the clavicle is only partially displaced from the articular surface on the sternum, the measurement from the acromion to the median line of the sternum is not altered. M. Malgaigne remarks, that in the partial dislocation, of which he records three examples, the displacement is always slightly *upwards* as well as forwards; whereas, in the complete dislocation, the sternal end of the clavicle usually descends *below* the natural level. (*Traité des Fractures, &c.* t. ii. p. 410, Paris, 1855.)]

Dislocation backwards.—[In this accident, of which M. Malgaigne has collected eleven examples, there is a depression where the end of the clavicle ought to be, this bone being displaced backwards behind the sternum, and, according to M. Malgaigne, behind the sterno-hyoid and thyroid muscles. It may be displaced backwards and downwards, so as to be completely concealed by the sternum, or backwards and upwards, so as to form a projection at the front and lower part of the neck. In some of the cases the displaced bone has compressed the trachea and œsophagus, and has interfered with respiration and deglutition, but in the majority these symptoms have not been present. The cause of the dislocation backwards has generally been violence applied to the shoulder in a direction from behind forwards, forcing the sternal end of the clavicle backwards, and causing the posterior sterno-clavicular ligament to give way. Sometimes, however, the force has operated directly on the sternal end of the clavicle, so as to force it backwards, as in a case recorded by Mr. Spender, where the patient had been thrown from his horse, and the animal, in attempting to rise, had placed its fore foot upon his clavicle. (*Lond. Med. Gaz.* 1844, vol. ii. p. 369.) A case of *compound* dislocation of the clavicle backwards, from direct violence, was under the care of Mr. Tyrrel, in St. Thomas's Hospital, in 1835. The patient, a railway labourer, had been buried by a slip of earth, and the sharp end of a pickaxe, with which he was working, had been driven into his chest. In this case the lung was wounded, and there was considerable laceration of the muscles; nevertheless he recovered favourably. (See *South*, *Trans. of Chelius*, vol. i. p. 778.)]

The only instance of the dislocation backwards known to Sir Astley Cooper proceeded from great deformity of the spine. In this extraordinary case, the bone gradually slipped behind the sternum, and produced so much inconvenience, by its pressure on the œsophagus, that the late Mr. Davie, of Bungay in Suffolk, was obliged to remove its sternal extremity. (*Sir A. Cooper, On Dislocations*, p. 395. 401.)

[*Dislocation upwards.* — In this displacement, of which M. Malgaigne refers to five examples, the sternal end of the clavicle may be felt resting upon the upper border of the sternum, between the sterno-cleido mastoid muscle in front, and the sterno-hyoid muscles behind. The shoulder is depressed, and approximated to the median line. A considerable interval may be noticed between the sternal end of the clavicle and the cartilage of the first rib. This accident may be caused by a fall on the shoulder, or by any severe blow on that part, operating in such a manner as to force it *downwards* and *inwards.*]

Treatment. — In reducing dislocations of the sternal end of the clavicle, we are to make a lever of the arm, by means of which the shoulder is brought outwards; and when thus brought outwards, it is to be pushed forwards, if the dislocation be in that direction; backwards, if the dislocation be behind; and upwards, if the dislocation be above.

The same position of the arm, and the same apparatus, as in fractures of the clavicle, are to be employed. The wedge-like pad, with its thick part towards the axilla, for the purpose of inclining the shoulder outward, a sling for the support of the weight of the arm, and a bandage judiciously applied, are especially necessary. In consequence of the obliquity and smoothness of the articular surfaces, the reduction is easy, but great attention is requisite to prevent a return of the displacement.

[In the dislocation forwards, some advantage may be gained by fixing a compress over the sternal end of the clavicle, to retain it in its natural situation. An ordinary hernia truss has been employed by M. Nélaton, the pad being placed over the head of the dislocated bone, and the spring passing under the axilla of the sound side. A similar proceeding might be adopted in the dislocation upwards, although, in this case, the adjustment of the pressure would be more difficult. In the dislocation backwards, any direct application of pressure to the seat of the injury to prevent recurrence of the displacement is of course impracticable.]

Dislocations of the Acromio-Clavicular Articulation.

[Desault and Boyer represented this as much less common than dislocation of the sternal end of the bone, while Sir Astley Cooper's experience, with which most surgeons now agree, pronounced them to be more frequent. The displacement of the acromial end of the clavicle is almost invariably *upwards.* Exceptional cases, however, are recorded, in which it has been driven *downwards* beneath the *acromion;* and *downwards and forwards*, beneath the *coracoid process.*

Dislocation upwards. — It must be remembered that in addition to the proper ligaments of this joint, the clavicle and scapula are firmly connected by the coraco-clavicular ligaments, which latter, as well as those of the joint itself, must be torn through before any *considerable* separation can take place. A *slight* degree of displacement, however, may occur without rupture of the coraco-clavicular ligaments, and dislocations of this joint have therefore been divided into the complete and the incomplete, the distinction depending upon the degree of separation permitted by the laceration or otherwise of the ligaments in question. Sir A. Cooper appears to have thought that no dislocation, complete or incomplete, could happen without rupture of the outer or *trapezoid* portion of the coraco-clavicular ligament, but that in the partial dislocation, the inner or *conoid* portion remains entire, while, in the complete dislocation, both portions must be torn through. The experiments of M. Bouisson, however, on the dead body show, that, when the acromio-clavicular ligaments are divided, the coraco-clavicular remaining intact, the imperfect dislocation can be readily produced by pressing the scapula downwards and inwards. A fall on the top of the shoulder, or a heavy weight, or a blow, pressing the acromion downwards may produce this dislocation.

The scapular end of the clavicle may be displaced *directly upwards* from the acromion, to the extent of an inch or even an inch and a half; more commonly displacement upwards is combined with displacement *outwards*, the clavicle passing on to the upper surface of the acromion, and the shoulder being drawn inwards by the muscles which approximate the arm to the body. Further, this displacement on to the acromion may be directly outwards, or outwards and forwards, the clavicle resting on the acromion near its apex; or outwards and backwards, when it will rest on that process near its union with the spine of the scapula. The displacement forwards towards the apex of the acromion is the least frequent. These varieties probably depend on the direction of the force by which the accident was produced.]

It has been asserted, that the violent action of the trapezius muscle, in pulling the clavicle upwards, may tend to produce the accident; but, as Sir Astley Cooper has remarked, the mere action of this muscle, without the simultaneous operation of great violence, could never tear both the ligaments of the coracoid process, which must give way ere this dislocation can happen. (*On Dislocations*, p. 406.) Pain at the top of the shoulder, a projection of the end of the clavicle under the skin covering the acromion, and a depression of the shoulder, are symptoms indicating what has happened. The patient also inclines his head to the affected side, and avoids moving his arm or shoulder.

This dislocation is reduced by carrying the shoulder outwards and backwards, and pressing the end of the dislocated bone downwards into its place. To maintain the reduction, a thick cushion is placed in the axilla, and Desault's bandage for fractures of the clavicle (see FRACTURES) is applied, making the turns ascend from the elbow to the shoulder, so as to press the luxated end of the bone downward, and keep it in its due situation, at the same time that the elbow is confined close to the side, and supported in a sling, by which means the shoulder will be kept raised and inclined outwards. This plan, which is advised by Boyer, is more efficient than the common practice, which consists in applying a compress, the figure of 8 bandage, and supporting the arm in a sling. A careful readjustment of the apparatus will be necessary every third or fourth day. However, the exact maintenance of the reduction, by any apparatus whatever, is found to be a matter of the greatest difficulty, and some slight deformity will remain, though it is agreeable to know that, notwithstanding this disadvantage, the use of the limb returns very well.

[Mr. South says, that in all the cases he has met with, and he has found the injury not unfrequent, he has never been able by any contrivance to keep the bone in its place, and has therefore given up the attempt, and only endeavours to keep it at rest, so that it may form new connections on the scapular spine. (See Note to *Trans. of Chelius*, vol. i. p. 780.)

For a full account of the various plans which have been proposed and practised by different surgeons for maintaining the reduction of this dislocation, the reader is referred to M. Malgaigne's elaborate work. The most simple, and probably the most likely to prove effectual, is that suggested by M. Malgaigne himself. It consists of a strap about two inches in breadth, furnished at one end with a buckle. The buckle being placed in front, opposite the patient's breast, the band is passed under the elbow, carried upwards behind the shoulder, and over the dislocated clavicle to be fixed to the buckle in front. Below, to retain this band near the elbow, a small piece of bandage is passed round the arm just above the elbow-joint, and sewn to the strap in front and behind. Above, to prevent its slipping off the shoulder, a second band or strap is fixed to the first just behind the shoulder-joint, brought round the trunk on the sound side, and fixed, by a second buckle, to the anterior part of the first strap just above the elbow. Compresses, placed under the strap, may be used, if necessary, to increase the pressure upon the projecting end of the clavicle. M. Malgaigne says he has employed this apparatus a considerable number of times, and has obtained easily what he desired, — a reduction *almost complete.* The time necessary for the consolidation of the joint appears to be about thirty days, and the apparatus must be worn for this period. Galen suffered from this accident in his own person; he wore very tight bandages for forty days, and was cured with scarcely any deformity.]

[*Dislocation downwards.*—The possibility of this accident was denied by Boyer, nevertheless three authentic instances have been placed on record. The subject of the first was a Russian soldier, in whom the accident had occurred when he was only six years old, and was caused by the direct pressure of a heavy weight upon the shoulder. The parts were dissected by M. Melle, in 1765. The external extremity of the clavicle was buried beneath the acromion, which covered it completely. The inferior surface of the acromion and the superior surface of the clavicle were covered with cartilage, and surrounded by a new fibrous capsule. The coraco-clavicular ligaments had been ruptured, and no trace of them remained. (See *Melle, Nova Acta Med. Phys.* 1773, t. v. p. 1, and *Malgaigne*, loc. cit. p. 448.) In 1816 a second case was seen by M. Fleury, in a man æt. 50, two months after its occurrence. The left clavicle had been luxated downwards and backwards, and was placed between the acromion and the coracoid process, resting upon this latter, and upon the upper border of the scapula, where it had formed a new joint. Although the dislocation was not reduced, there was no interruption to the movements of the shoulder or of the arm. (*Fleury, Journ. Universel*, t. iv. p. 144; and *Malgaigne*, loc. cit. p. 448.) The third case was seen by M. Tournel in 1847. It occurred in a soldier, who had fallen from his horse, and the animal in rising had trodden upon the anterior part of his shoulder. The clavicle appears to have passed outwards beneath the acromion sufficiently far to project beyond its outer border; for it is stated that the shoulder presented two prominences, one internal and superior formed by the acromion, the other external and inferior formed by the outer extremity of the clavicle. The shoulder had lost its rounded form, and was approximated to the sternum. The injured limb was longer than the opposite. Voluntary movement, especially in an upward direction, was impossible, but the communicated movements were free and without pain. The reduction was effected by placing the knee between the shoulders, and drawing them backwards; and the bone was kept in its place at first by Desault's bandage, afterwards by an apparatus contrived by M. Flamand. The cure was complete in thirty-two days, and it was ascertained some time afterwards that no traces of the accident remained, either in the conformation, or in the functions of the limb. (See *Tournel, Archives Gén. de Méd.* 1837, t. xv. p. 463; and *Malgaigne*, loc. cit. p. 448.)]

[*Dislocation under the Coracoid Process.* — This accident was unheard of until M. Godemer, of Ambrières, published in 1843 five instances of it, collected in the space of five years. A sixth has since been published by a M. Pinjon. The cause assigned is a fall on the anterior part of the shoulder. The clavicle appears to have become placed beneath the coracoid process, and its outer extremity, which was indistinctly felt, is stated to have been lodged in the axilla. The coracoid process and the acromion were unusually prominent under the skin. M. Godemer reduced these dislocations, by having the shoulder forcibly drawn backwards and outwards by an assistant, and then with his fingers dislodging the clavicle from beneath the coracoid process. Desault's bandage for fractured clavicle was employed to maintain the reduction. No other instances of this dislocation have been subsequently met with. (See *Malgaigne*, loc. cit. p. 450.)

Simultaneous Dislocation of both extremities of the Clavicle. — One instance of this accident has been met with by M. Richerand. It was caused by a fall on the shoulder from a considerable height. The external extremity of the clavicle was displaced upwards and backwards, the internal extremity upwards and forwards. Desault's bandage was applied, with compresses upon the dislocated extremities of the bone. By this means the reduction of the external dislocation was effectually maintained, but the inner extremity remained displaced. Nevertheless the patient appears to have soon recovered a very tolerable degree of movement of the limb. (See *Journ. Hebdom.* t. ii. 1831, p. 78.)].

DISLOCATIONS OF THE SHOULDER-JOINT.

Nature, which varies according to the necessities of different animals the number of their joints, has also been provident enough to vary the structure of these parts, according to the use of the different portions of their economy. To great mobility some unite considerable solidity; for ininstance, the vertebral column. Others are very strong, but only admit of a slight yielding motion, as we observe in the carpus, tarsus, &c. Lastly, other joints admit of a great latitude of motion; but their strength is easily overpowered by the action of external bodies. In man, such is the shoulder-joint.

Of all the very moveable articulations, not one is so often luxated as the shoulder-joint. Bichat found that this accident, at the Hôtel-Dieu, was as frequent, and even more so, than dislocations of all the other bones taken collectively.

Here every thing seems to facilitate the escape of the bone from its natural cavity. An oval shallow cavity, surrounded by a margin of little thickness, receives a hemispherical head, which is twice as broad as the cavity in the perpendicular direction, and three times as extensive from before backward. With respect to the ligaments, the joint is only strengthened by a mere capsule, which is thin below, where nothing opposes a dislocation; but thicker above, where the acromion, coracoid process, and triangular ligament, form an almost insurmountable obstacle to such an accident. With regard to the muscles and motions of this joint, strong and numerous fasciculi surround the articular surfaces; make them easily move in all directions; and, pushing the head of the humerus against the different points of the capsule, distend this fibrous sac; and, when their power exceeds the resistance, actually lacerate it. As for external bodies, what bone is more exposed than the os brachii to the effect of their force?

Thus subjected to the influence of these predisposing causes, the humerus would be in continual danger of being dislocated, if the scapula, which is as moveable as itself, did not furnish a point of support for it, by accompanying it in all its motions. This point of support accommodates itself to the variations in the position of the head of the os humeri, so that to the mobility of the articular surfaces, the strength of the joint is in a great measure owing.

The shoulder-joint, which is very liable to luxations in a general sense, is not equally so at all points. The head of the humerus cannot be displaced upwards. Here are situated the acromion and coracoid process, the triangular ligament stretched between them, the tendons of the biceps, supraspinatus, and the fleshy portion of the deltoid; insurmountable obstacles to the luxation of the head of the bone upwards. Supposing there were a force calculated to produce such an effect, the head of the bone must necessarily be driven outward as well as upward, ere its head could be displaced. This seemed to Desault impossible, because the trunk prevents the lower part of the arm from being directed sufficiently inward to produce this effect. However, many cases of this dislocation are now upon record; and one, to which, I shall presently advert, was caused by a direct blow on the forepart of the shoulder; a cause, which seems not to have been contemplated.

On the contrary, at the other margins of the glenoid cavity, there is little resistance. At the inferior one, the long portion of the triceps; at the internal one, the tendon of the subscapularis; and at the external edge, those of the infra-spinatus, and teres minor, will allow primitive luxations to take place, downward, inward, or outward. Downward, between the tendon of the long portion of the triceps and the tendon of the subscapularis, which last, in a case dissected by Sir A. Cooper, was ruptured (*Surg. Essays*, part. i. p. 7, and *On Dislocations*, p. 421) inward, between the fossa subscapularis, and muscle of this name; outward, between the fossa infra-spinata, and infra-spinatus muscle.

According to Sir Astley Cooper, the os humeri is liable to be thrown from the glenoid cavity of the scapula in four directions: three of these luxations are complete; the other is only partial. The first is *downwards and inwards*, the dislocation *into the axilla*, as it is usually called, in which case the head of the bone rests upon the inner side of the inferior costa of the scapula. The second is *forwards*, *under the pectoral muscle*, the head of the bone being placed below the middle of the clavicle, and on the sternal side of the coracoid process. The third is the dislocation *backwards*, in which the head of the bone can be plainly felt and seen, as a protuberance at the back and outer part of the inferior costa of the scapula, upon the dorsum of this bone. The fourth, which is only partial, is when the front of the capsular ligament is torn, and the head of the bone rests against the outer side of the coracoid process. "Of the dislocation in the axilla (says Sir Astley Cooper) I have seen a multitude of instances; of that forwards, on the inner side of the coracoid process, several; although it is much less frequent than that in the axilla: of the dislocation backwards, I have seen only two instances during the practice of my profession for 38 years." (*On Dislocations*, *&c.* p. 416.)

[Sir A. Cooper's description and classification of the dislocations of the shoulder-joint is still very generally followed in this country. Some of the French surgeons, however, among whom may be mentioned Velpeau, Nélaton, and Malgaigne, have introduced further subdivisions. M. Malgaigne, whose work is the most recent, proposes the following classification:—

1. Dislocations into the axilla.
   - *a.* Complete sub-coracoid, tolerably common.
   - *b.* Incomplete sub-coracoid, rare.
   - *c.* Sub-glenoid, rare.
2. Dislocations inwards.
   - *d.* Intra-coracoid, the most common of all.
   - *e.* Sub-clavicular, rare.
3. Dislocations backwards.
   - *f.* Sub-acromial, rare.
   - *g.* Sub-spinous, very rare.
4. Dislocation, upwards.
   - *h.* Supra-coracoid, two examples.

In the "subglenoid" variety, the head of the bone passes almost directly downwards, and rests against the axillary border of the scapula, immediately under the glenoid cavity; in the "complete subcoracoid" dislocation, it passes downwards and somewhat inwards, under the coracoid process, which process is placed over the centre of the head of the bone; in the "intra-coracoid" dislocation, it passes rather more inwards, but is still beneath the coracoid process, the only difference being that in this case two-thirds or three-fourths of the head of the bone project on the inner side of the process.

The distinction between the subcoracoid and the intra-coracoid is therefore very slight, and seems scarcely sufficient to warrant so complete a separation as M. Malgaigne has made between them; and, indeed, all three appear to be included by Sir A. Cooper in his dislocation into the axilla. The term intra-coracoid is also objectionable, since it suggests that the head of the bone is altogether on the inner side of the process, as in Sir A. Cooper's dislocation forward under the pectoral muscle; and M. Nélaton had already employed the word intra-coracoid in the description of the same displacement which M. Malgaigne designates "subclavicular." Sir A. Cooper's dislocation forwards, therefore, is represented by M. Nélaton's "intra-coracoid," but by M. Malgaigne's "subclavicular." With reference to the incomplete dislocation, M. Malgaigne maintains that the relation of the coracoid process to the glenoid cavity will not permit a displacement directly forwards against the outer side of that process, as described by Sir A. Cooper; but that the head of the bone must necessarily pass somewhat downwards as well; and this he describes as an "incomplete subcoracoid" dislocation.]

Causes.—The action of external bodies, directed against the arm, but particularly falls, in which this part is forced against a resisting body, gives rise to primitive dislocations; and then the different species of the accident are determined by the particular position of the humerus at the instant when the injury takes place.

Should this bone be raised from the side without being carried either forward or backward; should the elbow be elevated, and the fall take place on the side, then the weight of the trunk, almost entirely supported by this bone, forces downward its upper part, which stretches and lacerates the lower part of the capsular ligament. Thus a luxation downward is produced, and its occurrence may also be facilitated by the combined action of the latissimus dorsi, pectoralis major, and teres major muscles, as Fabre has judiciously remarked; for being at this period involuntarily contracted to support the trunk, they act with the power of a considerable lever; the resistance being the head of the bone, which they draw downward, while the fixed point is the lower end of the bone, resting against the ground. Some authors also consider, as the immediate cause of a dislocation downward, the strong action of the deltoid, which is supposed to depress the head of the bone, and push it downward through the capsular ligament. In support of this opinion, Bichat mentions the well-known case of a notary, who luxated his arm downward in lifting up a register.

The rationale of the primitive luxation forwards differs very little from that of the preceding case. The elbow is both separated from the side, and carried backward: in falling, the weight of the body acts on the humerus, the front part of the capsule is lacerated, and a luxation takes place in this direction.

The dislocation backwards is produced in the same sort of way. The elbow is carried forwards, towards the opposite shoulder; the posterior part of the capsule is stretched backwards, and if a sufficient force act on the limb, it is lacerated.

[In the above description of the causes of dislocations of the shoulder, indirect violence only has been taken into consideration, and Petit, Dupuytren, and many others, believed this was the only way in which the accident could be produced. It is now well established, however, that the direct application of force to the shoulder by a fall or a blow on the part, is by no means an unfrequent cause of dislocation. Sir A. Cooper was fully aware of this, and in speaking of dislocation downwards, he even says, that "the *most frequent* cause is a fall directly upon the shoulder on some uneven surface, by which the head of the bone is driven downwards, whilst the muscles are unprepared to resist the shock."—(*On Fractures and Dislocations, edited by Bransby Cooper*, p. 369.) Mr. Bryant has lately published an account of thirty-four cases of dislocated shoulder, observed by him at Guy's Hospital. He states that of these, twenty-two were examples of dislocation downwards, five of dislocation forwards, and six of the two former combined, together with one of dislocation backwards. In thirty-one out of the thirty-four cases, the cause of the injury was a *direct fall* upon the shoulder, either forwards, backwards, or outwards. In two instances only of dislocation downwards, and in one of dislocation downwards and forwards, was the bone displaced by a fall upon the extended arm.—(*Med. Times and Gazette*, May 1859, p. 493.)

M. Malgaigne's investigations into the causes of dislocations of the shoulder seem to show that certain displacements are ordinarily due to direct, and others to indirect violence. Thus he found that the dislocations directly downwards, "subglenoid," and "subcoracoid," were most commonly the result of falls upon the extended arm, rarely of falls or blows upon the shoulder; but that the dislocations downwards and forwards, "intra-coracoid," or more directly forwards, "subclavicular," were often produced by force applied directly to the shoulder itself, and operating upon its outer or posterior part. In the intra-coracoid displacement, which he believes to be the most common of all, the great majority were thus occasioned. Direct violence to the anterior part of the shoulder has also been found not unfrequently to be the cause of the dislocation backwards. These are results which might have been expected, taking into consideration the exposed condition of the shoulder-joint at its anterior and posterior aspects, as compared with its upper part, where it is greatly protected by the coraco-acromial arch.]

Several causes may lead to a *consecutive* luxation. If, after a dislocation has occurred, a fresh fall should happen, while the arm is separated from the trunk, the head of the humerus, which nothing confines, obeys with the utmost facility a force applied to it in this manner, and is again pushed out of the situation which it accidentally occupied.

Thus, a man, in going down stairs, met with a fall, and dislocated the humerus downwards; he immediately sent for Desault, who deferred the reduction till the evening. In the meantime, the patient, in getting upon a chair, slipped and fell again. The pain was more acute than when the first accident occurred; and Desault, on his return, instead of finding the head of the humerus as it was in the morning, in the hollow of the axilla, found it under the pectoralis major muscle. The action of muscles is a permanent cause of a new displacement. When the humerus is luxated downward, the pectoralis major, and the deltoid, draw the upper part of this bone upward and inward, which, only making a weak resistance to their action, changes its position, and takes one in the above double direction.

The various motions imparted to the arm may also produce the same effect, according to their direction. Thus, in consequence of unskilful efforts to reduce the bone, a luxation inward frequently follows one downward. By the French surgeons, a great deal of importance has been attached to the division of dislocations of the humerus into primary and consecutive; and perhaps some of their statements, on the secondary change in the position of the head of the bone, may be exaggerated. That a subsequent alteration in the situation of the bone may happen, from the causes specified by Desault, can hardly be questioned. The observations of Petit, Hey, and others, confirm the fact; and I have myself seen a dislocation in the axilla change into one forward under the pectoral muscle. However, Sir Astley Cooper believes that, excepting from violence, and the effect of absorption, the nature and direction of a dislocation are never changed, after the muscles have once contracted. (*On Dislocations*, p. 416.) Perhaps, with the latter qualification, no great difference prevails between him and other writers.

Symptoms.—Whatever may be the kind of dislocation, a depression is always manifest under the acromion, which forms a more evident projection, than in the natural state. Almost all the motions of the arm are painful; some cannot be performed in any degree; and they are all very limited. The arm cannot move without the shoulder moving also; because, the articulation being no longer able to execute its functions, both it and the shoulder form, as it were, one body. When the limb is moved, a slight crepitus may sometimes be felt, probably in consequence of the synovia having escaped through the laceration of the capsule. (*Sir A. Cooper*, *On Dislocations*, p. 418.) To these symptoms, generally characteristic of every sort of dislocation of the humerus, are to be added such as are peculiar to each particular case.

Symptoms of the Dislocation downwards.—When the luxation is downward the arm is a little longer than in the natural state; the natural roundness of the shoulder is lost, in consequence of the deltoid muscle being drawn down with the head of the bone; and the patient cannot use the arm. [The pectoralis major which forms the anterior fold, and the latissimus dorsi and teres major which form the posterior fold, of the axilla, and which are inserted into the margins of the bicipital groove, are carried downwards with the displaced bone. The vertical depth of the axilla is therefore increased, and the measurement from the clavicle to the lower border of the great pectoral muscle is greater on the injured than on the sound side. The arm is usually found to be rotated inwards. Numbness of the fingers, and partial paralysis of the muscles of the limb, from pressure or stretching of the nerves of the brachial flexus, is another symptom occasionally observed.] The elbow is more or less removed from the axis of the body by the action of the deltoid, the long head of the biceps and supra-spinatus muscle being also stretched, and tending to draw the bone outward. The pain, which arises from this position, compels the patient to lean towards the dislocated limb, to keep the fore-arm half bent, and the elbow supported on his hip, in such a way that the arm having a resting-place, may be sheltered from all painful motion, especially that of the elbow inwards. By this posture alone, Desault often recognised the accident. The head of the humerus may be felt in the axilla; but "only when the elbow is considerably removed from the side." (*Sir A. Cooper*, *On Dislocations*, p. 417.) This last circumstance is worthy of notice, as the inability to feel the head of the bone has led to mistakes.

[On this point, M. Malgaigne maintains that the head of the bone can always be readily felt without raising the arm if the dislocation is directly downwards, as in his sub-glenoid variety, or downwards and a little inwards, as in the sub-coracoid; but that if it is still more inwards, as in the intra-coracoid, it becomes necessary to raise the arm from the side before the head can be distinguished. Sir A. Cooper's dislocation downwards, it should be remembered, included all these three varieties, and as the intra-coracoid has been found by M. Malgaigne to be the most frequent of all, Sir A. Cooper's statement that it is necessary to raise the arm in order to feel the head of the bone is accounted for. M. Malgaigne states, that of 89 cases of dislocated shoulder seen by him, the head of the bone occupied the intra-coracoid position in more than two thirds.

It is important to notice that when the dislocation happens from *direct* violence, this is the position which the head of the bone is most likely to assume, whereas, if it is caused *indirectly*, by a fall with the arm separated from the side, it usually passes more directly downwards into the axillary space. The "intra-coracoid" dislocation also is very frequently complicated with fracture of the great tuberosity. The blow or the fall operating upon the posterior and outer part of the shoulder, breaks off that process at the same time that it drives the head of the bone downwards and inwards, towards the axilla. When the tuberosity is broken off, it is prevented by its muscles from passing forwards with the head of the bone; it therefore remains opposite to the glenoid cavity, which it partially fills, and so renders the sub-acromial depression less evident than in a dislocation unaccompanied by fracture. The not unfrequent association of dislocation with this fracture is of great practical importance, since when the complication is present, it tends to obscure one of the leading diagnostic marks of dislocation—the depression beneath the acromion; and unless the surgeon is well aware of it, it is, perhaps, more than any thing else, likely to lead him into error. Mr. R. W. Smith has described the fracture of the greater tuberosity of the humerus, and states that numerous examples of this accident have fallen under his observation. He does not, however, appear to consider the accompanying displacement of the head of the bone as constituting a dislocation, although in a shoulder joint which he had an opportunity of dissecting some years after the occurrence of the accident, he found the head of the bone lying *below the level of*, *and internal to*, *the coracoid process*, exactly the position claimed by M. Malgaigne for his intra-coracoid dislocation. The great tuberosity occupied the glenoid cavity; it was united by ligament to the head of the bone, which it accompanied in its movements. The head had formed for itself a new and shallow socket upon the costal surface of the neck of the scapula. (*On Fractures and Dislocations*, p. 178.)

Fractures of the anatomical neck, or of the surgical neck of the humerus, and fractures of the neck of the scapula, are injuries which might possibly be mistaken for dislocations of the shoulder; and further remarks on their diagnosis will be found in the article FRACTURES.]

Baron Dupuytren used to believe, that the elongation of the limb only occurred in the dislocation downwards below the glenoid cavity; but, in consequence of the researches of M. Malgaigne, and experiments made by himself, he was induced to alter his opinion on this point. M. Malgaigne observed, that, since the head of the humerus, when in its natural situation, occupies the concavity of an arch, formed by the acromion, the coracoid process, and the coraco-acromial ligament, it must evidently be upon a lower level, whether under one or the other pillar of this arch. In a shoulder joint, the ligaments of which had been recently dissected, Dupuytren dislocated the head of the humerus under the coracoid process, and ascertained by a careful measurement, that the arm was lengthened about half an inch. (*Dupuytren, Clin. Chir.* t. iii. p. 93.)

[The elongation of the arm will doubtless be greater, according as the bone is displaced more directly downwards from the glenoid cavity; while it will become less evident in proportion as it passes obliquely forwards and inwards as well as downwards, for then, although the head of the bone may be beneath the coracoid process, and therefore necessarily below its natural level, the elongation may be compensated for (supposing the measurement to be taken, as it usually is, from the point of the acromion to the external condyle) by the oblique direction inwards which the shaft of the humerus acquires. To insure a correct measurement, it is important, as M. Malgaigne observes, to take care that the two elbows are equally separated from the side, for the separation from the side of course approximates the condyle to the acromion. It is necessary also that the two acromions should be on the same level, and the inferior angle and spinal border of the two scapulæ equidistant from the spine.]

Dissection of the Dislocation downwards.— In all primitive dislocations from violence, and not from paralysis of the deltoid, and a gradual yielding of the capsule, I believe the latter part is always extensively lacerated. In general, authors have paid too little attention to this circumstance, which dissections have repeatedly demonstrated. Desault had two specimens of it imitated in wax; one was in a dislocation inward; the other in a dislocation downward; both of which were met with in subjects who died at the Hôtel Dieu. Bell also mentions similar facts; and another English surgeon, says Bichat, has observed the same occurrence. I suppose Bichat here alludes to Mr. Thompson, who long ago noticed the laceration of the capsule. (See *Med. Ob. and Inq.*)

Desault conceives, that the capsule may be sufficiently torn to let the head of the bone escape; but that the opening may afterwards form a kind of constriction round the neck of the humerus, so as to prevent the return of the head of the bone into the place which it originally occupied. The correctness of this statement, however, is positively denied by Sir A. Cooper, who remarks that they who entertain this belief, must forget the inelastic structure of the capsular ligament, and never have witnessed by dissection the extensive laceration which it suffers in dislocations from violence. (*Surgical Essays*, part i. p. 18.)

I believe that the observation of Mr. Crampton is correct, that at the period when Mr. Hey published the second edition of his *Practical Observations on Surgery*, in 1810, there was but one case on record, in which the actual state of the joint, in a *recent* dislocation of the shoulder, had been described and delineated. (*Case by H. Thompson*, in *Med. Obs. and Inq.* vol. ii. 1761.) Indeed, in this example, eighteen days had elapsed between the reception of the injury and the post mortem examination of the joint. In 1782, Professor Bonn gave the anatomy of several cases of unreduced dislocation of the humerus, but the most recent was of two years' standing. (*Comm. de Humero Luxato; Ph. Crampton*, in *Dublin Journ. of Med. Science*, vol. iii. p. 43.) Hey once saw a compound dislocation of the os humeri, the head of the bone being pushed through the integuments in the axilla; and, in that case, the long tendon of the biceps was torn from its groove; and the tendons of the supra-spinatus and infra-spinatus separated from the bone, a large shell of which was also torn off. (See *Hey's Surgery*, p. 811, ed. 2.) Mr. H. Thompson's dissection is remarkable, as being the oldest on record, and the identical parts are now preserved in University College museum. The tendon of the long head of the biceps was found violently stretched. The head of the bone was lodged at the inner side of the neck of the scapula, below the root of the coracoid process, between the sub-scapularis and serratus magnus. A portion of the humerus, including the greater tubercle, was broken off: and, of course, the supra-spinatus, infra-spinatus, and teres minor, were detached. The sub-scapularis was also torn from its attachment to the lesser tubercle; but both this muscle and the teres minor retained a connection with the periosteum and bone through their external fibres. The neck of the humerus was embraced behind by the subscapularis, and in front by the teres minor. Thompson suspected, that, in some cases, this might make a difficulty in the reduction; and hence, he was an advocate for raising the arm and turning it inwards, so as to relax the subscapularis. He also suspected, that the tendency to a return of the dislocation, sometimes exemplified, might depend on the extensive laceration of the capsular ligament, and the teres minor and subscapularis muscles. (See *Med. Obs. and Inq.* vol. ii. 1761.) Sir Astley Cooper dissected two cases of recent dislocation downwards. In one, on removing the integuments, a quantity of extravasated blood presented itself in the subcutaneous cellular tissue and that covering the axillary plexus of nerves, as well as between the muscles. The axillary artery and plexus of nerves were thrown out of their course by the dislocated head of the bone, which was pushed backwards upon the subscapularis muscle. The deltoid was drawn down by the displaced bone. The supra-spinatus and infra-spinatus were stretched over the glenoid cavity and inferior costa of the scapula. The teres major and minor had undergone but little change of position. The coraco brachialis was uninjured. In the space between the axillary plexus and coraco-brachialis, the head of the bone appeared. The capsular ligament was torn along the whole of the inner side of the glenoid cavity, and *the opening would have admitted a much larger body than the head of the humerus.* The tendon of the sub-scapularis, covering the capsule, was also extensively torn. The opening of the ligament, through which the tendon of the long head of the biceps passed, was somewhat lacerated, but the *tendon itself was not ruptured.* The head of the os humeri was thrown on the inferior costa of the scapula, between it and the ribs; and the axis of its new situation was about *an inch and a half below that of the glenoid cavity.* The subject of the second examination was a woman, fifty years of age, who had had dislocation in the axilla five weeks, and seemed to have *died of violence used in the extension.* The pectoralis major was slightly lacerated, and blood effused; the supra-spinatus was lacerated in several places; and the infra-spinatus and teres minor torn, but less extensively. Some of the fibres of the deltoid, and a few of those of the coraco-brachialis had also suffered; but *none of the muscles were so much injured as the supra-spinatus.* The capsular ligament had given way in the axilla *between the teres minor and sub-scapularis muscles;* the tendon of the sub-scapularis was torn through at its insertion into the lesser tubercle; and the head of the bone rested upon the axillary plexus of nerves and the artery. Sir Astley Cooper next endeavoured to reduce the bone; but finding the resistance too great, he became anxious to ascertain its origin, and divided one muscle after another, cutting through the coraco-brachialis, teres major and minor, and infra-spinatus; still the opposition was but little changed. He then conceived, that the deltoid muscle was the cause of failure, and relaxed it by elevating the arm. He next divided the deltoid, and then found the supra-spinatus his great opponent, *until he drew the arm directly upwards, when the head of the bone* glided into the glenoid cavity. His inference is, therefore, that *the deltoid and supra-spinatus are the muscles which most powerfully resist the reduction.* He considers also, that the best direction for the extension is that of a right angle with the body, or quite horizontally. "This dissection (says he) explains the reason, why the arm is sometimes easily reduced by raising it suddenly above the horizontal line, and placing the fingers under the head of the bone;" namely, because the muscles of opposition are relaxed. (See *Sir Astley Cooper, On Dislocations,* p. 386—389, ed. 4.)

To these interesting cases, which illustrate many important points relative to the dislocation downward, Mr. Crampton has added two others; one of a recent dislocation downward; the other of a recent dislocation forwards under the pectoral muscle, on the sternal side of the coracoid process. In the first, which occurred in 1808, a labouring man was brought into the county of Dublin Infirmary in a dying state, from injuries received by the fall of a wall upon him. After death, which happened in about a couple of hours, the right shoulder-joint, which was dislocated, was carefully dissected, and a drawing made of it. On removing the integuments of the axilla, the cellular membrane, which was extensively ecchymosed, formed a kind of cap, closely embracing the head of the os humeri, which was lodged on the inferior costa of the scapula, or rather on its neck. The *head of the bone,* in escaping from its socket, had *pushed the teres minor downwards,* and *burst through the lower part of the subscapularis muscle, some of the fibres of which closely embraced the neck of the bone, while the bulk of the muscle was pushed upwards, and detached from the inner surface of the scapula.* The short head of the biceps and the coraco-brachialis were forced to describe a curve outwards over the neck of the humerus on the sternal side, while the long head of the triceps crossed the neck of the bone obliquely on the dorsal side. The *tendon* of the *long head of the biceps remained in its groove;* but the sheath, in which it runs, was partially ripped up. The capsular ligament was completely torn from the lower part of the neck of the humerus to the extent of more than half its circumference. The great nerves and blood-vessels were forced to describe a curve backwards by the pressure of the head of the bone, which was in contact with them, The tendons of the supra-spinatus, infra-spinatus, and teres minor, were completely torn off from the humerus, carrying with them the surface of the greater tubercle. Mr. Crampton endeavoured to find out what would have caused, in this case, the chief opposition to the reduction, which of course could not be the muscles attached to the greater tubercle, which was broken off; and he found, that keeping the hand in the supine position created a difficulty by causing the biceps and triceps to get behind the head of the bone. How this position of the radius, however, could in any way affect the triceps, which is inserted into the olecranon, seems to me rather difficult to comprehend. (See *Dublin Journ. of Med. Science,* vol. iii. p. 44.)

[The not unfrequent coexistence of fracture of the greater tuberosity with dislocation of the shoulder has already been noticed. It appears especially to accompany the dislocation downward and *inward* — intra-coracoid of Malgaigne. This surgeon has dissected six specimens of this dislocation, an account of which is given in his work *On Dislocations,* p. 513.]

Symptoms of the Dislocation forwards.—Intra-coracoid, Nélaton ; Sub-clavicular, Malgaigne.—In addition to the general symptoms of dislocation of the humerus, a luxation forwards has the following: — The elbow is separated from the axis of the body, and inclined a little backward ; the humerus seems to be directed towards the middle of the clavicle ; motion backward is not very painful, but that forward is infinitely so ; there is a manifest prominence below the clavicle, under the great pectoral muscle ; and the arm is somewhat shortened. (*Sir A. Cooper, On Dislocations,* p. 435.) The coracoid process is on the outer side of the head of the bone ; which latter part, being lodged between the clavicle, second rib, and the coracoid process, the limb is even less moveable than the dislocation into the axilla.

In the dislocation forwards, the acromion is more pointed, and the hollow below it, from the depression of the deltoid muscle, is much more considerable. Sir A. Cooper also states that the pain attending this accident is slighter than when the head of the os humeri is thrown into the axilla, because the nerves of the axillary plexus are less compressed. [This statement of Sir A. Cooper will scarcely meet with general acception, since this is the position of all others in which the head of the bone is likely to press upon the axillary plexus, and Malgaigne speaks of numbness and other indications of paralysis as being more common in this dislocation than in others. Symptoms, referable to injury of the nerves, are probably owing to *pressure* in this dislocation, but to *stretching* or *laceration* in the subglenoid or subcoracoid varieties.] Dupuytren believed it to be seldom primary, but almost always consecutive to the dislocation downwards. (*Clin. Chir.* t. iii. p. 102.) A dissection by Mr. Crampton, however, leaves no doubt about the possibility of a dislocation forwards being sometimes primary. (See *Dubl. Jour. of Med. Science*, vol. iii. p. 47.) Dupuytren's own description of the manner in which the accident is usually caused, would render this fact sufficiently certain. If this dislocation commonly occur from a fall on the elbow, while separated from the side and inclined backwards (*Dupuytren*, t. iii. p. 101), does not this imply that under these circumstances, the head of the bone would be propelled inwards, or forwards, so as to lacerate the capsule in that direction?

[It has been already explained that this dislocation is often caused by direct force applied to the external and posterior part of the shoulder.

Occasionally the head of the bone in passing forwards occasions a fracture of the coracoid process, as in a case related by Dr. H. M. Colles. (See *Dublin Quart. Journ.* vol. xx. 1855, p. 59.)]

Dissection of the Dislocation forwards. — With respect to the state of the parts in the dislocation forwards, the head of the bone is thrown on the inner side of the neck of the scapula, between it and the second and third ribs. In an old case dissected by Mr. Key, and preserved in the museum at St. Thomas's Hospital, the head of the bone was thrown on the neck and part of the venter of the scapula, near the edge of the glenoid cavity, and immediately under the notch of the superior costa. Nothing intervened between the head of the humerus and scapula, the subscapularis being partly raised from its attachment to the venter. The head was situated on the inner side of the coracoid process, and immediately under the edge of the clavicle, without the slightest connection with the ribs. Indeed, this must have been prevented by the situation of the subscapularis and serratus magnus between the thorax and humerus. The tendons of all the muscles, attached to the tubercles, and the tendon of the biceps, were perfect. The glenoid cavity was completely filled up by ligamentous structure, to which the tendons of the muscles attached to the greater tubercle adhered by means of bands, while in the substance of those tendons a sesamoid bone had been formed to prevent the effects of friction in the motions of the arm. The newly formed socket reached from the edge of the glenoid cavity to about one-third across the venter; and *its surface was irregularly covered with cartilage.* The form of the head of the bone was considerably altered, and the cartilage in many places absorbed. There was a complete new capsular ligament. The pectoralis minor must have passed over the neck of the bone. (See *Ch. Aston Key*, in *Sir A. Cooper*, *On Dislocations*, p. 400, ed. 4.)

The following account of a dissection of the dislocation forwards, in the recent state, was published by Mr. Crampton. It is remarkable, as being an instance of *primary* dislocation forwards, *the head of the bone having been thrown at once on the neck of the scapula, without previously passing into the axilla.* The dislocation was *unattended with the rupture of any muscle*, or the separation of any tendon from its insertion into the bone. The head of the humerus was lodged on the cervix of the scapula at the root of the coracoid process, but extending nearly as far as the notch in the superior costa. It *had passed out through a rent in the capsular ligament, over the upper edge of the tendon of the subscapularis*, detaching this muscle from its connection with the venter of the scapula, and *pushing its fibres downwards*, so that they formed a curve, *which partly embraced the neck of the humerus.* The supra-spinatus and infra-spinatus were on the stretch, but not lacerated. *The opening in the capsular ligament was produced by a separation of it from the interior side* of the *brim of the glenoid cavity from top to bottom, and bounded on the top by the tendon of the supra-spinatus, and at the bottom, by the inferior edge of the tendon of the subscapularis.* It was of sufficient extent, but no more, to *permit the head of the bone to return easily through it.* The inferior part of the capsular ligament, corresponding to the axilla, was perfect. The great blood-vessels and nerves lay on the sternal side of the head of the humerus, *the axis of which was scarcely a quarter of an inch higher* than that of the glenoid cavity. (See *Ph. Crampton* in *Dublin Journ. of Med. Science*, vol. iii. p. 47.) The foregoing case settles the long-disputed question, whether the dislocation forwards is ever primary.

[The dissection of an interesting case of dislocation forwards, combined with fracture of the coracoid process, is described and figured by Dr. H. M. Colles. (See *Dublin Quart. Journ.* vol. xx. 1855, p. 59.)

An account of the dissection of a recent dislocation forwards, drawn up by Mr. Curling, is given by Mr. Bransby Cooper. The subject of it was a man who was thrown down by a cask falling upon him, while at work in the East India Docks, and was so severely injured that he died whilst being carried to the London Hospital. "The right humerus was found to be dislocated forwards beneath the pectoral muscle; the fibres of the deltoid muscle were tense. On reflecting the deltoid and pectoral muscles, the head of the humerus was seen situated in the inner side of the coracoid process, immediately below the clavicle, beneath the pectoralis minor, pushing this muscle forwards, and separated from the serratus magnus by the axillary plexus of nerves. Blood was extravasated under the deltoid muscle, and in the loose cellular substance of the axilla. The nerves, with the artery and vein, were forced from their natural situation to the sternal side of the head of the humerus, which made considerable pressure upon them. The coraco-brachialis and short head of the biceps were upon the stretch. The supra-spinatus, infra-spinatus, and subscapularis were completely detached from the tubercles of the humerus, and the teres minor tightly girted the neck of the bone, a few only of its fibres having been lacerated. The capsular ligament was entirely torn away from the whole circumference of the neck of the humerus. In order to ascertain what impediment might exist to the replacement of the head of the humerus in its natural situation, powerful extension of the limb was made at a right angle with the body ; the dislocation, however, could not be reduced. The short head of the biceps and the coraco-brachialis were next divided, and forcible extension again made, so as to draw the humerus downwards ; but it now became evident that the obstacle to reduction was the tendon of the long head of the biceps, which was so situated as to prevent the passage of the head of the bone to the glenoid cavity ; and during extension this tendon was rendered more tense in proportion to the degree of force applied. The os humeri was afterwards readily replaced in the glenoid cavity, by turning the tendon with the handle of a scalpel over the head of the bone." (See *Sir A. Cooper*, *On Dislocations, edited by B. Cooper*, p. 385, 1842.)

Symptoms of the Dislocation backwards.—The dislocation backwards is particularly characterised by a hard tumor under the spine of the scapula ; and by the somewhat increased length of the arm. The motions of the arm are impaired, but not in so great a degree as in the foregoing cases. [The flattening of the shoulder is only noticeable anteriorly, and the depression under the acromion can only be felt in that situation.] In one example, related by Mr. Toulmin, of Hackney, the arm could be moved considerably either upwards, or downwards ; but, motion forwards, or backwards, was very limited. And from the observations of Mr. Coley, of Bridgenorth, it would seem, that this dislocation may be attended with the peculiarity of the arm lying close to the side. (*Sir A. Cooper, On Dislocations*, p. 441—443.)

In two cases, brought to the Middlesex Hospital, the arm hung by the side, without being directed forwards or outwards. (See *Lond. Med. Gaz.* 1832, 1833, p. 478, and 1833, 1834, p. 142.) The same fact was noticed in a case reduced by Mr. Morton in University College Hospital.

In the cases reported from the Middlesex Hospital, the accident occurred as follows :—In one example, the patient was reaching down a box from the top of another, which was on a bedstead. In doing this, her arm was extended upwards and forwards, the hand being placed so as to receive the box, when this suddenly slipped off the other, and she felt her right arm give way, and fall powerless by her side. In the other, the patient, a woman, aged 94, trod upon some orange-peel, slipped, and fell on the forepart of the shoulder.

[Another case in an old woman has been recorded by Dr. H. M. Colles, also caused by slipping, and falling on the anterior part of her shoulder. (See *Dublin Quart. Journ.* vol. xx. 1855, p. 57.) Direct violence, indeed, appears to be the most frequent cause of this dislocation.]

In a dead subject, Boyer remarked a singular inclination of the glenoid cavity backwards, its articular surface also presenting on this side an extraordinary elongation, and the humerus readily slipping under the spine of the scapula. (*Mal. Chir.* t. iv. p. 176.) In the patient, whose history was published by M. Fizeau, and in whom a dislocation of the humerus outwards and backwards was seen both by that gentleman and Boyer, there was also the peculiarity, that the luxation was readily reproduced. (*Journ. de Méd. par Corvisart, &c.* t. x. p. 386.) Hence, Boyer suspects that this rare kind of displacement must have been facilitated by some preternatural disposition of the articular surfaces. Experience proves, however, that this is not an essential or even a common circumstance.

[Sir A. Cooper only met with two examples of this dislocation in 38 years, and he therefore considered it an extremely rare accident. It is, however, not quite so uncommon as he supposed ; Malgaigne refers to thirty-five recorded examples, three of which came under his own immediate observation. Four cases have been seen by the present editor, Mr. S. Lane. In these latter, there was great similarity in the symptoms. In all, the dislocated limb was hanging down, with the forearm and hand advanced somewhat in front of the body; the elbow was only slightly flexed, and nearly in contact with the side; the hand assumed a position of pronation. The limb, measured from the acromion to the point of the olecranon, was somewhat shorter than that of the opposite side. One of the patients was under observation for 10 years, another for 5 or 6; in neither of these did the displacement recur. The remaining two were hospital patients, and did not return for advice.]

Dissection of the Dislocation backwards.—Sir A. Cooper has given an account of the dissection of an old dislocation *backwards*. The accident had happened seven years previously—in a paroxysm of epilepsy. It was reduced without difficulty by extension, but the bone would not remain in the glenoid cavity. The head of the os humeri was found to occupy the space between the inferior costa and spine of the scapula. The tendon of the subscapularis muscle and the internal portion of the capsular ligament, had been torn at the insertion of that muscle ; but the greater part of the posterior portion of the capsule remained, and had been thrust back with the head of the bone, the back part of which it enveloped. The supra-spinatus muscle was put upon the stretch ; the subscapularis was diminished by want of action ; and the infra-spinatus and teres minor muscles were shortened and relaxed, as the head of the bone carried their insertions backwards. The tendon of the long head of the biceps was carried back with the head of the bone and elongated, but it was not torn. The laceration of the tendon of the subscapularis muscle probably accounted for the head of the bone not remaining in its natural cavity when reduced. (*Sir A. Cooper, On Dislocations, edited by B. Cooper*, p. 394.)

M. Laugier dissected a recent case of dislocation backwards, in which the tendon of the subscapularis was in like manner torn from its insertion. The supra-spinatus was also torn, and the head of the bone, having passed between the infra-spinatus and teres minor, was in contact with the under surface of the deltoid muscle. Another dislocation backwards was dissected by M. Maisonneuve. In this case the capsule was torn at its superior, external, and posterior parts, the great tuberosity was broken off, and was retained under the coraco-acromial ligament by the tendons of the supra and infra-spinati muscles. The head of the bone, having passed between the latter muscle and the teres minor, was covered only by the deltoid. The teres minor and subscapularis preserved their humeral attachments. The long tendon of the biceps had torn the fibrous sheath which retains it in its groove. (See *Malgaigne*, t. ii. p. 537, and pl. xxii.)

Many other detached dissections of the different dislocations of the shoulder have been placed on record by various authors. The additional dissections show endless deviations in the exact extent of the injury in each individual case; but the main features of each are sufficiently explained by what has been already stated.]

Incomplete Dislocation—downwards and forwards.—The principle was formerly inculcated, that all dislocations of orbicular joints were *complete;* but Sir Astley Cooper and Baron Dupuytren proved that dislocations of the shoulder may be *incomplete;* and the latter makes a similar statement also with regard to dislocation of the hip. (*Clin. Chir.* t. iii. p. 104.) The head of the humerus bursts through the anterior part of the capsule, and, without entirely quitting the articular cavity, lies upon the outer side of the coracoid process.

[The symptoms are thus described by Sir A. Cooper: "The head of the bone is drawn forwards against the coracoid process; there is a depression opposite the back of the shoulder joint, and the posterior half of the glenoid cavity is perceptible, from the advance of the head of the bone; the axis of the arm is thrown inwards and forwards; the inferior motions of the limb are still capable of being performed, but its elevation is prevented by the head of the humerus striking against the coracoid process; there is an evident protuberance formed by the head of the bone in its new situation, which is felt readily to roll when the arm is rotated." The causes are probably much the same as those which produce the dislocation forwards. (*On Dislocations, &c. edited by Bransby Cooper*, p. 401.)

The relation of the coracoid process to the glenoid cavity will scarcely permit the head of this bone to pass directly forwards, so as to rest, as is usually stated, against the *outer* side of the process, but it probably always passes, as M. Malgaigne maintains, somewhat *downwards* as well. This position assigned to the head of the bone by M. Malgaigne is in accordance with the description given by Sir A. Cooper of one of the cases which he observed, for he speaks of the head of the humerus as resting *against and under* the coracoid process, which was with difficulty felt above and to its inner side. (Loc. cit. p. 401.)

Mr. South, some years since, published an account of a case of incomplete dislocation forwards, combined with fracture of the coracoid process, and he believed that it was not possible for the accident to happen excepting this process were fractured at the same time. (*Med. Chir. Trans.* vol. xxii. 1839, p. 100.) This opinion may be correct, as far as regards a dislocation *directly forwards* against the *outer* side of the process; there are, however, several well authenticated cases on record of incomplete dislocation *downwards* and forwards, in which the nature of the displacement has been proved by post-mortem inspection. (See *Sir A. Cooper*, p. 401, and *Malgaigne*, p. 494.) In three instances of old dislocation referred to by the latter author, the head of the humerus had become deeply grooved by pressure against the anterior border of the glenoid cavity.]

[*Dislocation upwards—Supra-coracoid.*—The following case came under M. Malgaigne's observation:—A man, æt. 68, was thrown out of a vehicle, and fell upon his shoulder, his arm being pressed against his side. He was not seen by M. Malgaigne till two months and a half after the accident. The head of the humerus was found to be dislocated forwards and upwards, above the coraco-acromial ligament, corresponding externally with the internal border of the acromion, covering internally the coracoid process, reaching upwards to the lower surface of the clavicle, and raising the deltoid so much that a pin inserted perpendicularly over the most prominent part showed that it was only covered by soft parts to the depth of about a third of an inch, while more internally it had separated the deltoid and pectoral muscles, and was even still nearer to the surface. The arm was shortened about a quarter of an inch. Reduction was attempted with the pulleys, but without success. M. Malgaigne thought then of dividing subcutaneously the coraco-acromial ligament, which seemed to oppose the reduction, but on reflection thought it better to abstain from doing so. The dislocation, therefore, remained unreduced. (*Traité des Fract. &c.* vol. ii. p. 530.)

A very similar accident, combined, however, with fracture of the coracoid process, was under Mr. Tatum's care in St. George's Hospital. The case has been described by Mr. T. Holmes. The patient fell from a considerable height upon a heap of stones, striking the head, left side of the chest, and left elbow. The elbow joint was laid open, and the upper end of the ulna broken into numerous pieces. There was a large rounded prominence in front of the outer part of the clavicle. There was crepitus on moving the arm, which was shortened, and the elbow was directed away from the side. Mr Tatum came to the conclusion that the head of the bone was dislocated, and that the crepitus arose from fracture of the coracoid process, but in consequence of the dangerous condition of the patient from the injury to the head, no attempts at reduction were made. He died a fortnight after the accident. In the dissection, the head of the humerus was found immediately under the skin, having passed through the fibres of the deltoid, and having the cephalic vein on its inner side. It had fractured the coracoid process in its passage upwards, and was resting behind on the stump of this process, and on the clavicle. Internal to it was the fractured extremity of the coracoid process, with the muscles attached to it. External and posterior to it was the acromion process, separated from it by some fibres of the deltoid. Below and a little external to it was the glenoid cavity. The long head of the biceps remained attached to the scapula, and was situated below, and external to, the head of the humerus. The muscles attached to the greater tuberosity were torn through, but the subscapularis was intact. The capsular ligament had been torn through at its upper and inner part, forming a large hole for the passage of the head of the humerus. A case in many respects similar was under Mr. Prescott Hewitt's care in St. George's Hospital, but in this instance the state of the parts was not verified by post-mortem inspection, as the dislocation was reduced and the patient rapidly recovered. (See *Med. Chir. Trans.* vol. iii. 1858, p. 447.)]

[*Partial Dislocation upwards.*—A case of partial dislocation of the humerus upwards, combined with a displacement of the tendon of the biceps form its groove, has been recorded by Mr. John Soden, jun. (See *Med. Chir. Trans.* vol. xxv.

1841.) A man, æt. 59, injured his shoulder by falling backwards, and receiving the weight of his body upon his elbow. After the subsidence of the severe inflammatory symptoms which supervened, the joint was found to be slightly flattened at its outer and posterior part, and the head of the bone looked as if it were drawn up higher in the glenoid cavity than it should be. On moving the limb, a crepitating sensation was produced, simulating a fracture, but in reality caused by the friction of the head of the humerus against the acromion. On attempting abduction, the arm could not be raised beyond a very acute angle with the body, from the upper edge of the greater tubercle coming in contact with the acromion. The head of the bone was also unduly prominent in front. The arm could be readily swung backwards and forwards, but was powerless for all useful purposes, and severe pain was induced by any action of the biceps muscle. Six months after the accident, the man was brought into the Bath Hospital with a compound fracture of the skull, and died in a few days. On examining the joint, the long head of the biceps was found dislocated from its groove, and lying on the lesser tuberosity of the humerus. The capsule was slightly ruptured. The head of the humerus came in contact with the under surface of the acromion, and ulceration of the cartilage covering it had commenced. In consequence of this case, Mr. Partridge made some experiments to ascertain to what extent, and by what means, partial dislocation could be artificially produced. He found, though the capsule was completely divided, that so long as the tendon was undisturbed, no displacement of the bone upwards and forwards could be effected; and that division of the tendon alone was insufficient; but when the incision through the tendon included a small portion of the capsule, all impediment to the dislocation was removed. (*Sir A. Cooper, On Dislocation, &c. edited by B. Cooper*, p. 407.) In the museum of the Medico-Chirurgical Society of Aberdeen there is a preparation of an unreduced partial dislocation upwards, which in all respects very closely agrees with the description and drawing of the case related by Mr. Soden. It was taken from the body of a subject brought to one of the dissecting rooms in Aberdeen. (*Pirrie's Surgery*, p. 298.)

An account of the dissection of another case of partial dislocation upwards, has been published by Mr. Alfred Smee. This case differed from Mr. Soden's, in being accompanied by rupture instead of displacement of the tendon of the biceps; the ruptured end had adhered firmly to the bicipital groove, and consequently had lost all immediate influence on the joint itself. The upper part of the great turberosity was converted into an articular surface, and corresponded to another smooth surface formed under the acromion. (See *Lancet*, vol. i. 1845, p. 323.) Mr. Callaway believes that the cases described as incomplete dislocations of the shoulder may not unfrequently depend on injury of the long tendon of the biceps. In his investigations on this subject, he collected records of twenty-two cases of injury of this tendon; of these, five were dislocations, and the remaining seventeen ruptures. Both the dislocation and the rupture of the tendon, he observes, are accompanied by lateral and posterior flattening of the shoulder and prominence of the head of the bone anteriorly, from which latter circumstance it arises that the injury may be mistaken for a partial dislocation. Rupture of the tendon, says Mr. Callaway, usually takes place in persons beyond the meridian of life; the usual situation of the separation is about midway between the glenoid cavity and the anatomical neck of the humerus. Should it occur within the groove, there is more marked retraction of the separated portion of the belly of the muscle, because it, in this instance, escapes from the groove. In three cases observed by Mr. Barron, the tendon was detached from its natural origin at the glenoid cavity, but adhered instead, and still by its extremity, to the upper part of the bicipital groove. Of the five cases of dislocation, the tendon was dislocated inwards and to the lower part of the joint, in three: it was lodged respectively on the greater and lesser tuberosities in the two others. In the dislocation there appears to be more pain and greater loss of power than in the rupture of the tendon. The subsequent inflammation also is more severe, and the patient is longer in recovering the use of his arm. Mr. Stanley, who has related three cases of injury of this tendon, found that in one the slightest movement of the arm backwards, and in another, pressure upon the joint, were followed by acute pain, precisely in the situation where the tendon of the biceps turns over the head of the humerus. The symptoms of these injuries being obscure, and the deformity slight, they are probably often considered simply as sprains, or bruises, but they will differ from a sprain or bruise, in requiring a much longer period for their reparation. In the rupture, the repair will consist in adhesion of the tendon to the bicipital groove; in the dislocation, it will form for itself new connexions, and will by degrees accommodate itself to its new position, and by degrees the movements of the joint will be more or less perfectly recovered. Any treatment directed to the replacement of the tendon, if it is believed to be dislocated, is unlikely to prove effectual; it will be better to keep the joint at rest, and counteract inflammatory symptoms, and as there is usually a tendency to displacement of the head of the humerus forwards, it should be thrown backwards by bringing the elbow forwards and fixing it in a sling. (See *Callaway, On the Shoulder Joint*, p. 143, 1849. *Dr. Robert Knox, On an Altered Condition of the Tendon of the Biceps, Lond. Med. Gaz.* vol. i. 1828, p. 404. *E. Stanley, On Rupture of the Tendon of the Biceps, Lond. Med. Gaz.* vol. iii. p. 12, 1828. *J. Gregory Smith, Pathological Appearances of Seven Cases of Injury to the Shoulder Joint, Lond. Med. Gaz.* vol. xiv. 1834, p. 280. *E. E. Barron, Peculiar Formation of the Biceps Muscle, Lond. Med. Gaz.* vol. xx. 1837, p. 554.)]

The following singular observation is recorded by Baron Larrey: —

"Among the curious anatomical preparations, (says he) which I saw in the cabinet of the university of Vienna, there was a dissected thorax, shown to me by Professor Prokaska, in which the whole orbicular mass of the head of the right humerus, engaged between the second and third true ribs, projected into the cavity of the chest. This singular displacement was the result of an accidental luxation, occasioned by a fall on the elbow, while the arm was extended and lifted from the side. The head of the humerus, after tearing the capsular ligament, had been violently driven into the hollow of the axilla, under the pectoral muscles, so as to separate the two corresponding ribs, and pass between them. The head of the bone surmounted this obstacle, and penetrated entirely into the cavity of the thorax, pushing before it the adjacent portion of the pleura. Every possible effort was made in vain to reduce this extraordinary dislocation. The urgent symptoms which arose were dissipated by bleeding, warm bathing, and antiphlogistic remedies. The arm, however, remained at a distance from the side, to which condition the patient became gradually habituated ; and after several years of suffering and oppression, he at length experienced no inconvenience. The patient was about sixteen or seventeen when he met with the accident ; and he lived to the age of thirty-one, when he died of some disease, which had no connection with the dislocation. His physicians were anxious to ascertain the nature of this curious case, of which they had been able to form only an imperfect judgment. They were much surprised to find, upon opening the body, the head of the humerus lodged in the chest, surrounded by the pleura, and its neck closely embraced by the two ribs above specified. They were still more astonished to find, instead of a hard spherical body covered with cartilage, only a very soft membranous ball, which yielded to the slightest pressure of the finger. The cartilage and osseous texture of the whole portion of the humerus, contained within the cavity of the chest, had entirely disappeared. Of the humerus, there remained only some membranous rudiments of its head, and a great part of these seemed to belong to the pleura costalis." (*Mém. de Chir. Milit.* t. ii. p. 405—407.)

[*Complications*—Dislocations of the shoulder may be complicated with fracture of the bones in the immediate neighbourhood of the joint, or with injury to the large nerves or blood-vessels of the upper extremity.

Dislocation with Fracture.—The frequent occurrence of fracture of the greater tuberosity of the humerus with dislocation of the shoulder, has been already alluded to. Sometimes the dislocation is associated with fracture of the neck of the humerus, anatomical or surgical, or with fracture of the glenoid cavity of the scapula. These latter cases it will be more convenient to speak of in the article FRACTURE, to which therefore the reader is referred.

Injury of Nerves—Paralysis.—One consequence, mentioned by Avicenna, is a palsy of the upper extremity, arising from the pressure made by the head of the bone upon the axillary plexus of nerves.

The paralysis may affect the entire limb, or may be confined to particular portions of it. More often it is not present, or, at any rate, it is not noticed, till two or three days after the accident. Paralysis of the deltoid muscle has been not unfrequently observed, from injury to the circumflex nerve, which, as Boyer observed, is especially liable to be overstretched. A case has lately come under the observation of the writer, in which, in addition to the circumflex nerve, the musculo-cutaneous nerve would appear to have been injured. The patient has lost all power of raising the arm from the side, and also of flexing the elbow joint. The deltoid, the biceps, and brachialis anticus muscles are wasted, but the triceps, and all the muscles of the fore arm, both flexors and extensors, are unaffected.

In some cases there is loss of sensation, or numbness, tingling or pricking of the skin, in addition to the muscular paralysis, but more frequently common sensibility is unaffected. Mr. Callaway has related a case, under the care of Mr. Cock, in which the parts supplied by the median and ulnar nerves were paralysed, both as regards motion and sensation. (*Callaway, On the Shoulder Joint*, p. 137, 1849.) Laceration of the circumflex nerve was once met with by Mr. Hilton, in a post-mortem examination, where the patient had died from other injuries. (*Guy's Hosp. Reports*, 1847, vol. v. p. 92.) Sometimes the affection subsides by degrees, disappearing entirely after a longer or shorter period; sometimes it is persistent, the difference depending, no doubt, upon the degree of pressure, stretching, or laceration, to which the nerves have been subjected.

Desault twice met with complete paralysis of the limb; in one of the patients it was permanent, in the other it disappeared at the end of fifteen days. Boyer saw three cases of paralysis of the deltoid, resulting from the dislocation downwards. In two the affection yielded to the employment of counter-irritants; in the third it persisted for the remainder of the patient's life. M. Nélaton met with one case of paralysis of the deltoid, which was treated with large blisters, and disappeared ten days after the reduction of the dislocation. (*El. de Pathol. Chir.* t. ii. p. 368.)

In the case recorded by Mr. Callaway recovery took place very slowly, and was not complete till nearly two years after the accident. Blisters, stimulating liniments, and galvanism, are the measures most likely to prove beneficial.

Injury of Blood-vessels.—M. Nélaton met with a case of dislocation downwards, where the axillary artery was injured, and an aneurism was the result, for which, three months after the accident, ligature of the subclavian artery became necessary. Notwithstanding the ligature, however, the aneurism gave way, and the patient died. In a case observed by M. Bérard, the two internal coats of the artery were torn through, and the external coat elongated into a narrow tube. The artery became obliterated, gangrene took place, and the patient died. Fortunately, these complications are of rare occurrence.]

Reduction of Dislocations of the Shoulder Joint.—We may refer to two general classes, the infinitely various means for the reduction of a dislocated humerus. The first are designed to push back, by some kind of mechanical force, the head of the bone, into the cavity from which it is displaced, either with or without making previous extension. The others are merely intended to disengage the head of the bone from the place which it accidentally occupies, leaving it to be put into its natural situation by the action of the muscles. The first all act nearly in the following manner: — Something, placed under the axilla, serves as a fulcrum, on which the arm is moved as a lever, the resistance being produced by the dislocated head of the humerus, while the power is applied either to the lower part of this bone, or the wrist. The condyles of the humerus being drawn downward and inward, the head of the bone is necessarily moved in the opposite direction, towards the glenoid cavity, into which it slips with more or less facility. Thus operated the machine, so celebrated among the ancients and moderns, under the name of the ambe of Hippocrates; whether used exactly in the form described by him, or with the modifications devised by Paul of Ægina, Ambrose Paré, Duverney, Freke, &c.

Extension removes the bone from its unnatural situation, and has been executed in different ways. Sometimes, the weight of the body on one side, and the dragging of the end of the dislocated bone on the other, tend to produce this effect. Such was the action of the ladder, door, &c. described in Hippocrates's Treatise on Fractures, and repeated in modern works. Sometimes, the trunk is fixed in an unchangeable manner, while the arm is extended, as is practised in employing the machine of Oribasius, one of the methods formerly adopted in public places, where wrestlers combated. Sometimes no extension is sensibly executed; and while the end of the humerus is pushed outward by a body placed under the axilla, the surgeon pushes it upward into the glenoid cavity.

The following are the objections common to all these contrivances: — However well covered the body placed under the axilla may be, to serve as a fulcrum, there is always a more or less inconvenient chafing, frequently dreadful stretching and laceration of parts, in consequence of its application, when the trunk is suspended upon it, as in the instance of the door, &c. In this way, Petit saw a fracture of the neck of the humerus produced, and even a laceration and aneurism of the axillary artery.

Desault often employed the following method: — While the patient was seated upon a chair of moderate height, he took hold of the hand on the affected side, placed it between his knees, which he moved downward and backward, in order to make the extension and disengage the head of the bone, while an assistant held back the trunk to effect the counter-extension. This was sometimes executed by the weight of the body, and effort of the patient. At the same time, the surgeon's hands were applied to the arm, in such a way, that the four fingers of each were put in the hollow of the axilla, and the thumbs on the outer part of the arm, which being pushed upward, and a little outward, the head of the humerus usually returned with ease into its natural cavity.

Petit describes this plan, but combined with the use of a napkin, passed under the patient's axilla, and over the surgeon's neck, who raises the dislocated end of the bone, by extending his head.

When the luxation downward was very recent, Desault occasionally reduced it by a still more simple process; namely, by placing his left hand under the axilla, to serve as a fulcrum, while with the right, applied to the lower and outer part of the arm, he depressed the humerus towards the trunk, and at the same time raised the upper part of the bone. The head of the humerus, directed upward and outward by this double motion, returned into the glenoid cavity without the least resistance.

Reduction, by means of the surgeon's heel in the patient's axilla, is commended by Sir Astley Cooper as the best in three-fourths of recent dislocations. The patient (he observes) should be placed in the recumbent posture, upon a table, or a sofa, and near its edge. "The surgeon then binds a wetted roller round the arm, immediately above the elbow, upon which he ties a handkerchief. Then, with one foot resting on the floor he separates the patient's elbow from his side, and places the heel of his other foot in the axilla, receiving the head of the humerus upon it, whilst he himself is in the sitting posture by the patient's side." The arm is then steadily drawn with the handkerchief for three or four minutes, at the end of which the bone in common cases is easily replaced. If more force be required, a long towel can be used, which several persons may pull. Sir Astley Cooper generally bends the fore-arm nearly to a right angle with the os humeri, because this position relaxes the biceps, and lessens its resistance: in many cases, however, he makes the extension at the wrist; a plan, in which he finds more force requisite, but the bandage is less apt to slip.

[Mr. Skey thus explains the mechanism of the reduction by means of the heel in the axilla. "It should be constantly kept in mind," he observes, "that the shoulder-joint has this peculiarity in its construction, viz. that it is composed of two bones, each of which is movable on the trunk, and that, in the act of extension, we not only affect the position of the bone we are extending, but, through the agency of the muscles connecting them, we also affect the relations of the bone we are extending *from*; and in the case of the humerus and scapula, that the agents of extension do affect both bones, cannot be doubted." Fixing the scapula he considers useless and objectionable, since by doing so, "we retain the glenoid cavity in a direction looking straight outwards from the trunk; but if we leave the scapula untouched, then by the act of drawing down the humerus, we depress at the same time the acromion, by means of the deltoid which is attached to both. The consequence is, that in depressing the acromion, *we direct the socket of the bone towards the dislocated head*, and readily get rid of the obstacle, which is often immediately caused by the rim of the glenoid cavity alone, and we bring the two surfaces of bone within the range of what I may call their natural affinity, and by the agency of which they immediately coalesce. With the heel in the axilla, we make a simple extension of the arm from the wrist; we leave the scapula unfettered, to assume its own direction; and by the extending force, slightly as it is applied by one person only, *the scapula is made to revolve on its centre through the leverage exercised on the acromion by the deltoid*; and the pectoralis major and latissimus dorsi, being this relaxed, exercise no prejudicial influence on the movements of the humerus. I have seen the protracted efforts of pulleys, drawing outwards, fail again and again, with the utmost effort, when the head of the bone has been restored to the glenoid cavity, by the single agency of one person subsequently placing his heel in the axilla." (*Skey, Op. Surg.* p. 86.)]

Another simple mode of reduction, which Sir Astley Cooper considers proper for recent dislocations, delicate females, and very old, relaxed, emaciated persons, is that by means of the surgeon's knee, as a fulcrum, in the patient's axilla. The patient is placed on a low chair, on the side of which the surgeon rests his foot, while he takes hold of the os humeri just above the condyles, and applies his other hand to the acromion. The arm is then drawn down over the knee, and the head of the bone returns into its place. (*On Dislocations*, p. 432.)

When the muscles are very powerful, or the displacement has continued several days, Sir Astley Cooper, instead of the treatment by the heel in the axilla, recommends the patient to be put upon a chair, and the scapula to be fixed by means of a bandage, which allows the arm to pass through it, and is buckled on the top of the acromion so that it cannot slip downward. A wetted roller is next applied round the arm, just above the elbow, and over the roller a strong worsted tape, fixed with what the sailors term the *clove-hitch* knot. The arm should now be raised to a right angle with the body; and, if much difficulty be experienced, *even above the horizontal line, in order to relax more completely the deltoid and supra-spinatus muscles.* Two persons are then to pull the worsted tape, and two the scapula bandage, in opposite directions, with a steady, equal, and combined force. After the extension has been kept up a few minutes, the surgeon is to place the knee in the axilla, with his foot resting upon the patient's chair; he now raises his knee, while he pushes the acromion downwards and inwards, and the head of the bone usually slips into the glenoid cavity. Sometimes, Sir Astley Cooper has seen a gentle rotatory motion of the limb, made during the extension, bring about the reduction.

In old cases, and others attended with great difficulty from the powerful contraction of the muscles, Sir Astley prefers making the extension with pulleys, because with them, when the resistance is likely to be long, jerks and unequal force are more likely to be avoided than in the preceding method of reduction; and the assistants less apt to be fatigued. The patient sits between two staples, which are screwed into the sides of the room; the bandages are then applied precisely in the same way as when the extension is made without pulleys; and the force is applied in the same direction. The surgeon is to pull the cord of the pulleys gently and steadily until pain is complained of, when he is to maintain the extension already made, but not increase it. In two or three minutes, more force should be applied and very gently increased, until pain be again complained of, when another stop should be made. The surgeon should proceed in this way for a quarter of an hour, at intervals slightly rotating the limb. When the extension seems great enough, an assistant should hold the cord of the pulleys, and keep up the degree of extension, while the surgeon puts his knee into the axilla, and resting his foot upon the chair, gently raises and pushes back the head of the bone towards the glenoid cavity, into which it generally returns without the snap usually heard when the reduction is effected by other means. Sir Astley Cooper precedes the use of the pulleys with venesection, the warm bath, and a grain of tartarised antimony every ten minutes, until faintness is produced. (*On Dislocations*, p. 942.)

[This plan of counteracting muscular resistance is no longer adopted in the present day. In all old cases, and in recent ones when the resistance of the muscles is great, chloroform should be administered, and its *full* effect should be obtained before the surgeon commences his operations. The *partial* influence of chloroform is almost invariably productive of muscular contraction, and is therefore worse than useless.

According to Mr. Skey, there is no reason why the principle of the heel in the axilla, of which he approves strongly, should not be applied conjointly with the use of pulleys. For this purpose, he "employs a well-padded iron knob, which may represent the heel, from which there extend laterally two strong straight branches of the same metal, each ending in a bulb or ring of about four inches in length, the office of which is designed to keep the margins of the axilla as free from pressure as possible ; for what operation can be more absurd than the endeavour to fix the scapula by means of girds carried round the shoulder, in which we include the margins of this cavity, viz.: the pectoralis major and the latissimus dorsi, as in a vice, and by which we endeavour to drag up the arm, *at the same instant that we make the most strenuous efforts to drag it down by a yet inferior force?* It is of the utmost importance to have the margins of the axilla untrammelled, in order that the bone be allowed to descend unchecked, at least by our own agency. The iron knob should be passed high up into the axilla, and attached to the cord fastened into a staple. The person of the patient should be placed on the back, or inclined over on to the opposite side, and the cords passed up on each side of the shoulder, one in front and the other behind the joint ; the arm should be drawn downwards, as nearly as possible parallel to, and in contact with, the body. Extension should be made from the wrist, and, especially in old cases, continued gradually. As the humerus descends the scapula will roll forwards, and the glenoid cavity, instead of starting away from the head of the humerus, will be directed downwards towards it, in the axillary cavity, or equally so when under the pectoral muscle ; and although I have never employed the same means in reducing dislocation on the dorsum scapulæ, I have no doubt of its power to accomplish it." (*Op. Surg.* p. 87.)]

In Dublin, the extending power is applied to the wrist, as in France and Germany. (*Ph. Crampton*, *Dubl. Jour.* vol. iii. p. 182.) This gentleman also expresses a doubt about the possibility or advantage of fixing the scapula.

[Mr. Vincent appears to think that the extension, as usually practised, is often unnecessary, even in old cases. According to him, "it is not by the force of extension, but by the adaptation of appropriate manipulation, that *old cases* are to be reduced." Thus, in a case in which the head of the humerus had been luxated seven weeks, and extension had been conducted in the usual way for a long time and with the fullest force, without effect, *he drew the limb across the chest obliquely*, and by this means returned the head of the bone into the glenoid cavity with very little effort. In another case of six weeks' standing, after having tried the usual plan in vain ; by first drawing the arm down, and then carrying it across the chest over the body, the bone slipped easily into its place. (See his *Obs. on some parts of Surgical Practice*, p. 27, London, 1847.) In these cases, however, the adhesions had probably been broken down by the extension previously practised ; and it may be doubted whether, had this not been the case, the reduction would have taken place so easily as it did.]

For the purpose of preventing the head of the bone from slipping out of its place again, the arm should be kept for some days quiet, the elbow bandaged close to the side, and supported in a sling. Sir Astley Cooper recommends a cushion to be put into the axilla, and a stellate bandage and sling to be applied. (*On Dislocations*, p. 432.) After the reduction of a dislocation downward, the facility of a fresh displacement is said to depend very much upon the extent to which the tendon of the subscapularis muscle has been lacerated. (*Sir A. Cooper's Surgical Essays*, part i. p. 7.) The swelling about the joint, brought on by the accident, usually disappears without trouble.

Pott and Sir Astley Cooper are of opinion, that the narrowness of the opening in the capsular ligament can never create any impediment to the reduction. But Desault and Hey (*Pract. Obs.* p. 301, ed. 2), entertained the opposite opinion; and hence the former was an advocate for moving the head of the bone about very freely, with the view of lacerating the capsule more extensively. Messrs. Logan and Hey, of Leeds, sometimes succeeded with slight extension, and gentle motion of the bone in various directions. This practice answered in several cases, where the head of the humerus had passed far under the pectoral muscle. (See *Hey's Surgery*, p. 311, ed. 2.)

Mr. C. White, of Manchester, also believed that the reduction was sometimes prevented by the head of the bone not being able to get through the laceration in the capsule again. He succeeded in reducing some cases, which he supposed to be of this nature, in the following manner:—Having screwed an iron ring into a beam at the top of the patient's room, he fixed one end of the pulleys to it, and fastened the other to the dislocated arm by ligatures attached to the wrist, placing the arm in an erect position. In this way, he drew up the patient, till his whole body was suspended; but, that too much force might not be sustained by the wrist, Mr. White at the same time directed two other persons to support the arm above the elbow. He now used to try with his hands to conduct the arm into its place, if the reduction had not already happened, as was sometimes the case. Occasionally a snap might be heard, as soon as the patient was drawn up; but the reduction could not be completed till he was let down gain, and a trial made with the heel in the armpit. When no iron ring was at hand, Mr. White used to have the patient raised from the ground by three or four men, who stood upon a table. (*Cases in Surgery*, p. 95.)

There can be little doubt, that the success of Mr. White's plan was not owing to its action on the opening in the capsule, but depended upon another principle, first explained by Sir Astley Cooper, and mentioned by him in italics, that it may receive due attention. Mr. Crampton takes a similar view:—"If it be true (says he) that, in some cases, the supraspinatus muscle, retaining its connection with the greater tubercle, is the cause of the resistance to the extending power (*Sir A. Cooper on Dislocations*, p. 377), it is obvious, that this resistance can be best overcome by raising the arm, and thus relaxing the opposing muscle. The success, which not unfrequently attends the method of reduction first recommended by Mr. White, of Manchester, by drawing the arm directly *upwards*, in a line parallel to the axis of the trunk, *is no doubt to be attributed to the relaxation* which it effects *of the supraspinatus and deltoid muscle.* It is probable also, that, in this position of the humerus, the head of the bone is in some measure unlocked from the neck of the scapula, against which it is, when dislocated downwards, strongly compressed by the contraction of the muscles." (*Crampton in Dublin Jour. of Med. Science*, vol. iii. p. 181.) Mr. Hey, also, sometimes adopted White's method for old dislocations, especially those under the pectoral muscle. The usefulness of raising the arm to lessen the pressure of the edge of the glenoid cavity against the neck of the humerus is likewise particularly pointed out by him. (*Pract. Obs. on Surgery*, p. 299, ed. 2.) According to Mr. Crampton, the practice was at one time common in Steevens' Hospital, as the large ring in the cross-beam of the ante-room testifies. In relation to the merit of the first introduction of this plan, Mr. Crampton justly assigns it to Mr. C. White:—"The British surgeon (he observes) will be a little surprised to find this method introduced as a new and important mode of reduction in the Hôtel-Dieu. M. Malgaigne, the gentleman who introduced the practice to the notice of Dupuytren, stated that the anatomy and pathology of this kind of dislocation had led him to adopt this method, before he was acquainted with the method of Mothe (White?) The method of Mothe, as stated by M. Malgaigne, 'consists in making extension, the arm being lifted up forcibly, and consequently shortened, instead of extending the limb in a depressed, or elongated position.' (*Crampton in Dublin Jour. of Med. Science*, vol. iii. p. 182.) M. Mothe's memoir was presented to the Academy of Surgery in 1785. Mr. White's paper was printed in 1764. It is but justice to M. Malgaigne to mention, that Mr. Crampton has here supposed that Mr. White's first suggestion of the practice has not been admitted by M. Malgaigne. On the contrary, he states, that the anatomy and pathology of the shoulder-joint led him to adopt the practice, before he had become acquainted with White's observations, who had formerly resorted to it, though only in old dislocations. (See *Gaz. Méd. de Paris*, Sept. 1832. He only proposed it also as "*une méthode inusitée en France.*" (See *Dupuytren*, *Clin. Chir.* t. iii. p. 86.) I am glad to have had this opportunity of doing justice to M. Malgaigne, whose observations on many parts of surgery reflect the highest honour upon him: and even on this subject he comes off with reputation; for, though it was Mr. Charles White that first adopted the practice, it was Sir Astley Cooper, and M. Malgaigne, who first gave a scientific description of the principles on which its efficiency depends.

[In his last work on dislocations, M. Malgaigne does not approve of so great an elevation of the arm as was recommended by White and Mothe; on the contrary, he thinks that this exaggerated elevation occasions a triple inconvenience, because, 1st, it stretches beyond measure the pectoralis major, teres major, and latissimus dorsi muscles; 2nd, it brings the neck of the humerus in contact with the acromion, friction against which constitutes an additional obstacle; 3rd, it applies the long portion of the triceps against the glenoid cavity, which is thus closed against the head of the humerus. According to him, it is sufficient to elevate it until its axis is nearly parallel to the axis of the glenoid cavity; which axis corresponds nearly with a line drawn from the centre of the cavity to the middle of the triangular surface which terminates the spine of the scapula. The elbow should be carried slightly *backwards* at the same time that the arm is elevated. In this attitude, the deltoid, biceps, coraco-brachialis, supra-and infra-spinati, subscapularis, and triceps muscles are relaxed, and so also is the uninjured portion of the capsular ligament. He says that, occasionally, especially in women, he has found it sufficient simply to elevate the arm without making any traction upon it, and then the hand being placed in the axilla as a precaution to prevent the bone slipping out again, he brings the elbow down to the side. In this proceeding, the head of the bone is probably brought to the level of the glenoid cavity, and is then replaced by the action of the muscles. In general, however, moderate extension, combined with the elevation, will be necessary. The mode of proceeding should be varied according to circumstances. When the muscular development is not great, he contents himself with pressing the shoulder downwards with his left hand, and pulling upon the arm with his right. In more robust subjects, he makes them sit upon the ground ; the extension is thus more conveniently made ; and, if necessary, with both hands, while an assistant presses downwards upon the acromion. In a dislocation of eighteen days' standing, in an athletic individual, he placed the patient in the recumbent position, then, having embraced the top of the shoulder with a cloth, the two ends of which being brought downwards parallel with the trunk, were entrusted to two assistants, he effected the extension himself with complete success. It must not be forgotten, that when the head of the bone has entered the glenoid cavity, it must be sustained in its position by the hand in the axilla while the arm is being brought down to the side. M. Malgaigne says, that he has never failed in this way to reduce the dislocation downwards, when it was not more than of a few days' standing.

The method of reduction by elevation of the arm is most applicable to those cases in which the displacement is directly downwards towards the axilla, less so to those in which the head of the bone has passed somewhat inwards as well. M. Velpeau was the first to establish this distinction, and M. Malgaigne has arrived at a like conclusion. The latter surgeon believes that extension combined with elevation of the arm is the best for the sub-coracoid and sub-glenoid dislocations ; but for the dislocation which he describes by the name of intra-coracoid, he prefers to make the extension horizontally. In these latter cases, in addition to the extension, he employs the knee in the axilla as a fulcrum, over which the head of the bone can be tilted into its place. (Op. cit. p. 519, &c.) It will be remembered, that the three varieties of dislocation just alluded to were probably all included by Sir A. Cooper in his dislocation into the axilla.]

Reduction of the dislocation forwards.—When the head of the humerus is dislocated forwards, or under the middle of the clavicle, the reduction is more difficult than in any of the others, for the head of the bone is not only further away from the glenoid cavity, but it is also more firmly fixed in its new situation. In this dislocation, Sir Astley Cooper recommends the elbow to be bent, to relax the biceps muscle, and the extension to be made obliquely downwards and a little backwards ; for, if it be made horizontally, the head of the os humeri is pulled against the coracoid process. In most instances of this kind, he says, the plan of reduction, by means of the heel in the axilla, will also succeed, care being taken to apply the foot rather more forward than in a dislocation into the axilla, so that it may press on the head of the bone. However, when the dislocation has continued several days, he considers gradual extension with pulleys necessary. As soon as the head of the bone has been drawn below the level of the coracoid process, it is to be pressed backwards with the surgeon's heel or knee, and the elbow at the same moment pulled forwards. (Op. cit. p. 439.)

When the head of the bone had deserted the axilla, and slipped under the pectoral muscle, Mr. Hey found, that it could be more readily brought back into the axilla by making the extension in the direction opposite to that in which it has passed from the axilla :—" This effect is often greatly promoted by making the extension with the arm elevated, as Mr. White has advised." (See *Hey's Surgery*, p. 298, ed. 2.)

[It has been remarked, however, that when the head of the bone is carried far forwards under the pectoral muscle, traction in the vertical direction, after the method of White, by putting this muscle on the stretch, rather tends to close the passage by which the head of the bone should return to its place, and so interferes with the reduction.

M. Velpeau, in a case in which he failed twice to effect reduction by raising the arm, succeeded immediately by making the extension obliquely downwards. A similar success was obtained by M. Maisonneuve in a case under M. Velpeau, who therefore came to the conclusion that the extension should be first made obliquely downwards, and then horizontally. The advice given by M. Malgaigne coincides pretty closely with what has just been stated. This surgeon does not consider the vertical mode of making extension as applicable to the dislocation at present under consideration. (See *Traité des Fract. &c.* t. ii. p. 527.)]

In the partial dislocation, or that where the head of the bone lies at the scapular side of the coracoid process, the mode of reduction is the same as that employed in the complete dislocation forwards ; but it is necessary to draw the shoulder backwards ; and as soon as the reduction is accomplished, the bone is to be kept from slipping forwards again by maintaining the shoulders in that position with a bandage. (*Sir Astley Cooper*, op. cit. p. 449.) The elbow and fore-arm should also be supported, as much forward as possible, in a sling.

Reduction of the dislocation backwards.—The dislocation on the dorsum of the scapula appears, from some cases in Sir Astley Cooper's work, to be reducible by nearly the same mode of extension as that employed for the reduction of the dislocation in the axilla. Mr. Coley, of Bridgenorth, who met with two cases of luxation backwards, advises the reduction to be effected by elevating the arm, and rotating it outwards, so as to roll the head of the humerus towards the axilla, when it is to be kept in this position while the arm is brought down into a horizontal direction: on the extending force being now applied, the bone is easily reduced. (Op. cit. p. 444.) In one case in the Middlesex Hospital, " the patient was seated on the ground, with the sound side close to a wall, in which was a staple on a level with the shoulder, to which the apparatus for fixing the trunk and scapula was attached. Extension was made by two men by means of a cloth attached to the humerus, the direction of which was forwards, outwards, and a little upwards, the surgeon standing behind the patient, and retaining the scapula from yielding forwards. After hanging on for some time, and then by a more forcible extension, the head of the bone slipped into its socket with a snap. An effort at the reduction by one man on the towel had previously failed." (See *Lond. Med. Gaz.* 1832, 1833, p. 479.) The case in University College Hospital was reduced by Mr. Morton with the utmost facility.

[In the four cases seen by Mr. S. Lane, which have been before alluded to, the reduction was accomplished without difficulty by placing one hand at the back of the shoulder, to press the head of the bone forwards, while the other hand was applied to the front of the joint to press the clavicle and scapula in the opposite direction. An assistant at the same time made slight extension upon the limb at right angles to the trunk. A very similar method is advised by M. Malgaigne, who believes, that direct pressure with the thumbs upon the displaced head of the bone, aided by counter-pressure on the front of the shoulder with the other fingers, will suffice in the majority of cases. The pressure may first be made somewhat in the outward direction, to dislodge the head of the bone from behind the glenoid cavity, and this will perhaps be facilitated by rotating the limb inwards at the same time. If the resistance is great, it it will probably be overcome by slightly elevating the elbow and carrying it *backwards.* In a case in which the arm had been moved freely by Boyer in the upward, downward, and forward directions without benefit, reduction immediately took place when it was carried forcibly backwards. The dislocation having recurred, it was reduced a second time with great facility by M. Fizeau, by carrying the lower end of the humerus backwards with one hand, while he pressed the head of the bone forwards with the other. (See *Malgaigne, Traité des Fract. &c.* t. ii. pp. 539, 540.)]

An important fact, noticed by M. Malgaigne, and exemplified at the Hôtel-Dieu, is, that after an old dislocation of the shoulder has been reduced, the arm may still remain longer than the other, and the head of the humerus rather more below the acromion. (See *Dupuytren*, *Clin. Chir.* t. iii. p. 90.) The circumstance is ascribed to the diminution of the depth and capacity of the glenoid cavity, and other pathological changes.

[In a case of dislocation of the humerus of four months' standing reduced by M. Malgaigne with the pulleys, the reality of the reduction was doubted by another surgeon, in consequence of the head of the humerus projecting somewhat more *forwards* than on the sound side, and considerably more than after the reduction of a recent dislocation. Five months after the reduction, however, the patient had full use of her arm. He had also observed that in the dislocation backwards reduced after a long period, a slight *posterior* projection remains. If the dislocation has not been very old, these projections may disappear afterwards; but sometimes they persist, without however the reduction having been incomplete, or the limb being prevented from recovering its motions. (See *Rev. Méd. Chir.* vol. viii. p. 314, 1851.)

Sir A. Cooper thought that three months might be fixed as the period beyond which it would be imprudent to make the attempt at reduction. Many cases, however, have been placed on record, where it has been effected at a much later period than this. M. Malgaigne succeeded at five months; M. Roux at six months; Mr. Lane, in St. Mary's Hospital, at six months; Flajani at seven months: and many other instances might be mentioned. A very remarkable case occurred, in the practice of Dr. Nathan Smith of Connecticut, of dislocation of both humeri into the axilla, from puerperal convulsions; in this instance, one side was reduced at seven months and a half, and the other at ten months and a half. Dieffenbach reduced a dislocation forwards, under the clavicle, after an interval of two years, by the aid of subcutaneous incisions. Extension and counter-extension being made by assistants, he first divided the most tense portion of the pectoralis major close to its tendon. Then introducing the knife at the posterior border of the axilla, he divided the latissimus dorsi and teres major and minor muscles. He then passed the knife in at three places by the head of the humerus, and divided in a similar way, under the skin, the dense and hard false ligaments which surrounded the new joint; after which, by the aid of powerful extension, he conducted the humerus towards the joint, into which it suddenly slipped, without again springing out. No unpleasant symptom ensued, and the functions of the limb were perfectly restored. (See *Lancet*, May 9, 1840.)

Mr. Bransby Cooper thinks that in judging of the propriety of the attempt at reduction of a dislocated limb, a better criterion than mere length of time since the accident will be found in the precise condition of the new joint, especially as to the degree of motion of which it is capable. If any useful motion can be performed, it may be considered as ill-judged to attempt to restore the dislocated bone to its former articulating cavity, for it seems invariably to happen that as a new joint becomes fitted for use, so the structures of the old one are rendered incompetent to restoration. Where continued efforts have been made to use the limb, and a useful motion acquired, more permanent injury is likely to be sustained by the restoration of the bone to its original situation, than if it be allowed to remain, and means be employed to perfect the adaptation of recently formed structures.

It is necessary to mention that great mischief has resulted from too violent or too prolonged extension, and this sometimes in recent dislocations as well as in those of long standing. The integuments have been extensively lacerated, muscles have been torn through, and suppuration in and around the joint has taken place. M. Malgaigne mentions as many as twelve cases of rupture of the axillary artery, the great majority of which terminated fatally, although one recovered after ligature of the subclavian artery.

Partial or complete paralysis from injury done to the nerves has also been observed, and in one case, which of course terminated fatally, four of the nerves of the brachial plexus were torn out from the spinal marrow by the roots.]

[*Congenital dislocations of the shoulder.*—Many of the cases which have been described as congenital dislocations of the shoulder, have probably depended upon paralysis of the limb, existing at birth, or occurring at an early age. In these dislocations, dependent upon paralysis, the shoulder is flattened, the deltoid and scapular muscles are atrophied, and the capsular ligament is elongated, and allows the head of the bone to leave the glenoid cavity, but it can be readily replaced, and the natural form of the joint is to a certain extent restored.

In the true congenital luxation, however, says Mr. R. W. Smith, who was the first to investigate the subject, there is superadded to the atrophy of the muscles a malformation of the bones composing the shoulder joint. Mr. Smith has described four cases of dislocation forwards, sub-coracoid, and two of dislocation backwards, sub-acromial, which he believes to be truly congenital. In one of the former, in which the disease affected both limbs, he had the opportunity of dissecting the shoulder joints. The subject was a lunatic female, who died at the age of 29. On the left side there existed scarcely any trace of an articular surface, in the situation which the glenoid cavity occupied in the normal state; but there had been formed upon the costal surface of the scapula, a socket of a glenoid shape, around which the glenoid ligament, perfect in every respect, was continued from the margin of that small portion of the natural articular surface, which existed upon the axillary margin of the bone. On the right side the appearances were similar, but not so strongly marked. The muscles of the shoulder and arm were atrophied. Of the other three patients with congenital dislocation forwards, examined by him, two were 20 years of age, the third was a boy æt. 9. The deformity was in each similar in character to that described above, and the affection had existed from birth, or from the earliest period of the patient's recollection.

Mr. Smith also dissected the shoulder joints of a female lunatic, æt. 42, the subject of symmetrical sub-acromial dislocation. There was no trace of a glenoid cavity on either side, in the natural situation, but upon the external surface of the neck of the scapula there was a well formed socket, which received the head of the humerus. This was covered with cartilage, and surrounded by a perfect glenoid ligament. Mr. Smith thinks the complete absence of a glenoid cavity in the natural situation, the existence of the deformity on each side, the perfect resemblance between the abnormal sockets in form, size, and position, the integrity of the tendon of the biceps, and of the capsular and glenoid ligaments, all support the opinion that the dislocation must have existed at birth. Mr. Smith has since met with another example of congenital dislocation of both shoulders backwards, in a man who died at the age of 60 years. The shoulder joints were exhibited at the Dublin Pathological Society, April 3, 1853.

In the present state of our knowledge, and in the absence of a more extended series of observations, it is, as Chelius has remarked, impossible to determine with certainty whether the cause of the luxation should always be sought for in an original deficient formation of the articular surfaces, or whether such dislocations may not be produced by the peculiar position of the fœtus in the womb, the particular changes subsequently found depending on the long continuance of the displacement. (See *R. W. Smith, On Fractures and Dislocations,* p. 256. Dublin, 1847.)

In such cases as those described by Mr. Smith, where there is no glenoid cavity in the natural situation, all attempts to remedy the deformity may of course be expected to prove unavailing. A very remarkable case, however, has been recorded by M. Gaillard, where a dislocation backwards, believed to be congenital, was reduced at the age of 16. Horizontal extension was made on four occasions, in a space of eight days, and on the fourth trial the dislocation was reduced. The bone, however, slipped out of place almost immediately; it was replaced on the following day, and maintained in position for an hour. Ten days later it was again reduced, and this time the reduction was permanent. Two years afterwards, the limb, which before the operation was wasted and stunted in its growth, had increased considerably in length, and enjoyed free motion in all directions, and it was hoped that ultimately its use would be completely restored. (*Mém. de l'Acad. de Méd.* 1841, p. 703, and *Malgaigne*, p. 569.)]

DISLOCATIONS OF THE ELBOW.

Notwithstanding the extent of the articular surfaces of the humerus and ulna, the strength of the muscles and ligaments surrounding the joint, and the mutual reception of the bony eminences, rendering the articulation a perfect angular ginglymus, a dislocation of both the radius and ulna from the humerus sometimes happens. The ulna is most frequently luxated backwards; sometimes laterally, and very rarely forward. The luxation backwards is facilitated by the small size of the coronoid process, which, when the humerus is forcibly pushed downwards and forwards, may slip behind it, and ascend as high as the cavity, which receives the olecranon in the extended state of the fore-arm.

[Dislocations of the elbow are very common in children; they are, in fact, more frequently seen in children than in adults, and in this respect form a striking contrast with dislocations of the shoulder, which are almost entirely confined to adult age, and are very rare in children.]

Sir Astley Cooper's experience made him acquainted with five different luxations of the elbow:—1. That of the radius and ulna backwards. 2. That of both these bones laterally. 3. That of the ulna alone. 4. That of the radius alone forwards. 5. That of the radius backwards. (*On Dislocations*, p. 467.)

[Subsequent experience has shown that Sir A. Cooper's classification does not comprise all the dislocations of this joint; but that others are occasionally observed; and these, although of rare occurrence, will nevertheless call for a separate consideration. It becomes necessary to speak therefore of

1. Dislocation of both bones backwards.
2. Dislocation of both bones laterally.
3. Dislocation of both bones forwards.
4. Dislocation of the ulna backwards and the radius forwards.
5. Dislocation of the ulna backwards alone.
6. Dislocation of the radius forwards.
7. Dislocation of the radius backwards.
8. Dislocation of the radius outwards.]

1. *Dislocation of both bones of the fore-arm backwards.*—This is by far the most frequent of all the dislocations of the elbow joint. It may be complete or incomplete. In the *complete* dislocation, as described by Sir A. Cooper, both the radius and ulna may ascend more or less behind the humerus; but the coronoid process of the ulna is carried above the articular pulley, and is placed opposite to the cavity destined to receive the olecranon. The head of the radius is placed behind and above the external condyle of the humerus. The annular ligament, which confines the superior extremity of

the radius to the ulna usually remains entire, but it may be lacerated : in which case, even when the bones are reduced, it is difficult to keep them in their proper places, as the radius tends constantly to quit the ulna.

[According to Sir A. Cooper, this accident usually happens in a fall, when a person puts out his hand to save himself, *the arm not being perfectly extended*, so that the bones are forced back behind the axis of the os humeri, by the pressure of the whole weight of the body upon them. (*On Dislocations*, p. 441.) According to Bichat, the dislocation is produced in consequence of a *forced extension of the fore-arm upon the arm*. Thus, in a fall, the hand comes to the ground, and the fore-arm, fully extended upon the arm, receives the whole weight of the body ; the humerus, then pressing forcibly upon the anterior ligament, ruptures it, together with the internal lateral ligament, and passes in front of the coronoid process of the ulna. It has been known to happen, also, from a blow on the anterior surface of the fore-arm, just below the elbow joint, the blow in this case driving the bones of the fore-arm directly backwards from the humerus; and in like manner, a blow on the posterior surface of the humerus, the hand being fixed, may project the humerus directly forwards upon the bones of the fore-arm. M. Malgaigne's views of the mechanism of the mode of production of this dislocation are peculiar, and differ from those of most other surgeons. He thinks it takes place during slight flexion of the fore-arm, by a movement of torsion of the fore-arm inwards and backwards upon the humerus, as in a fall on the elbow more or less separated from the body, or a fall in which the whole inner side of the fore-arm strikes against the ground. (See *Traité des Fract. &c.* vol. ii. p. 574.)]

The fore-arm is in a state of half flexion, and every attempt to extend it produces acute pain. The situation of the olecranon, with respect to the condyles of the humerus, is changed. The olecranon, which, in the natural state, is placed on a level with the external condyle, which is itself situated lower than the internal, is even higher than the latter. Posteriorly a considerable projection is formed by the ulna and radius, and on each side of the olecranon a hollow appears. A considerable hard swelling is felt on the fore part of the joint, arising from the projection of the lower end of the humerus. The hand and fore-arm are supine, and the power of bending the joint is in a great measure lost. (*Sir Astley Cooper*, *On Dislocations*, p. 468.)

[The supination of the hand is denied by Malgaigne, who says he has never observed it, but, on the contrary, he has usually found it in a marked condition of *pronation*. The same surgeon remarks, that the fore-arm can usually be readily moved in pronation or supination ; and in some subjects it can be extended even beyond the straight line, while in others complete extension is impossible. It is the movement of flexion which is especially interfered with, and it is seldom that the arm can be bent to a right angle without severe pain. But a movement altogether unnatural, and seldom wanting during the first twenty-four hours, is that by which the humerus and fore-arm can be balanced laterally one upon the other. The head of the radius can be felt behind the external condyle, rolling upon the ulna in pronation and supination, and by pressing with the finger upon its upper surface, its cup-shaped depression with its rounded border can be recognised.]

The swelling which supervenes in twenty-four hours after the accident may obscure the diagnosis; but, notwithstanding the assertion of Boyer, I believe the olecranon and internal condyle are never so concealed, that the distance between them cannot be felt to be increased. It is true, that the friction of the coronoid process against the humerus may cause a grating noise, similar to that of a fracture ; and some attention is requisite to establish the diagnosis between a fracture of the lower end of the humerus, and a dislocation of the fore-arm backwards. " This dislocation (says Sir Astley Cooper) is at first sometimes undiscovered in consequence of the great tumefaction, which immediately succeeds the injury ; but this circumstance does not prevent the reduction, even at the period of several weeks after the accident ; for I have known it thus reduced by bending the limb over the knee, even without great violence being employed." (*On Dislocations*, *&c.* p. 470.)

A luxation backward must be attended with serious injury of the surrounding soft parts. The lateral ligaments are constantly ruptured, and sometimes the annular ligament of the radius. In a case, dissected by Sir Astley Cooper, the annular ligament was entire. The biceps muscle was only slightly put upon the stretch ; but the brachialis was excessively so. Probably the lower insertions of the biceps and brachialis anticus would likewise be more frequently lacerated, by the violent protrusion of the head of the humerus forwards, were it not that their attachments are at some distance from the joint. This mischief, however, occasionally takes place. The lower end of the humerus, indeed, has been known not only to lacerate these muscles, but to burst the integuments, and present itself externally ; an instance of which is recorded by Petit, and two such cases I saw during my apprenticeship at St. Bartholomew's. Boyer justly remarks, that it is difficult to conceive how, under these circumstances, the brachial artery and median nerve can escape. In fact, this vessel has sometimes been ruptured, and mortification of the limb been the consequence; but this injury of the artery, and the laceration of the muscles and skin, are rare occurrences. (*Mal. Chir.* t. iv. p. 215.) Nor, if the artery were wounded, would gangrene be invariably the result; for, if my memory is correct, an instance, in which the limb was saved, notwithstanding such a complication, used to be mentioned by Mr. Abernethy in his lectures, and a similar fact is recorded by Cruveilhier.

Cruveilhier has published an engraving of the changes, which followed an unreduced dislocation of the elbow. The case is a dislocation of the bones of the fore-arm from the humerus backward. The head of the radius and the olecranon project behind the lower end of the humerus, which bone is maintained in the bent position by deposits of osseous matter, which extend in a pointed form to a considerable height. Extension and flexion of the elbow are both equally impossible ; motion is restricted to a slight yielding, allowed by some disproportion between the lower end of the humerus and the capacity of the osseous shell. The new bony formation arises from the radius and ulna, uniting them solidly together, embracing the lower end of the humerus to which it moulds itself, and ascending an inch and a half above the end of the humerus. There are several perforations, or deficiencies in it, through which the humerus is perceptible. The coronoid process of the ulna, which is blunted, is lodged in the fossa behind the humerus. "The case proves (says M. Cruveilhier), that, in the dislocation of the fore-arm from the the humerus backward, the displacement backward is limited by the coronoid process meeting with the olecranal fossa of the humerus : that there must be a more or less considerable laceration of the brachialis muscle ; and that the tendon of the biceps must generally remain entire, and make a tense cord, constituting a limit to the displacement backwards. If the violence occasioning a dislocation backwards should be carried farther, not only may there be laceration of the brachialis, but also of the tendon of the biceps, the brachial artery, the veins, the median nerve, and even the skin, attended with protrusion of the bone. I have seen a case of this kind, in a lady who was thrown from her horse, and fell on the palm of her hand. When I arrived, a profuse hæmorrhage from the artery had just ceased, in consequence of syncope. The dislocation having been reduced, I kept myself ready to secure the artery, but the bleeding did not return." The case terminated favourably. (See *Cruveilhier, Anat. Pathol.* liv. ix. ch. iv. p. 8.)

In a modern publication, an instance of a dislocation of the heads of the radius and ulna backward is related, where the lower end of the humerus protruded through the integuments, and, as it could not be reduced, it was sawn off. The patient, a boy, recovered the full use of his arm. (*Evans, Pract. Obs. on Cataract, Compound Dislocations, &c*, p. 101, 1815.)

[The injury with which dislocation of the elbow is most likely to be confounded, is a fracture of the humerus, just above the elbow, or in young persons, a separation of its epiphysis from the shaft. Many of the symptoms mentioned, but especially the projection of the humerus anteriorly, and of the ulna posteriorly, are common to both cases. The following diagnostic marks mentioned by Malgaigne are worthy of attention. In the fracture, the cutaneous fold of the elbow is always below, or at the most, on a level with the projection of the humerus forwards. In dislocation, this cutaneous fold always ascends, and is situated above the projection. In fracture, the epicondyle and the epitrochlea are behind the axis of the humerus ; in dislocation they are in a line with it. In fracture, they are at the same distance from the olecranon as on the sound side ; in dislocation the interval is necessarily augmented. Another sign of dislocation, which M. Malgaigne considers important, is to be found in the sharp internal margin of the trochlear surface of the humerus ; which may, he says, almost always be felt through the integuments, at the anterior and inner part of the joint ; he has never met with swelling sufficient to prevent this ridge from being distinguished, with the prominence of the epitrochlea situated at the normal distance above it. The following source of error in old dislocations is noticed by the same authority ; it happens, sometimes, that the lymph effused under the tendon of the triceps acquires such a consistence, that it affords to the touch the sensation of bone, and might induce the belief that the olecranon has preserved its normal relation to the humerus. In illustration of this he relates the case of a young man, the subject of a dislocation of the elbow of two months and a half standing, who had consulted various surgeons, and had found them undecided in their opinion whether his injury was a dislocation or a fracture. There was no depression above the olecranon, although the prominent margin of the trochlea could be felt projecting anteriorly. The question was finally decided by Malgaigne, who inserted a needle through the tissues above the olecranon down to the humerus, the needle traversed without difficulty the thickened lymph, which had imposed upon the sense of touch, and thus showed to what extent the olecranon was really separated from the humerus in comparison with the sound side.—*Traité des Fract.* t. ii. p. 582.]

Incomplete dislocation backwards.—[The incomplete dislocation of the fore-arm backwards was described by J. L. Petit, but it does not appear to have been recognised by Sir A. Cooper, and its possibility is altogether denied by Boyer, who says that, if the summit of the coronoid process is not forced by the effort which causes the displacement beyond the transverse diameter of the articular pulley of the humerus, the latter, on account of the obliquity of its surfaces, will fall back into the sigmoid cavity of the ulna when the effort at displacement has ceased. (*Mal. Chir.* t. iv. p. 214.) The existence of an incomplete dislocation has, however, now been fully established by Malgaigne, who believes it to be even more common than the complete kind. The symptoms are very similar to those of the complete kind, the chief difference being in degree. Thus, the olecranon is prominent behind, and the humerus in front of, the joint, the antero-posterior diameter of which is therefore increased. The head of the radius is partially displaced backwards from the external condyle, the point of the coronoid process is sometimes situated beneath the trochlea, sometimes passes behind it altogether, so that as far as this bone is concerned, the dislocation may be really complete. The limb is *not shortened*, and the bones of the fore-arm are fixed against the humerus, and cannot be so readily moved in different directions as in the complete dislocation. The point of the olecranon is on a level with, or even a little *beneath*, the humeral tuberosities, and the olecranon is not so distant from them posteriorly as in the complete dislocation ; but the principal distinctive mark is that only a portion of the cup-shaped depression on the head of the radius can be felt with the finger behind the external condyle in the incomplete dislocation, whereas in the complete the whole of it can be distinguished. (See *Malgaigne, Traité des Fract. &c.* vol. ii. p. 598.) Several cases of incomplete dislocation of the elbow have also been recorded by Dr. Stapleton. (See *Dublin Quart. Journ.* vol. v. p. 184, 1849.)]

Reduction of the dislocation of both bones of the fore-arm backwards.—The following method of reduction is advised by Boyer :—The patient being seated, the surgeon, placing himself on the outside of the dislocated limb, is to place the four fingers of both hands in front of the elbow, and his two thumbs upon the prominence formed by the olecranon, so that he can conveniently make pressure in opposite directions: upon the inferior extremity of the humerus to press it backwards, and upon the olecranon, to carry it forwards. Two assistants then take hold, one of the shoulder, and the other of the wrist, and make extension and counter-extension. At the proper moment, the surgeon employs his fingers in the manner indicated, and directs the assistant charged with the extension to flex the fore-arm, and he will perceive that the articular surfaces have recovered their natural situation. (*Traité des Mal. Chir.* t. iv. p. 223.) This method will generally be successful. If the strength of the patient, or the long continuance of the luxation, render it necessary to employ a greater force, extension is to be made with a towel applied on the wrist, and a cushion is to be placed in the axilla, and the arm and trunk fixed, as is done in cases of luxation of the humerus.

In Sir Astley Cooper's method, the patient sits in a chair. The surgeon places his knee on the inner side of the elbow, in the bend of the joint; and, taking hold of the patient's wrist, bends the arm. At the same time, he presses on the radius and ulna with his knee, so as to separate them from the os humeri. Thus the coronoid process is pushed out of the posterior fossa of the humerus; and whilst the pressure is kept up with the knee, the arm is to be forcibly, but slowly, bent, and the reduction is soon effected. According to the same authority, the bones may also be reduced by bending the arm over a bedpost, or by bending it, whilst it is engaged in the opening of the back of the elbow chair in which the patient sits. (*On Dislocations*, p. 469.)

[Sir A. Cooper's method is that most commonly adopted in this country; it is not, however, universally approved. Mr. Skey prefers simple extension in the straight line; thinking that it affords the readiest mode of detaching the coronoid process from the posterior surface of the humerus, and also because it employs equal and fair tension both on the biceps and brachialis in front, and on the triceps behind; all that is required for success being, in his opinion, to bring the coronoid process below the trochlea of the humerus—for the radius presents little or no obstacle—when it will rush forward to its natural surface, and the dislocation is reduced. (*Op. Surg.* p. 94.)

The resources, then, which the surgeon has at his command for the reduction of recent dislocations, consist of the following methods:—1st. Simple extension in the straight line; to which may be added, if necessary, pressure and counter-pressure upon the displaced extremities of the bones. 2nd. Extension in the straight line, and coaptation by means of direct pressure on the ends of the bones, and a sudden change from the straight to the bent position, as advised by Boyer. 3rd. Extension throughout in the bent position, as recommended by Sir A. Cooper.

In the case of an *incomplete* dislocation, either of these plans will suffice, but a less degree of extension will probably be required, as it is only necessary to disengage the articular surfaces from each other, when they will either pass of their own accord into their proper situation, or the coaptation can be completed without difficulty by pressure.]

After the reduction, a bandage may be applied, evaporating lotions used, and the arm kept in a sling. The swelling, which follows, is to be combated by antiphlogistic means. At the end of seven or eight days, when the inflammation has subsided, the articulation is to be gently moved, and the motion is to be increased every day, to remove the stiffness which often follows these injuries.

Most recent dislocations of the elbow are easily reduced, and as easily maintained so; for a displacement is prevented by the reciprocal manner in which the articular surfaces receive each other, and by their mutual eminencies and cavities.

[If a recurrence of the displacement should take place after the reduction, it is probable that the dislocation is complicated with fracture of the coronoid process. When that process, and the brachialis muscle which is inserted into it, are detached from the ulna, there is nothing to prevent the bone again passing backwards behind the trochlea, under the slightest impulse from without, or simply by the contraction of the triceps muscle. When this fracture exists, the detached coronoid process may perhaps be felt on the anterior aspect of the joint; or by bending the fore-arm beyond a right angle, the surfaces may be brought into contact, and crepitus be distinguished. To maintain the reduction, it will be necessary to keep the elbow bent at, or somewhat beyond, a right angle, and this position must be maintained for three weeks or a month, before passive movements are commenced, in order to afford time for the union of the fracture. Sir A. Cooper believes that the union will be in most cases ligamentous.]

Sometimes in this luxation, the annular ligament, which confines the head of the radius to the extremity of the ulna, is torn, and after the reduction the radius becomes displaced either backwards or forwards from the ulna. In such cases, pronation and supination are difficult and painful; though the principal luxation has been reduced. The radius may be easily replaced by pressing it in the proper direction, and it is to be kept in its place by a compress, applied to the anterior or posterior aspect of the fore-arm, as the case may require. The bandage and compress are to be taken off every two or three days, and the joint gently bent and extended.

[For the reduction of old dislocations, greater force will be required. Boyer recommended for their reduction the employment of the pulleys, in the same way as in dislocation of the shoulder, to make extension and counter-extension in a straight line from the wrist and shoulder. He advised that the joint should be previously moved forcibly in different directions, to weaken or to break down, if possible, the new adhesions which have been formed.

A dislocation of the elbow becomes irreducible at a much earlier period than a dislocation of the shoulder. Boyer speaks of a month or six weeks as the time beyond which it would be useless to interfere. Many instances are recorded, however, in which reduction has been accomplished after a much longer interval than this. Sir A. Cooper succeeded at three months, M. Maisonneuve also at three, and M. Roux at five months. Mr. Darke was successful on two occasions, once at five months, and once at fourteen weeks after the accident. In these cases *continuous extension* was practised; the traction being kept up in the first case for the extraordinary period of eight hours and a-half. The pulleys were applied, and the force was increased every ten minutes for two hours and a-half; the elbow was then bent to 25°, and the extension was continued at this angle for two hours. It was then bent to 60°, and traction was made for another two hours. It was then bent to a right angle, and extended for an hour. Then the fore-arm was made the fixed point, and extension was practised upon the arm for an hour. At length, at the end of this time, the reduction was effected. (See *Gaz. Méd.* 1843, p. 302 ; and *Malgaigne*, Op. cit. p. 103.)

Now that we have the assistance of chloroform, it is perhaps not too much to say, that the reduction may be attempted with advantage up to a period of six or eight months, for even if perfect replacement cannot be accomplished, so as to remedy the deformity, the rupture or elongation of the adhesions will be followed by a great increase in the mobility, and consequently in the usefulness of the injured limb.

If too much force is used there is some risk that the olecranon may be fractured. Several instances of this have been met with ; but in some the fracture of the olecranon appears to have been advantageous, inasmuch as it permitted the reduction to take place. (See *Malgaigne*, op. cit. p. 145.) In one case of six months' standing, M. Gerdy practised subcutaneous section of the triceps tendon, but without success. Several melancholy instances are on record, showing the unfortunate results of the employment of an excessive degree of force in the reduction. In some, the vessels and nerves have been torn through, and mortification of the limb has been the result. In a case under Lisfranc, of dislocation of four months' standing, in a child of ten years old, death took place on the following day, and was apparently caused by the exhaustion and shock consequent upon the operation.]

2. *Lateral dislocations of the elbow.*—These are differently described by Boyer and by Sir A. Cooper. The former speaks of the displacement as taking place *directly inwards* or *directly outwards*, and as being the result of considerable violence, acting upon the arm and fore-arm at the same time, and in opposite directions. It is almost invariably partial, on account of the great breadth of the articular surfaces, which are still in contact, though their relations are more or less changed ; in the dislocation inwards, for example, the superior extremity of the radius corresponds to the trochlear surface of the humerus ; and in the dislocation outwards, the greater sigmoid cavity of the ulna receives the external condyle of the humerus. In the one case, the external condyle, and in the other, the internal condyle, is unnaturally prominent, while in both the transverse diameter of the elbow is increased. Nevertheless, he says, if the action of the exciting cause is sufficient, the bones may be removed altogether from their natural contact, and the dislocation is then complete. In the latter case, if the bones of the fore-arm are carried outwards, they may even overlap the humerus, and be drawn up on its outer side : but if the luxation is inwards, this does not take place, the bones of the fore-arm being sustained by the internal condyle of the humerus, which is so much more prominent than the external. (See *Boyer, Traité des Mal. Chir.* t. iv. p. 229.)

Sir A. Cooper does not appear to have met with the lateral dislocation, as described by Boyer, but speaks of the lateral displacement as combined with displacement backwards. The lateral dislocations described by him are, in fact, a combination of the complete dislocation backwards with a partial displacement either outwards or inwards.]

In the dislocation *backwards* and *outwards*, the coronoid process is situated on the back part of the external condyle. The projection of the ulna backwards is even greater than in the dislocation of both bones directly backwards, and the radius forms a protuberance behind, and on the outer side of the elbow. By moving the hand, the rotation of the head of the radius can be distinctly felt. In the dislocation *backwards* and *inwards*, the ulna is thrown behind the internal condyle, when it still projects backwards, as in the external lateral dislocation ; and the head of the radius is in the posterior fossa of the humerus, and the external condyle of the os humeri projects very much outwardly. (*Sir A. Cooper*, op. cit. p. 448, ed. 1842.)

[The manner in which these dislocations are produced is, in Sir A. Cooper's opinion, the same as in that directly backwards, but the direction of the fall is varied, or it may be caused by the wheel of a carriage passing over the arm whilst it is placed upon uneven ground. M. Malgaigne believes that the cause of the dislocation backwards and outwards is usually a fall on the inner surface of the ulna, which impresses upon the fore-arm a movement of rotation inwards and backwards, combined, at the same time, with impulsion outwards.

Lateral dislocations of the elbow are much less frequent than those directly backwards, but there is no doubt that they do occur, both in the manner described by Boyer, and in that described by Sir A. Cooper, although of the two varieties the latter appears to be the more common. M. Malgaigne has collected four examples of the incomplete dislocation outwards, and five of that inwards—one of the latter coming under his own observation. He has himself witnessed five cases of dislocation backwards and outwards, and four of dislocation backwards and inwards.

With respect to *complete lateral dislocations*, it does not appear that any example has been met with in the direction *inwards*, although several well-authenticated cases of complete dislocation outwards are on record. One is mentioned by Dupuytren (*Leçons Orales*, t. i. p. 131); another by M. J. Cloquet (*Gaz. des Hôp.* t. ii. p. 139) ; and a third by M. Nélaton (*Elém. de Pathol. Chir.* t. ii. p. 391.) Several others have since been observed, amounting to ten altogether. M. Malgaigne believes them to be caused in the same way as the dislocation backwards and outwards ; the force producing which may, if carried to a greater extent, cause the bones of the fore-arm to pass entirely beyond the humerus on the outer side. From the cases which have been observed, the general characters of this dislocation appear to be, that the two bones are displaced on the outer side of the humerus, not in a direct line, but with the radius turned forwards, and projecting in this direction beyond the plane of the external condyle. The fore-arm is therefore twisted inwards upon its axis, in such a manner that its posterior surface looks outwards, and its anterior surface inwards. This rotation inwards was in one case carried to so great a degree, that the head of the radius was lodged in the coronoid depression on the anterior surface of the humerus. The prominence of the olecranon is absent from the posterior surface of the arm, where the smooth posterior surface of the humerus can be felt, terminating in the depression for the olecranon and the articular surface of the trochlea, which are covered only by the skin. The olecranon is very prominent externally and the greater sigmoid cavity embraces and conceals the external condyle and condyloid ridge. The arm is in a condition of semiflexion and much pronated. In the case observed by M. Nélaton, in which the dislocation was of twenty years' standing, flexion and extension could only be performed in a very limited degree, but the movements of pronation and supination were preserved. In another case, observed by M. Robert, of an old man of seventy, who had dislocated the bones in his infancy, flexion and extension were tolerably free, and the arm was nearly as strong as on the sound side. (See *Malgaigne*, loc. cit. p. 614.)

A case of complete dislocation outwards was lately (Dec. 1859) seen at St. Mary's Hospital, and reduced by Mr. Davis, one of the house surgeons. The patient had fallen from a cart and had struck the inner side of his elbow. He was brought to the hospital a few minutes after the accident, and before any swelling had had time to take place. The upper end of the ulna rested upon the external condyle of the humerus, and the triceps was noticed passing obliquely outwards to join the displaced olecranon: the fossa for the olecranon could be distinctly felt at the back of the joint; the radius was placed in front of the external condyle.]

Reduction of the lateral dislocations of the elbow.—Boyer advised the reduction of the *direct lateral* dislocations to be effected, by extending the fore-arm on the humerus, and at the same time pushing the extremity of the humerus, and the ends of the ulna and radius, in opposite directions.

In each of the *backward* and *lateral* dislocations, (according to Sir Astley Cooper,) the reduction may be performed by bending the arm over the knee, even without particularly attending to its direction inwards or outwards; for as soon as the radius and ulna are separated from the humerus by the pressure of the knee, the muscles give them the proper direction for reduction. But in a recent case, as one which he relates proves, he considers that the business may be most readily accomplished by forcibly extending the arm; for when this is done, the biceps and brachialis, which are stretched over the condyles of the humerus, draw the heads of the radius and ulma into their right places again. (p. 427.)

[With reference to this latter proceeding, M. Malgaigne refers to a case of dislocation backwards and outwards, related by M. Debruyn, in which he thinks it may have caused the tendons of the biceps and brachialis to slip behind the external condyle. The case is also instructive, as exemplifying the evil consequences of too great employment of force. In this case after various methods had tried and failed, the suggestion of Sir A. Cooper was acted upon, but equally without success. The reduction was then postponed. On the following day, when the traction was renewed, it was found that in proportion as the bones of the fore-arm were drawn downwards, they were carried still further outwards, so as to give to the displacement the character of a complete dislocation outwards, but it was found impossible to carry the olecranon *inwards*, and immediately the extension was suspended: the bones flew back to their former position. Gangrene supervened, and the arm was amputated. The dissection showed that the tendons of the brachialis anticus and biceps had passed behind the external condyle. The brachial artery and median nerve were found to be ruptured. (p. 613.)

In the *complete dislocation outwards*, the reduction has usually been accomplished with much greater facility than might have been expected. The surgeon may embrace the humerus with his his two hands, and press with his thumbs upon the outer surface of the olecranon, to push it first inwards, and then forwards; should the radius be much rotated inwards,in the manner which has been described, it may be carried outwards by supinating the hand; in one case, supination, combined with very slight traction, effected the reduction, coaptation being completed by the muscles, without the intervention of the surgeon. (See *Malgaigne*, loc. cit. p. 618.)

In the case seen at St. Mary's Hospital, the ulna was readily reduced by bending the elbow over the knee, but the radius remained in front of the external condyle. This bone was next replaced by means of pressure upon its head, while the arm was kept in the extended position. The patient rapidly recovered the movements of the limb.]

[3. *Dislocation of both bones of the fore-arm forwards.*—It was asserted by J. L. Petit, that this dislocation was impossible, unless accompanied by fracture of the olecranon process; and this statement has been repeated by most surgical writers. Subsequent observations, however, have proved this opinion to be doubly incorrect, inasmuch as there are at least six well authenticated instances of the dislocation *without* the fracture, and only three published cases in which the two were combined. A fall upon the elbow, when the joint is flexed, appears to be the ordinary cause of this accident. The dislocation may be incomplete or complete. In the former, which appears to be rather the more frequent of the two, the summit of the olecranon is applied to the inferior part of the humeral trochlea, causing *an elongation* of the limb equivalent to the height of the olecranon, and the head of the radius is separated by a sensible interval from the external condyle. The fore-arm may be extended in a straight line with the arm, or it may be found slightly flexed. In the complete dislocation, the extremities of the radius and ulna are situated in front of the humerus, and may ascend so far as to produce a decided *shortening* of the limb. There will be a deep depression posteriorly, while in front the radius and ulna are prominent beneath the integuments. In a case of compound dislocation observed by Mr. Prior, the humerus protruded through the integuments posteriorly, to the extent of two inches and a half, and the radius and ulna had ascended to a similar distance in front. In this case the fore-arm was bent at a right angle with the arm. (See *Lancet*, *Dec.* 1844.)

The reduction of the incomplete dislocation has always been accomplished with ease. The surgeon should make pressure, in opposite directions, upon the dislocated bones of the arm and fore-arm, while the limb is gradually brought from the straight to the flexed position.

In a case of *complete* dislocation, M. Monin first attempted to bring down the olecranon to the level of the trochlea, by making vigorous extension in a straight line. Failing to accomplish this, he forcibly flexed the elbow, bringing it thus into the position in which he presumed it to have been when the accident happened; then making extension upon the humerus, by means of a band passed beneath the axilla, he applied his two hands, with the fingers crossed, upon the anterior surface of the fore-arm close to the elbow, and thus drawing the radius and ulna downwards and backwards, effected the reduction at once.—(*Malgaigne*, op. cit. p. 628.)

Three recorded cases only of dislocation forwards, with fracture of the olecranon could be met with by Malgaigne. One was observed by M. Ph. Boyer. The subject of it had fallen upon the palm of the hand, from a height of 45 feet. Posteriorly the olecranon could be felt between the condyles, moveable transversely, while in front the head of the radius and the point of the coronoid process could be felt raising the brachialis anticus and biceps, a finger's breadth above the level of the condyles. The reduction was easily effected, but as soon as the limb was left to itself, the displacement recurred. The patient died shortly from other injuries, and the autopsy displayed a fracture of the base of the olecranon, leading obliquely downwards and backwards, with the radius and ulna carried forwards, and mounting upwards half an inch above the humeral condyles.

A preparation of this injury remaining unreduced, is preserved in the Dupuytren Museum, and is described and figured by M. Malgaigne, Pl. xxiv. The olecranon has united by bone to the ulna, not in a straight line, but forming a considerable angle backwards with the shaft.

M. Velpeau met with a somewhat analogous case of eight years' standing, but without union of the olecranon, which was carried upwards two fingers' breadth above the lower end of the humerus. The radius and ulna were situated in front, resting upon the anterior surface of the humerus. This patient had, nevertheless, a tolerably useful arm. (See *Malgaigne*, t. ii. p. 633.)

The principal difficulty in the case under consideration, would be to maintain the bones in their proper situation after reduction. For this purpose, the most appropriate method would be to keep the limb in the straight position by the application of a splint to the anterior surface of the arm and fore-arm, as in ordinary fracture of the olecranon, with the addition of a compress to press the radius and ulna backwards, and keep them in their place.]

[4. *Dislocation of the ulna backwards and the radius forwards.*—An instance of this singular form of injury was met with by Mr. Bulley, of Reading, and is described by him in the *Provincial Med. and Surg. Journ.* June 1841. A man, aged 28, fell from a railway waggon, coming to the ground upon his hands. On examination, the ulna was found to be dislocated backwards, the coronoid process being lodged in the cavity for the olecranon; while the radius, on the contrary, was dislocated forwards, above the point occupied, in the normal condition, by the coronoid process, thus crossing the ulna. The fore-arm was slightly flexed, and every attempt to further flex or to extend it produced severe pain. Slight extension sufficed to reduce the ulna, but the radius remained in front of the condyle, and prevented flexion of the limb. Pressure upon the radius reduced it in its turn, and 19 days afterwards the patient left the Hospital, and was able to return to his duties.

A very similar case was observed, in the same year, by M. Michaux, and was also reduced without difficulty, the ulna being first replaced and then the radius. A third has been recorded by M. de Mayer, but in this instance, in consequence of the swelling, the nature of the injury was not recognised till the fourteenth day, and reduction was then found to be impossible. (See *Malgaigne*, p. 630.) Mr. Erichsen speaks of having witnessed two instances of this accident at University College Hospital. (*Science and Art of Surgery*, p. 232.)]

5. *Dislocation of the ulna backwards alone.*—[According to Sir A. Cooper, the ulna is sometimes thrown backwards upon the os humeri without being followed by the radius. The limb, he states, is then much deformed by the contortion inwards of the fore-arm and hand. The olecranon is unduly prominent posteriorly. Extension of the arm is impracticable, and it cannot be bent to more than a right angle. The distinguishing marks of the accident are the projection of the ulna, and the twist of the fore-arm inwards. It is caused, says Sir A. Cooper, by a severe blow on the lower end of the ulna, by which it is pushed suddenly upwards and backwards. In a specimen of this injury in the museum of St. Thomas's Hospital, in which the dislocation had existed a long time without reduction, the coronoid process is thrown into the posterior fossa of the humerus; the olecranon projects posteriorly; the radius rests upon the external condyle, and has formed a small socket for its head, in which it was able to roll. The coronary and oblique ligaments had been torn through, and also a small part of the interosseous ligament.

According to MM. Nélaton and Malgaigne, the ulna and radius are not usually separated from each other in this dislocation, and the coronary ligament is not necessarily ruptured, but the ulna passes backwards and somewhat outwards behind the radius, and the radius executes a movement ot rotation upon the external condyle, which allows it to preserve its normal relation with the displaced ulna. The point of the olecranon is therefore approximated to the epicondyle, but is situated at a considerably increased interval from the epitrochlea. The fore-arm is usually slightly flexed; but it may be found completely extended, as in one case observed by M. Malgaigne. Pronation and supination are performed without difficulty. M. Malgaigne believes this accident to be caused, not in the way suggested by Sir A. Cooper, but by a fall on the elbow or inner side of the fore-arm, impressing upon the ulna a movement of rotation inwards and backwards. It is the same force, he believes, which, when more powerfully exerted, carries the radius also backwards, and produces the complete dislocation.

Sometimes, however, the ulna does not occupy the position just described, but becomes displaced inwards, as well as backwards; and when this is the case, its connexion with the radius must necessarily have been destroyed. In a case communicated to Mr. B. Cooper by Mr. Gosset, the coronoid process rested against the inner condyle; and in another seen by M. Sédillot, the ulna projected on the inner side of the elbow, on the same level as the prominence of the epitrochlea. The accident, in Mr. Gosset's case, was supposed to have been caused by a fall on the outer side of the olecranon, when the arm was bent. (See *Sir A. Cooper, On Dislocations, &c.* ed. by *B. Cooper*, 1842, p. 450.) The reduction may be accomplished in the same way as in the dislocation of both bones backwards, and it is usually attended with less difficulty than the dislocation of both bones.

M. Malgaigne describes a remarkable case, in which *the ulna was dislocated backwards and outwards behind the radius*, but in which the ulna was so placed, that the greater sigmoid cavity was directed outwards, and the coronoid process pointed outwards and forwards. The reduction was readily effected, the patient being placed under the influence of chloroform, by slight extension from the wrist, combined with pressure upon the displaced ulna in the appropriate direction. (Loc. cit. p. 631.)]

6. *Dislocation of the radius forwards.* — The radius, the moveable agent of pronation and supination, rolls round the ulna, by means of two articular surfaces; one above, slightly convex, broad internally, narrow outwardly, and corresponding to the lesser sigmoid cavity of the ulna, in which it is lodged; the other below, concave, semicircular, and adapted to receive the convex edge of the ulna. Hence, there are two joints, differing in their motions, articular surfaces, and ligaments.

Above, the radius in pronation and supination only moves on its own axis; below, it rolls round the axis of the ulna. Here, being more distant from the centre, its motions must be both more extensive and powerful, than they are above. The head of the radius, turning on its own axis in the annular or coronary ligament, cannot distend it in any direction. On the contrary, below, the radius, in performing pronation, stretches the posterior part of the capsule, and presses it against the immoveable head of the ulna, which is apt to be pushed through, if the motion be forced. A similar event, in a contrary direction, takes place in supination. The front part of the capsule being rendered tense, may now be lacerated.

In the dislocation of the head of the radius forwards, this part is thrown into the hollow above the external condyle, and upon the coronoid process of the ulna. According to Sir Astley Cooper, the fore-arm is slightly bent, but cannot be bent to a right angle, nor completely extended. When it is suddenly bent, the head of the radius strikes against the fore part of the os humeri. The hand is in the prone position, and, if rotated, the corresponding motion of the head of the radius can be felt at the upper and front part of the elbow joint. A depression can be felt posteriorly in the situation normally occupied by the head of the radius. The coronary or annular, the oblique ligament, the front of the capsular, and a portion of the interosseous ligament, are torn. [One symptom, mentioned by Malgaigne, but unnoticed by any other writer, is an oblique inclination outwards of the fore-arm. This obliquity increases, and perhaps partly accounts for, the ascent of the radius in front of the external condyle.]

Sir Astley Cooper refers the cause of this accident to a fall upon the hand, when the arm is extended; in which event the radius receives the weight of the body, and is forced up by the side of the ulna, and thrown over the external condyle upon the coronoid process. It has also been caused by falls on the elbow; and by traction upon the hand while in a condition of supination.

Sir Astley Cooper has seen six examples of the dislocation of the head of the radius forwards. And the accident, although denied by Boyer, is now well known to be of tolerably frequent occurrence.

[Mr. Bransby Cooper met with a case which was complicated by a fracture of the radius about an inch and a half below its head, a circumstance which at first occasioned some doubt as to whether or not the projection in front of the joint was formed by the head of the radius, since upon rotating the hand no motion of the tumor could be perceived.

An *incomplete* dislocation of the radius forwards also sometimes occurs. This partial displacement was noticed by Hippocrates, and M. Malgaigne believes it to be the most frequent of all the displacements to which the radius is subject. It occurs most frequently in very young children, from traction on the hand to prevent the child from falling; but it has been noticed also in adults from falls upon the hand or upon the fore-arm. The forearm is slightly flexed, the hand is pronated, and supination is impossible without causing severe pain. The displacement varies in extent; usually the projection of the head of the radius may be felt in front, and a corresponding depression posteriorly. The depression may perhaps be felt when the projection forwards is so slight as not to be distinguished, in consequence of the greater thickness of soft parts in front than behind. The partial dislocation may occur without rupture of the coronary ligament, as in one case in which M. Malgaigne had an opportunity of examining the joint after death. He has met with it twice in infants at the breast; and he refers to one instance where it was observed in a newly-born child, which the mother, who was delivered in a carriage without assistance, had allowed to fall at her feet (loc. cit. p. 648). M. Bourguet has published as many as seventeen examples of this partial dislocation observed by himself. (See *Rev. Méd. Chir.* 1854, t. xv. p. 287. See also *Goyrand, Gaz. Méd.* Feb. 1837.) The latter surgeon also regards this partial displacement as tolerably common, since in the period of eight years he met with as many as ten instances of it.

Reduction.—To reduce the complete dislocation, the fore-arm should be placed in the supine position; extension should then be made upon the radius by pulling upon the hand; counter-extension being applied above the elbow. The extension is made upon the hand rather than on the fore-arm, because if applied in the latter situation, a considerable portion of the force exerted would be uselessly expended upon the ulna. When sufficient extension has been made, the reduction may be completed, by the surgeon pressing directly upon the head of the radius, to push it backwards into its place.]

Sometimes the reduction is attended with much difficulty. In two of the cases recorded by Sir A. Cooper it could not be accomplished; in the third, it was effected during a syncope, by extending the fore-arm, while the olecranon rested on Sir Astley's foot. In the fourth, the patient was placed on a sofa, and his arm bent over the back of it, in which state extension was made from the hand, *without including the ulna.* The sofa fixed the os humeri, and the reduction was accomplished in a few minutes. The chief things to be observed are, to let the extension act upon the radius alone, without the ulna, and during the extension to let the hand be supine. (*Dislocations*, p. 474—477.) Sometimes, when the bone has been replaced, there is great difficulty in retaining it in its position; when this is the case, the fore-arm should be kept in the supine position with the elbow flexed, and pressure should be made over the head of the radius by means of a splint, pad, and bandage, until the torn parts are healed.

[If the reduction cannot be accomplished, a very considerable degree of motion will be regained in course of time, by exercise of the limb. A remarkable case of this dislocation reduced by gradual and repeated extension more than two years after the accident has been already alluded to, *ante* p. 502.

The *incomplete* luxation is usually easily reduced on the principles above recommended, but it also will often require pressure subsequently to keep the head of the bone in its place.]

Into University College Hospital a lad was admitted in 1836, the upper head of whose radius had been thrown considerably above the external condyle for some years; and the motions of whose elbow were but little impaired by the accident. I have also seen two or three instances in children of dislocations of the upper head of the radius from weakness, or relaxation of the annular ligament.

7. *Dislocation of the radius backwards.* —The displacement backwards is described by Boyer as occurring more frequently in children than adults. The reason of the circumstance is ascribed to the lesser firmness both of the ligaments and of the tendinous fibres of the extensor muscles, which fibres, in a more advanced age, contribute greatly to strengthen the external lateral ligament. In a child, also, the lesser sigmoid cavity of the ulna is smaller, and the annular ligament, extending round the head of the radius, is longer, and more apt to give way. Hence, in a subject of this description, efforts, which may not at first produce a dislocation, if frequently repeated, cause a gradual elongation of the ligaments, a change in the natural position of the bones, and, at length, a degree of displacement as great as in a case of luxation, suddenly and immediately effected. (*Mal. Chir.* t. iv. p. 239.)

According to Boyer the dislocation of the head of the radius backwards is always complete, its articular surfaces being perfectly separated both from the lower end of the humerus, and from the little sigmoid cavity of the ulna. The usual cause of the accident is a pronation of the fore-arm, carried with great violence beyond the natural limits. [Most surgeons, however, describe a partial dislocation backwards, associated with relaxation of the ligaments. Some partial displacement must, in fact, necessarily result from the elongation of the ligaments which Boyer himself described. At the same time, incomplete luxation backwards, as the immediate result of injury, is very uncommon, and M. Malgaigne could only discover one unequivocal example of it.

Dislocation of the radius backwards may be produced by a fall on the palm of the hand, the fore-arm being in a state of pronation; and possibly also by direct force applied to the anterior surface of the head of the bone. According to M. Nélaton, both this and the preceding dislocation may be caused by falls on the hand, while the fore-arm is prone, but for the dislocation backwards it is necessary that the elbow should be flexed, while for the dislocation forwards it must be extended].

In a dislocation of the head of the radius backwards, the fore-arm is bent, and the hand fixed in the state of pronation. Supination can neither be performed by the action of the muscles, nor by external force; and every attempt to execute this movement produces a considerable increase of pain. The hand and fingers are moderately bent, and the head of the radius may be observed forming a considerable projection behind the external condyle of the humerus.

Sir Astley Cooper has never seen a dislocation of the head of the radius backwards in the living subject; but a man was brought for dissection into the theatre of St. Thomas's Hospital, who had such a dislocation, which had never been reduced. The head of the radius was thrown behind the external condyle, and rather to the outer side of the lower extremity of the humerus. The fore part of the coronary ligament was torn through, as well as the oblique one, and the capsular was partially lacerated.

[Professor Langenbeck of Göttingen has published two cases of this accident. One was in a man aged 20, the other in a child aged 5 years. (See *Sir A. Cooper*, *On Dislocation*, ed. by *Bransby Cooper*, p. 460). Several others are mentioned by Malgaigne, amounting in number to twelve altogether. One of these was observed by himself. (*Traité des Fract. &c.* t. ii. p. 665.) One case of incomplete displacement backwards in a youth of 19 has been recorded by M. Denucé. (*Thèse Inaug. sur les Lux. du Coude*, 1854.)

Mr. Bransby Cooper saw a case of dislocation of the radius outwards and backwards, but this was complicated with a fracture through the coronoid process of the ulna, entirely separating the upper extremity from the shaft of the bone. The shaft was drawn forwards by the brachialis anticus, while the upper fractured portion was drawn backwards by the triceps. Fifteen weeks having elapsed since the accident, no means were employed for its reduction].

As facts of pathological anatomy relating to this dislocation, Cruveilhier informs us that he is acquainted with only the two cases, of which Sandifort has given engravings. (*Museum Anat.* ch. 103.) In both instances the head of the radius is luxated backward, and the radius and ulna cross at their upper part, as in extreme pronation, and are there ankylosed to one another. In one of these examples the head of the radius is diminished; the lesser articular surface of the humerus has disappeared, and been confounded with the trochlea, so as to correspond to the enlargement of the greater sigmoid cavity of the ulna. The connection of the radius to the lesser sigmoid cavity of the ulna extends a good way along the inner side of the coronoid process and front surface of the ulna. Directly below this connection the radius is increased in size, and is much deformed. In consequence also of the lower end of the ulna having lost its relations to the corresponding cavity of the radius, it no longer exists. In the second example, the radius and ulna, where they cross, are soldered together; and the lower end of the ulna is considerably deformed, and its head converted into a mere tubercle; while the head of the radius, which is displaced outwards and backwards, is divided into two parts; one, still corresponding to the lesser articular surface of the humerus; the other not touching that surface except in extreme flexion of the joint.

Cruveilhier refers to a case reported in the

Journ. Hebdom. de Méd. as a *congenital dislocation of the upper head of the radius in each arm*, and allusion is also made by M. Paillard to another instance of the same kind, which was met with many years ago by Dupuytren. Cruveilhier does not concur in regarding these cases as congenital; and adverts to the frequency of incomplete displacements of the head of the radius backwards in young children, owing to the imperfect development of the lesser sigmoid cavity of the ulna, the consequent looseness of the annular ligament, and the frequently forcible pronation of their hand, when held by it to keep such young subjects from falling. In Cruveilhier's Livraison ix. pl. 3. are given representations of an old unreduced dislocation of the head of the radius, which lies behind and to the outer side of the lower end of the humerus, and is lodged in a little cup of a fibrous structure, formed, as Cruveilhier suspects, at the expense of the anconæus and its aponeurosis, or else of the remains of the external lateral and annular ligaments. The head of the radius has undergone a change of shape, and become convex and oblong. The neck is slender, and projected outwards, and the tubercle very diminutive.

Fig. 4. of the same plate illustrates the pathology of another unreduced dislocation of the head of the radius backwards, which, as well as in the foregoing example, lies on the same level as the apex of the olecranon, in consequence of an elongation of the head and neck of the bone, and not of its ascent. The tubercle of the radius, which is nearly effaced, and the insertion of the biceps, are on a level with the coronoid process of the ulna. There is a little cup of fibrous structure for the head of the bone, which last part has a thin investment of cartilage. The lesser sigmoid cavity of the ulna is obliterated. (See *Cruveilhier*, *Anat. Pathol. Livr.* ix. Pl. 3, *fol. Paris* 1829—1832.)

The reduction of the dislocation backwards is to be accomplished by extending the fore-arm and endeavouring to bring it into the supine posture, at the same time that the surgeon tries to press with his thumb the head of the radius forwards, towards the condyle of the humerus, and into the lesser sigmoid cavity of the ulna again. Success is indicated by the patient being now able to perform the supine motion of the hand, and to bend and extend the elbow with freedom.

For the purpose of preventing a return of the displacement, and giving nature an opportunity of repairing the torn ligaments, measures must be taken to hinder the pronation of the hand. Boyer recommends, with this view, a roller, compresses, and a sling; but it appears to me that a splint, extending nearly to the extremity of the fingers, and laid along the inside of the fore-arm, with a pad of sufficient thickness to keep the hand duly supine, would be right, in addition to the sling, roller, &c.

[8. *Dislocation of the radius outwards.*—This is an extremely rare accident. One case came under M. Nélaton's observation in a young man aged 20. The dislocation was said to have occurred in his infancy. The head of the radius formed a very prominent tumor on the outside of the epicondyle. The fore-arm was midway between pronation and supination. Supination was impossible; but the power of flexing and extending the fore-arm was preserved. The preparation of this elbow joint is in M. Nélaton's possession. (See *Elém. de Pathol. Chir.* t. ii. p. 400.)

Three other instances are referred to by M. Malgaigne, two of which were recorded by M. Thomassin in 1776, and one subsequently by M. Chédieu. These appear to be the only authentic cases of dislocation of the radius directly outwards; although several others have been met with in which a dislocation backwards or forwards has been combined with displacement outwards. An interesting case of dislocation outwards and forwards has been given by Mr. J. Adams. (See *Cyclop. of Anat. & Physiol.* vol. ii. p. 73: *Abnormal conditions of the elbow joint.*) Several others also have been observed in combination with fracture of the ulna; the force producing which, after fracturing that bone, operates directly on the radius and drives it outwards. Two such cases are related by Monteggia. The following is an instance of dislocation of the radius outwards, combined with fracture of the olecranon. Sir A. Cooper saw a gentleman æt. 25, whose pony having run away with him when he was twelve years of age, he had struck his elbow against a tree whilst his arm was bent and advanced before his head. The olecranon was broken and the radius dislocated upwards and outwards above the external condyle; and when the arm was bent, the head of the radius passed the os humeri. He had recovered useful motion of his arm, but neither flexion nor extension was complete. (*On Dislocations*, ed. by *B. Cooper*, p. 462.)

The reduction of the dislocation outwards may be effected by extension from the hand, and pressure upon the head of the bone in the same way as in the other dislocations of the radius. Should the dislocation be combined with fracture of the ulna, the double injury, instead of increasing the difficulty, will, according to M. Malgaigne, facilitate the reduction, since it will allow the extension to operate more directly upon the radius.]

DISLOCATIONS OF THE LOWER EXTREMITY OF THE ULNA.

Dislocations of the lower end of the ulna remained unnoticed, until Desault favoured the profession with a particular account of them. He, however, described them as dislocations of the lower end of the radius from the ulna; but Sir Astley Cooper, and Dupuytren, and most subsequent writers, have spoken of them as dislocations of the lower end of the ulna from the radius; and they differ from a luxation of the radius at the wrist, inasmuch as the hand is not thrown in the opposite direction to that of the radius, which bone is merely displaced from the convex articular surface of the ulna, the hand going along with it. This circumstance makes a material difference in the mode of reduction, with reference to the direction in which the hand is to be pushed.

[The ulna may be displaced either backwards or forwards from the radius. Both are uncommon accidents, but, of the two, the former seems to be more frequent.

Dislocation backwards. — Forcible pronation appears to be the most common cause of this injury. Pronation of the radius causes the head of the ulna to project against the posterior part of its capsule, and if the stress becomes too great the capsule gives way, and the head of the bone escapes.

Desault gives the case of a laundress, who dislocated the lower end of the ulna backwards, by a powerful pronation of her hand in twisting a wet sheet; and another in a child, five years old, in whom the luxation was produced by traction upon the lower part of the fore-arm, which was turned forcibly in the direction of pronation. M. Malgaigne refers to several others in which the same cause came into operation.]

The symptoms are, constant pronation of the fore-arm; an inability to perform supination, and great pain on its being attempted; there is an unusual projection at the back of the joint, in consequence of the protrusion of the head of the ulna through the capsule, and a corresponding depression anteriorly; the position of the radius is more forward than natural; there is constant adduction of the thumb, which is almost always extended, and a half-bent state of the fore-arm.

[M. Malgaigne gives a caution against mistaking this injury for incomplete dislocation of the upper end of the radius backwards, since both accidents are producible by forced pronation, and they may be the more easily confounded, since they both impress the same attitude upon the limb. (*Traité des Fract. &c.* t. ii. p. 685.)]

Reduction.—According to Desault, in the reduction of the dislocation of the ulna backwards, or, as he described it, of the radius forwards, an assistant is to take hold of the elbow and raise the arm a little from the body, while another is to support the hand and fingers.

The surgeon is to take hold of the end of the fore-arm with both his hands; one applied to the inside, the other to the outside, in such a manner that the two thumbs meet each other in front of the limb, between the ulna and radius, while the fingers are applied to the back of the wrist. He is then to endeavour to separate the two bones from each other, pushing the radius backwards and outwards, while the ulna is held in its proper place. At the same time, the assistant, holding the hand, should try to bring it into a state of supination, and consequently the radius, which is its support. Thus pushed, in the direction contrary to that of the dislocation, by two powers, the radius is moved outward and the ulna returns into the opening of the capsule, and into its articular cavity.

Sir A. Cooper reduces a dislocation of the lower end of the ulna backwards, by pressing the bone forwards, and maintains the reduction with splints, well padded, and a compress of leather over the end of the ulna. (*On Dislocations*, p. 505.)

Dislocation forwards.—This is more rarely met with than the case last described; for in the course of a long experience, Dupuytren had seen but two instances of it. One happened to an officer of the *gendarmerie*, whose horse fell with him, and the right fore-arm was injured between the horse's head and the ground. On presenting himself at the Hôtel-Dieu, about thirty-four hours after the accident, the fore-arm appeared very much swollen; the hand was in the mid-state between pronation and supination; there was an unusual projection of the skin at the middle of the front of the wrist, while, at its inner part, the styloid process was not perceptible; and behind, instead of the customary prominence, formed by the head of the ulna, there was a depression. When the ulna was traced from the elbow to the hand, the direction of it was felt to be forwards and outwards, crossing over and above the lower end of the radius. As the latter bone continued free from displacement, the carpus did not project either backwards or forwards. No crepitus was distinguishable, and the prone and supine movements of the hand were entirely obstructed. (*Dupuytren, Clin. Chir.* t. iv. p. 503—506.) Sir Astley Cooper has not recorded any example of this rare dislocation of the end of the ulna forwards, which never presented itself to Desault but once, and that was in the dead body of a man, both of whose arms were dislocated, and of whom no particulars could be learnt. The end of the ulna was placed in front of the scaphoid cavity of the radius, and in contact with the os pisiforme, to which it was connected by a capsular ligament. (*Boyer, Mal. Chir.* t. iv. p. 249.) The latter writer has also recorded one instance of the accident, produced by violent supination of the wrist. (Vol. cit. p. 253.)—[M. Malgaigne refers to several others, apparently referable to the same cause—namely, excessive supination. (*Traité des Fract.* t. ii. p. 637.)

Reduction.—In the dislocation of the lower end of the ulna forwards, the same proceedings which were recommended for the dislocation backwards, executed in the opposite direction, would accomplish the reduction. (See *Œuvres Chir. de Desault*, t. i.)

In one example of this very rare accident, which was under Dupuytren, counter-extension with the elbow bent to a right angle over a folded cloth, and extension, made from the wrist itself, failed to reduce the bone; but, as soon as Dupuytren made extension from the hand, and pressed this part strongly outwards, while, with both his thumbs, he propelled the ulna inwards and backwards, the reduction was effected. (*Dupuytren, Clin. Chir.* t. iv. p. 507).

[It should be remembered that the fracture of the lower end of the radius is very commonly attended with a projection of the lower end of the ulna on the front and inner side of the wrist. The symptoms of the fracture however, are in this case so well marked that there is little risk of mistaking it for one of simple dislocation.]

A protrusion of the small end of the ulna through the skin forwards must be excessively rare, owing to the strength of the ligaments, and the thickness of the integuments themselves, in this direction; but, in the dislocation backwards, the ligaments make less resistance, and the skin is almost close to the bone, so that, in this case, the protrusion is more likely to happen. If the dislocation were compound, ought the end of the bone to be sawn off, or amputation performed? Dupuytren is in favour of immediately reducing the end of the ulna, and making free incisions for the relief of the tension and strangulation likely to ensue. He would not saw off the end of the ulna—much less would he amputate. (*Clin. Chir.* t. iv. p. 510.) The free incisions, I think, would be early enough when the confinement of the inflamed parts by the fascia had actually come on, and threatened mischievous consequences.

Dislocations of the Wrist.

The carpal bones are usually described as being capable of being luxated from the lower end of the radius forwards or backwards, inwards or outwards. The case backwards, which has been stated to be the most frequent, is facilitated by the direction of the convex articular surfaces of the scaphoid, lunar, and cuneiform bones, which slope more backwards than forwards. According to Sir Astley Cooper, the direction of the force determines the direction in which the carpal bones are thrown: thus, if a person, in falling, put out his hand to save himself, and fall upon the palm, a dislocation may happen, the radius and ulna being forced forwards upon the annular ligament, and the carpal bones thrown backwards. A considerable swelling is produced by the radius and ulna on the fore part of the wrist, and a similar protuberance upon the back of the wrist by the carpus, with a depression above it, and the hand is bent back. When the carpal bones are dislocated forwards under the flexor tendons, and the radius and ulna backwards upon the posterior part of the carpus, the accident has been caused by a fall on the back of the hand. In each of these cases, two swellings are produced; one by the radius and ulna; the other by the bones of the carpus. Sprains will often cause a great swelling over the flexor tendons, and give rise to the suspicion of a luxation, from which they may be known by the swelling being single, and its not having made its appearance directly after the injury.

Notwithstanding these statements, respecting dislocations of the wrist, Dupuytren invariably found that these pretended accidents always turned out to be fractures of the radius near the articulation; and he was of opinion, that there is not a single unequivocal instance on record of a dislocation of the radio-carpal articulation. He had dissected numerous wrists, but never observed a luxation of them from a fall on the palm. The only cases, which he met with, were consequent to diseases of the articulation, or symptomatic of other lesions. (*Clin. Chir.* t. iv. p. 162.) Dupuytren quotes the following lines from a memoir on fractures of the fore-arm by Pouteau:—"*Ces fractures sont le plus souvent prises pour des entorses, pour des luxations incomplètes, ou pour un écartement ou du cubitus ou du radius à leur jonction vers le poignet.*" Desault likewise, in noticing fractures of the lower end of the radius, adverts to their having sometimes been mistaken for dislocations:—"At the present time (says Dupuytren) there can be no doubt about the frequency of fractures of the lower end of the radius, and about the impossibility, or at all events, the extreme rarity of dislocations." This celebrated surgeon dwells upon a variety of anatomical circumstances, which seem to account for the rarity of the latter kind of accident; and explains how in a fall upon the hand or front of the wrist, the force acts upon the radius, and is very likely to break its lower end, which, though thick, is of a soft spongy structure. The resistance to the dislocation forwards, made by the several flexor tendons, which pass under the annular ligament is also taken into the account. So considerable is the total resistance, when the wrist is very much extended, that Dupuytren was convinced that a force of 2000 pounds would not overcome it. As for a dislocation backwards from a fall on the back of the hand, Dupuytren conceived that there was effectual resistance made to its occurrence by the extensor tendons. So strong were Dupuytren's doubts of the possibility of a dislocation of the lower end of the radius forwards, that he was induced to examine very carefully the only case of it recorded with any details in modern times, namely, that published by Professor Cruveilhier. (*Anat. Pathol. Mal. des Articulations.*) The subject was an adult female, about whom no information could be obtained. The fore-arm seemed shorter than natural; the lower ends of the radius and ulna formed a considerable prominence under the skin; but the radius projected less than the ulna, and did not descend so far. The upper extremity of the carpus was on a plane superior and anterior to that of the lower extremity of the bones of the fore-arm. The hand formed a right angle with the fore-arm, and inclined towards the radial side. Extension was impossible; but flexion could be carried much beyond a right angle. In the dissection, Cruveilhier found all the muscles of the arm in a state of atrophy, and especially the radial and ulnar extensors and flexors, and the pronators and supinators. The upper row of carpal bones were remarkably altered in shape, and, with the exception of the pisiform bone, reduced in size by one half. The second row was likewise altered, and, indeed, of the os magnum and unciform bone the mere rudiments remained while the upper part of the trapezium and trapezoid bones, which should correspond to the scaphoid, was diminished. The ulna, but slightly altered in shape, reached five or six lines beyond the lower end of the radius. The radius was shortened and deformed, principally at its lower end, which was large and irregular, and grooved on its posterior surface for the lodgment of the extensor muscles. From these and some other particulars, M. Cruveilhier concluded, that the accident had been a dislocation of the bones of the fore-arm backwards, or of the carpus forwards. On the contrary, Dupuytren suspected that the case had been a fracture, which, from the atrophy of the carpal bones, had probably taken place in infancy. Amongst other considerations, which influenced Dupuytren in regarding the case as a fracture, was the shortened state of the radius; while the ulna, which was also luxated, was half an inch longer than it. On the presumption of the case being a fracture, or a detachment of the epiphysis, everything is readily explicable. The epiphysis of the radius was believed by Dupuytren to have been separated by a fall on the back of the hand, and the violence seemed to him to have thrown it with the carpus and hand forwards. The union of the epiphysis to the bone appeared to him to account for the unusual process, which supports the new articulation; and the ulna itself, really dislocated, was longer than the radius, which latter besides being broken, had been shortened by the displacement of the fragments. According to M. Malgaigne, the shortening of the radius, on the supposition of the case being a dislocation, was inexplicable.

Many years ago, a bricklayer was taken to the Hôtel-Dieu with several dangerous injuries received in a fall. His skull was fractured, and there was a good deal of deformity about the wrist. Some surgeons thought that there was a dislocation of the carpus backwards. On the contrary, Dupuytren pronounced the case to be a fracture of the inferior part of the fore-arm. The patient having died of the consequences of the injury of the head, the correctness of Dupuytren's diagnosis was verified in the *post mortem* examination. M. Marjolin was mistaken in a similar case, as was likewise proved by dissection.

Cruveilhier gives an engraving of a fore-arm, in which the radio-carpal articulation had been dislocated by the force of the contraction of the cicatrix of an extensive burn. The end of the radius was in front of the carpal bones. (See *Anat. Pathol. Mal. des Articulations*, Fol. Paris, 1829—1832.) This example, however, does not affect the general accuracy of Dupuytren's observations, with regard to the excessive rarity of dislocation of this joint by external violence.

Another source of occasional deception is a particular conformation of the wrist in certain classes of workmen, whose employments lead them to make sudden, violent, and repeated extensions. In consequence of these efforts, the ligaments of the wrist not unfrequently become relaxed, so as to allow the bones to move more extensively than in the natural state. The carpus, being then not firmly fixed to the fore-arm, yields to the action of the flexor muscles, and becomes displaced in front of the lower ends of the radius and ulna. Deformity, and some degree of weakness are the only inconveniences of this state of the wrist, which rarely obliges the individual to discontinue work. (See *Dict. des Sciences Méd.*) When a fracture of the lower end of the radius is mistaken for a dislocation, or neglected, the interosseous space becomes effaced; the fore-arm, instead of its proper flat form in this situation, acquires a cylindrical shape; and the movements of pronation and supination are destroyed. (*Dupuytren, Clin. Chir.* t. iv. p. 211.) I have seen two cases, within a recent period, where the epiphysis of the lower end of the radius was separated from the rest of the bone by a fall. Both the patients were boys, who had sustained other severe injuries.

[There can be no doubt about the extreme rarity of these dislocations, but, nevertheless, Dupuytren went too far when he denied their existence altogether. M. Malgaigne has collected eight examples of the dislocation backwards, and six of the dislocation forwards, one of which latter was observed by himself. Of the eight dislocations backwards, however, five were compound, while of the remaining three, one, recorded by M. Voillemier, which afforded a perfect example of dislocation in every other respect, was complicated with fracture of the styloid process of the ulna; and in another, observed by M. Lenoir, it was found that a small portion of bone had been detached from the posterior border of the articular surface of the radius and had followed the carpus in its displacement backwards. Both these patients died from other injuries, and the wrist joints were carefully examined. Of the six dislocations forwards, three were associated with fracture of the styloid process of the radius, but two, recorded by MM. Malle and Collin, were unattended by any complication whatever. (See *Malgaigne, Traité, des Fract.* t. ii. p. 698 *et. seq.*)

A case observed by Mr. Haydon, in 1840, of a boy æt. thirteen, who was thrown from a horse, and fell on the palms of his hands, is recorded in Sir A. Cooper's work on Dislocations. Both wrists were dislocated, one (*the left*) presenting a dislocation of the radius forwards; the other (*the right*) presenting a dislocation of the radius and ulna backwards. If this case can be depended upon, it is remarkable, as showing that the direction in which the force is applied does not always determine the direction of the dislocation, since here the same kind of force produced an opposite displacement on the right and left side. The force was believed to have operated in the same direction on both sides, because there were "extensive bruises on the palms of both hands, but not the slightest on the back of either hand." These injuries were believed to be dislocations, unattended with any fracture, because "the two tumors in each member were so distinct, the reduction was so complete, and the strength of the parts after reduction so great; and also from the very trifling pain felt after reduction—for within an hour after, the patient could rotate the hand and supinate it when prone; this could not, it was believed, have been done had there existed a fracture (p. 485, *B. Cooper's Edition*, 1842). It certainly seems extraordinary that two examples of this dislocation, which is admitted on all hands to be so extremely rare, should occur at once in the same individual.

In distinguishing between a dislocation of the wrist and a fracture of the lower extremity of the radius, the position of the styloid process should be carefully noted. In the dislocation, this process will be in a line with the shaft of the bone, and at the same distance from the external condyle of the humerus as on the sound side. In the fracture the styloid process follows the carpus in its displacement, and does not coincide with the axis of the rest of the bone. Care should be taken, however, lest the lower end of the shaft of the radius be mistaken for its styloid process, an error which is not unlikely to happen when the fracture is very near the wrist, or in children when a separation of the epiphysis has taken place. A comparison of the injured with the sound side, by measurement from the external condyle to the supposed styloid process, should set this point at rest; confirmative evidence may also be obtained by observing that if the radius be uninjured, its styloid process should be situated at a somewhat lower level than that of the ulna. Further information on these points will be met with in the article on Fractures of the radius.]

Reduction.—If a dislocation of the radio-carpal joint were to be met with, gentle extension and counter-extension would be requisite, while the two surfaces of the joint should be made to slide on each other in a direction contrary to what they took when the accident occurred. [A better plan, M. Malgaigne thinks, would be to exercise direct pressure with the thumbs, either from above downwards upon the carpus, or from below upwards upon the radius.]

[*Dislocation of the radius at the wrist.*—A dislocation of the *radius only* is thus described in Sir A. Cooper's work on Dislocations:—"This bone is sometimes separately thrown upon the fore part of the carpus, and lodged upon the scaphoid bone and os trapezium. The outer side of the hand is, in this case, twisted backwards, and the inner forwards; the extremity of the radius can be felt and seen, forming a protuberance on the fore part of the wrist, and the styloid process of the radius is no longer situated opposite to the os trapezium. This accident usually happens from a fall when the hand is bent back; and I have also known it arise from a fall upon the hand, by which the condyles of the os humeri were broken obliquely, and the radius dislocated at the wrist, being thrown upon the fore part of scaphoid bone, where it could be distinctly felt."—"The extension necessary to reduce this dislocation of the radius, and the treatment which it demands, are the same which are required for the luxation of both bones; and there is no difficulty in the operation, the hand being extended whilst the fore arm is fixed." (*Sir A. Cooper*, *On Dislocations*, edited by *B. Cooper*, p. 489, 1842.]

[*Congenital dislocation of the wrist.*—Mr. R. W. Smith has carefully described the appearances observed in the dissection of two cases of *congenital* dislocation of the wrist joint. In one of these (a female lunatic, æt. 26) both joints were dislocated, but in opposite directions; the right limb exhibiting a displacement of the carpus forwards, the left, backwards. The deformity in the right limb presented a remarkable similarity to that observed in M. Cruveilhier's case, which has been already quoted at length; and Mr. Smith believes that this latter was also an instance of congenital luxation. (*On Fractures and Dislocations*, p. 238.)]

Dislocations of the Carpus.

A simple dislocation of the carpal bones from each other seems almost impossible. The os magnum, however, is sometimes partially luxated from the deep cavity formed for it in the os scaphoides and os lunare. This displacement is produced by too great a flexion of the bones of the first row on those of the second, and the os magnum forms a tumour on the back of the hand. (*Chopart*, *Boyer*, *Richerand.*) Chopart once met with a partial luxation of the os magnum. Boyer had seen several examples of the accident, which, he says, is more common in women than men ; a circumstance which he imputes to the ligaments being looser in females, and to the bones of the carpus in them having naturally a greater degree of motion. The tumor increases, when the hand is bent, and diminishes, when it is extended. The case does not produce any serious inconvenience. If the wrist be extended, and pressure be made on the head of the os magnum, the reduction is easily accomplished ; though a renewal of the displacement cannot be prevented, unless the extension and compression be kept up by means of a suitable apparatus, during the whole time requisite for the healing of the torn ligaments. As the inconveniences of the accident are slight, few patients will submit to any tedious, irksome treatment ; and sometimes the surgeon is never consulted, till it is too late to think of replacing the bone.

Sir Astley Cooper has seen two cases of displacement of the os magnum in females ; the accidents produced a weakness of the hand, and arose from relaxation of the ligaments. One example is also given of a dislocation of the os scaphoides, which was thrown backward upon the carpus, with the lower portion of the broken radius. (*On Dislocations*, p. 514, 515.)

[In 1830 a policeman applied at Guy's Hospital, in consequence of an injury his wrist had sustained from a fall on the hand, which was bent under him till the palmar aspect of the fingers came in contact with the fore-arm. On the back of the wrist was a round hard tumor, rather larger than a marble, opposite to and above the base of the metacarpal bone of the middle finger. Reduction was effected by making extension from the middle and forefingers only, while pressure was kept up on the os magnum, which suddenly slipped into its place without any difficulty, and the tumor disappeared. On flexing the hand the displacement returned, and splints and compresses were necessary to maintain the reduction. (For further details see *Sir A. Cooper*, *On Dislocations*, *Bransby Cooper's edition*, p. 503.)

A case was seen by Mr. Erichsen, at University College Hospital, in which the semi-lunar bone was believed to be dislocated. The patient had fallen from a height, doubling his right hand under him. A small hard tumor was felt, projecting on the dorsal aspect of the wrist, which disappeared on extending the hand and employing firm pressure, but started up again as soon as the wrist was forcibly flexed. It was evident that this bone belonged to the first row of the carpus artilating with the radius, and from its size, position, and shape, which could be pretty distinctly made out through the integuments ; there could be little doubt that it was the semi-lunar bone. (*Science and Art of Surgery*, p. 234.)

Mr. Fergusson speaks of one example, in which the pisiform bone was detached from its lower connections by the action of the flexor carpi ulnaris. (*Pract. Surg.* p. 237, ed. 3.)

M. Maisonneuve met with a case in which the second row of carpal bones was dislocated backward upon the first. The dislocation was complicated with fracture of the scaphoid bone, a small piece of which remained united to the trapezium, and also of the cuneiform, part of which, together with the pisiform, had followed the unciform bone. The patient fell from a height of 40 feet, and died of the injuries which he received. (See *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 719.)]

Compound dislocations of the carpal bones generally arise from gunshot violence, or other great mechanical injury. In these cases, it is sometimes necessary to take away the displaced bones altogether ; and, too frequently, the accident is complicated with so much additional mischief as to require amputation.

Dislocations of the Metacarpus.

Dislocation of the metacarpal bone of the thumb. — The first metacarpal bone, which is articulated with the os trapezium, and admits of the movements of flexion, extension, abduction and adduction, is occasionally luxated ; but the accident is uncommon. Although, from the nature of the joint, between the first metacarpal bone and the trapezium, one might infer, that a dislocation is possible in four directions, some of these varieties must be very rare. The dislocation backwards is produced by the application of external force to the back of the metacarpal bone, which is violently bent, the case usually arising from a fall on the outer edge of the hand. The capsular ligament is lacerated, the extensor tendons of the thumb are pushed up, and the head of the bone slips behind the trapezium.

In the cases, which Sir Astley Cooper has seen, the metacarpal bone was thrown inwards, between the trapezium and the root of the metacarpal bone of the fore-finger, so as to form a protuberance towards the palm ; the thumb was extended backwards, and it could not be brought towards the little finger. Considerable pain and swelling followed the accident. In the reduction, Sir Astley Cooper deems it best to make extension with the thumb inclined towards the palm, in order to lessen the resistance of the flexor muscles. Steady extension must be unremittingly kept up; and, if the reduction cannot be accomplished in this way, the same experienced surgeon considers it advisable "to leave the case to the degree of recovery, which nature will in time produce, rather than divide the muscles, or run any risk of injuring the nerves and blood-vessels." In a compound dislocation, produced by the bursting of a gun, the bone is to be reduced, the integuments brought together, and the part poulticed. When the muscles are severely torn, amputation of the thumb may be necessary, in which case Sir Astley Cooper recommends the removal of the articular surface of the trapezium with a saw. (*On Dislocations*, p. 488, ed. 4.) The cutting pliers would perhaps answer better.

[Contrary to the experience of Sir A. Cooper, most surgeons speak of the dislocation backwards as more common than that forwards. Mr. Fergusson says, he has seen "several" of the former, but has met no example of the latter kind of injury. M. Malgaigne could meet with no record of dislocation forwards, excepting that of Sir A. Cooper, but refers to as many as nine cases of the dislocation backwards, four of which were complete and five incomplete. Two of the complete and one of the incomplete came under his own observation. (*Traité des Fract. &c.* t. ii. p. 722.) It appears that the dislocation backwards may be caused in two ways: First, as stated above, by force applied to the dorsal surface of the metacarpal bone, so as bend it towards the palm; and secondly, by violence applied to the palmar surface, so as to bend it forcibly backwards. In the complete dislocation the thumb is shortened, and the carpal extremity of the bone forms a very palpable projection on the back of the carpus; but if it is of the incomplete kind there is no shortening, and the prominence is, of course, less striking; or it may perhaps be concealed altogether in the inflammatory swelling which ensues. In the complete dislocation the thumb is usually slightly flexed towards the palm. Extension upon the thumb, combined with pressure forwards upon the displaced end of the bone, will effect the reduction, which should be maintained for a time, by a properly adjusted compress and bandage.]

Dislocation of the metacarpal bones of the fingers. — The connection of the four inner metacarpal bones with one another, and with those of the carpus, is so close, and the degree of motion so slight, that a dislocation can hardly take place. Thus, Sir Astley Cooper, in his vast experience, has never seen them dislocated, except by the bursting of guns, or by the passage of heavy carriages over the hand; cases frequently demanding amputation. (*On Dislocations*, p. 519.)

[A dislocation forwards of the second metacarpal bone was observed by M. Bourguet in a man, aged 45, and was the result of direct pressure upon the posterior and upper part of the bone. Reduction was effected by making extension from the injured finger, and counter-extension from the wrist, pressure being made, at the same time, upon the dislocated end of the bone, to push it backwards into its place. Splints were applied for a fortnight to guard against a relapse, and at the end of that time the cure was found to be perfect.

Dislocation of the third metacarpal bone has been twice noticed. On both occasions the displacement was backwards. In the first case, observed by M. Blandin, the dislocation was believed to be incomplete; but in the second, under the care of M. Roux, it was complete, and there was shortening of the middle finger. In this case, the reduction was effected by extension from the middle finger, combined with pressure downwards upon the carpal extremity of the bone. (See *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 727.)]

DISLOCATIONS AT THE METACARPO-PHALANGEAL ARTICULATIONS.

Dislocation of the thumb.—[The first phalanx of the thumb may be dislocated, either backwards or forwards upon the metacarpal bone. The backward displacement is tolerably common; that forwards is much more rare.

The dislocation *backwards* is usually the result of a fall upon the palmar surface of the thumb, or of external violence so applied as to force the phalanx backwards upon the metacarpal bone, from which it projects backwards at an obtuse angle, and remains extended, while the second phalanx is bent. More rarely, the phalanx does not project at an angle, but is found in a line parallel with the metacarpal bone. This is often the case after attempts of reduction have been made. The head of the metacarpal bone is prominent towards the palm, where it is covered only by the integument. The motion of the joint is lost, but that between the metacarpal bone and the os trapezium continues free.

M. Malgaigne describes an *incomplete* dislocation backwards, of which he has observed two cases. The slighter degree of prominence in front and behind the joint, and the absence of shortening, together with the greater facility of reduction, would distinguish this from the complete dislocation.]

Reduction.—This dislocation should be speedily reduced; especially if complete, for, after eight or ten days, it becomes irreducible. Sir Astley Cooper recommends the extension to be made, while the thumb is bent towards the palm, and the flexor muscles relaxed; and the following is his method of applying the extending force, which he adopts also for dislocations of the toes, thumb, and fingers in general: — "The hand is to be first steeped in warm water, for a considerable time, to relax the parts, as much as possible. Then a piece of thin wetted leather (wash leather for instance), is to be put around the first phalanx, and as closely adapted to the thumb as possible. A portion of tape, about two yards in length, is then to be applied upon the surface of the leather in the knot, which is called by the sailors, the *clove-hitch*, for this becomes tighter as the extension proceeds. An assistant places his middle and fore-finger between the thumb and fore-finger of the patient, and makes the counter-extension, whilst the surgeon, assisted by others, draws the first phalanx from the metacarpal bone, directing it a little inwards, towards the palm of the hand. The extension should be supported for a considerable length of time, and if success does not attend the surgeon's efforts, it is right to adopt the following plan: — The leather and sailor's knot are to be applied as before directed, and a strong worsted tape is to be carried between the metacarpal bone of the thumb and the fore-finger. The arm is then to be bent around a bed-post, and the worsted tape fixed to it. A pulley is then to be hooked to the tape, which surrounds the first phalanx, and extension is to be made. This mode is almost sure to succeed." (*Sir A. Cooper*, op. cit. p. 493, ed. 4.) [A very convenient instrument for seizing the thumb and making extension upon it, has been devised by M Luer, and modified by M. Charrière, the surgical instrument maker of Paris. (See *Bulletin Gén. de Thérap.* t. xxxiv. June, 1848, p. 500.) A description and representation of it will also be found in the *Dublin Quart. Journal*, Aug. 1850, p. 118.] Even in cases which are quite recent, this kind of dislocation sometimes cannot be reduced without the utmost difficulty; and the different proposals which have been made, respecting this particular accident, by Mr. Evans, the late Mr. Hey, Sir C. Bell, and Boyer, deserve the notice of the surgical practitioner. On this subject, however, Sir Astley Cooper remarks, that he has seen too much mischief arise from injury to the tendons and ligaments, ever to recommend their division, in order to facilitate the reduction, when extension will not succeed. (*On Dislocations*, p. 523.)

[The cause of the difficulty, which has so often been met with in reducing the dislocation of the thumb, has been differently accounted for. Mr. Hey believed it to arise from the lateral ligaments slipping behind the head of the metacarpal bone, and closely embracing the constricted portion or neck. He thought they might thus prevent the enlarged head of the bone passing backwards into its place. Dupuytren thought it was the result of change in direction of these ligaments, which became placed at right angles to instead of parallel with the axis of their bones, and retain the phalanx closely applied against the metacarpal bone. But, as M. Malgaigne observes, in the first place, the lateral movements, which can be communicated to the dislocated phalanx, militate against this idea of constriction by the ligaments; and, secondly, the dislocations which have been artificially produced on the dead body, are almost constantly attended with rupture of one, at least, and often of both the ligaments. (*Traité des Fract. &c.* t. ii. p. 734.) Sir Geo. Ballingall thought the obstacle arose from the constriction of the neck of the bone by the short muscles of the thumb, because, when the phalanx passes backwards, the end of the metacarpal bone passes between the two tendons of the flexor brevis pollicis, and its neck is then closely embraced by the inner portion of that muscle and the adductor on the inside, and the outer portion with the abductor on the outside.

Dr. Adair Lawrie of Glasgow has published an account of the dissection of a dislocated thumb, which is confirmatory of this view: — The dislocation had existed for three years, and several unsuccessful attempts had been made to reduce it. The end of the phalanx was thrown on the back and inner side of the metacarpal bone, to the distance of at least an inch. The end of the metacarpal bone projected forwards to a corresponding distance, free from muscle or ligament. The anterior ligament was torn from the metacarpal bone. The posterior ligament was pressed back, but apparently nearly entire. The anterior portion of the external lateral ligament was torn; the posterior portion was stretched, and thrown back and across the metacarpal bone. The internal lateral ligament was entire. New ligamentous connections had formed between the displaced bones. The end of the metacarpal bone had passed between the two portions of the flexor brevis, one of which was on each side of it grasping it firmly. Dr. Lawrie, however, thought that a great part of the outer head had been torn, but that the inner head was uninjured, having slipped to the inner side of the metacarpal bone. The tendon of the flexor longus lay on the inner side of the metacarpal bone, along with the inner head of the flexor brevis, pressing on the adductor, and pushing it back. On the outside the abductor was also thrown back and a little stretched.

From a series of experiments on the dead body, however, Dr. Lawrie was led to think that, though the muscular constriction might sometimes cause considerable difficulty, the following condition of the parts was likely to prove still more formidable, He found, in dissecting some of the dislocations which he had artificially produced, that the *anterior* ligament was completely torn from the metacarpal bone, and remained attached to the phalanx and sesamoid bones, in such a manner that the torn ligament and sesamoid bones were carried backwards by the phalanx, and placed between it and the metacarpal bone. The result was that the opening in the ligaments, by which the metacarpal bone escaped, was thrown back nearly half an inch, and the remains of that ligament and sesamoid bones formed a partition between the displaced ends of the bones, and constituted a mechanical obstacle to the reduction. This state of parts would, of course, be greatly aggravated by the contraction of the muscles attached to the sesamoid bones and anterior ligaments. (See *Lond. Med. Gaz.* vol. ii. 1837, p. 93.)

M. Pailloux, having met with an irreducible dislocation of the thumb, at the Hospital St. Louis, also made experiments on the dead body, and arrived at the same conclusion with Dr. Lawrie, that the rupture of the anterior ligament at its insertion into the metacarpal bone, and its interposition, together with the sesamoid bones, between the articular surfaces, was the principal cause of the difficulty. (*Nélaton, El. de Pathol. Chir.* t. ii. p. 420, *and Pailloux, Bulletin de la Soc. Anat.* 1826.)

The plan of reduction, recommended by Sir A. Cooper, of extension downwards with flexion towards the palm, has already been described. Instead of extension, direct pressure was recommended by Mr. Hey. The pressure should be made upon the dislocated end of the phalanx, to push it forwards over the end of the metacarpal bone. Dr. Penneck advised the employment of a piece of tape to pull upon the dislocated extremity of the bone. He tied the middle part of the tape round the first phalanx, letting it cover a part of the end of the dislocated bone, and having the knot on the opposite side. Then making extension with it, he found the dislocated phalanx slip readily into its place, when the tape slipped off, and the bone was reduced. (*Lancet*, vol. i. 1828, p. 268.) Another plan, first suggested by Sir C. Bell, is to forcibly bend the thumb backwards, at the same time that the posterior extremity of the phalanx is pressed forwards; by this means the anterior edge of the articular surface of the phalanx may be tilted forwards until it overlaps the end of the metacarpal bone, and when this has been effected, sudden flexion towards the palm will accomplish the rest. I have seen a dislocation reduced with the greatest ease by this method, and I have employed it myself, and succeeded in the first attempt in a case in which powerful and repeated extension downwards had been previously tried. It has the advantage of not increasing at the outset the tension of the constricting muscular and tendinous fibres, and thereby provoking their further contraction; while, if the obstacle is caused by the anterior ligament and sesamoid bones in the manner which has been described, it appears to be almost the only way in which their disengagement is likely to be effected. Should these means fail (and failures have repeatedly occurred in the hands of the most distinguished surgeons), the question will arise, what further measures can be resorted to? Sir C. Bell proposed to divide one of the lateral ligaments by subcutaneous section, but, as has been shown, it is questionable whether these are the real cause of the resistance. M. Malgaigne suggests the division, in the same way, of the muscles which form the external border of the muscular opening ("*boutonnière*"), through which the head of the metacarpal bone has passed. This method, however, was practised without success, in 1845, at the Hospital St. Antoine, and it failed also in the hands of M. Blandin, although combined with section of the lateral ligaments as well. This latter case, however, was of 30 days' standing. (*Malgaigne*, loc. cit. p. 742.) Dr. Lawrie thinks, that if the knife is used at all, it should be passed into the joint in such a manner as (if possible) to disengage the anterior ligaments and sesamoid bones from their unnatural position. (*Lond. Med. Gaz.* vol. ii. 1837, p. 93.)

M. Malgaigne, on one occasion, after various methods had been unsuccessfully tried, introduced a pointed instrument through the skin into the articular surface of the phalanx, for the purpose of pushing it forwards, but he found that the point penetrated too far into the osseous tissue. He therefore, withdrew it, and inserted it in front into the centre of the head of the metacarpal bone; then pulling upon the phalanx with one hand, and pressing upon the metacarpal bone with the instrument in the other hand, he immediately felt the bone return into its place. The reduction, which was for the moment necessarily imperfect on account of the presence of the instrument, was easily completed by a little pressure as soon as this was withdrawn (p. 741).]

[*Dislocation forwards.*—This is much more rare than the preceding. Sir A. Cooper passes it over altogether without notice: and more recently M. Malgaigne has stated that he could find only four published cases, which he could consider as unequivocal examples of it. A fifth, in which the displacement was incomplete, was observed by himself. It appears to be usually the result of force applied to the dorsal surface of the phalanx. In the complete dislocation the head of the metacarpal bone is prominent posteriorly, and the end of the phalanx is thrown towards the palm. The displacement is not always directly forwards. In a case seen by M. Nélaton, the end of the phalanx was dislocated forwards and *outwards*; in one observed by M. Lombard, it was thrown forwards and *inwards*, to such an extent that it rested against the outer border of the third metacarpal bone, and the thumb had undergone a shortening equal to the whole length of its first phalanx. This dislocation was the result of a fall on the *palmar* surface of the thumb. The position of the thumb does not appear to be constant; in M. Nélaton's case the first phalanx was flexed to an angle of 45° with the metacarpal bone; in M. Lombard's, it formed, with the metacarpal bone, an angle of 60° in the opposite direction, while in a third case, seen by M. Lenoir, it was neither flexed nor extended. In all three, the phalanx was *rotated inwards.*

The *reduction* is attended with much less difficulty than in the dislocation backwards. It should be conducted on the same principles as in the backward displacement, only, if pressure is used upon the extremities of the bones, it must, of course, be applied in the reverse direction.]

Dislocation of the fingers at the metacarpo-phalangeal articulations. — The first phalanges of the fingers may be dislocated backwards off the heads of the metacarpal bones. A luxation forwards is more difficult; because the articular surfaces of the metacarpal bones extend a good way forwards, and the palm of the hand makes resistance to such an accident.

[The index and little fingers from their more exposed situation, are more frequently dislocated than the others. The injury is not always confined to one finger, but two, three, or even all four may be dislocated at once.

The reduction may be effected by the same processes as in the dislocations of the thumb, but is not always to be accomplished without difficulty. M. Malgaigne remarks, that in the fingers as well as in the thumb, the metacarpal bone may be constricted by the muscular and tendinous fibres on each side of it, — interossei and lumbricales; while M. Biéchy has shown by experiment that here also the anterior ligament may be interposed between the base of the phalanx and the end of the metacarpal bone. (*Malgaigne,* loc. cit, p. 748.)]

DISLOCATIONS OF THE PHALANGEAL ARTICULATIONS.

According to Sir Astley Cooper, dislocation of the fingers more frequently happens between the first and second phalanges, than between the second and third; the second being thrown forward, towards the theca, and the first backwards. The reduction is effected by making extension with a slight inclination forward, so as to relax the flexor muscles. When reduction is impracticable by common means, or from the oldness of the dislocation, Sir Astley Cooper disapproves of the scheme of dividing the ligaments, in order to succeed. The mischief, which he has known arise from injuries of tendons and ligaments, deters him from advocating the practice. (*On Dislocations*, p. 485, 486. ed. 4.)

[The dislocation of the *second phalanges from the first* may take place either backwards, forwards, or laterally. M. Malgaigne, who has published an elaborate memoir on the subject of dislocations of the phalanges, found that out of thirteen cases, five were in the first, five in the second, and three in third direction. The displacement forwards, according to the same authority, may be either complete or incomplete. In none of the cases alluded to does there appear to have been any difficulty in replacing the bone in its proper situation, and the question of the propriety of dividing the lateral ligaments is therefore not very likely to arise.

Dislocation of the *third phalanges from the second* may take place either backwards or laterally, and may be complete or incomplete. M. Malgaigne could find no example recorded, as regards these joints, of dislocation forwards. Dislocation of the *extreme* phalanx of the thumb, however, which is more frequent than of the fingers, may occur either backwards or forwards, but the backward displacement is one commonly met with. The phalanx is usually thrown backwards, in such a manner that its articular surface is turned towards the dorsal surface of the first phalanx ; but it is worth remarking, that the same position *may* be met with in the dislocation forwards, the end of the thumb being turned back, although the articular end of the phalanx has been thrown forwards. For the extreme phalanges, in consequence of the difficulty of obtaining a firm hold, Mr. Penneck's plan of making extension seems especially well adapted.]

Dislocations of the Bones of the Pelvis.

Experience proves, that the bones of the pelvis, notwithstanding the vast strength of their ligaments, may be dislocated by violence: thus, the sacrum may be driven forwards towards the interior of the pelvis; the ossa ilii may be displaced forwards and upwards; and the bones of the pubes may be totally separated at the symphysis, and an evident degree of movableness occur between them. For the production of these accidents, however, the operation of enormous force is requisite ; and, in fact, their usual causes are falls from a great height; the fall of a very heavy body against the sacrum, at a period when the body is fixed; and the pressure of the pelvis between a wall, or post, and the wheel of a carriage, or waggon. Hence, the dislocation is generally the least part of the mischief occasioned by such kinds of violence, and the case is often attended with concussion of the spinal marrow, injury of the sacral nerves, extravasation of blood in the cellular substance of the pelvis or cavity of the peritoneum, injury of the kidneys, and fracture of one or more of the bones of the pelvis.

In addition to the complications, which may attend a dislocation of the bones of the pelvis, and arise immediately from the external violence, the case is always followed by inflammation, the consequences of which may be very serious, not only on account of the extent of the articular surfaces affected, but because such inflammation may extend to the peritoneum and viscera of the abdomen and pelvis, of which I have myself seen instances.

When these cases do not prove fatal from the direct effect of the great violence committed on many parts, or from peritonitis, the same unpleasant event sometimes follows rather later from suppuration of the articular surfaces taking place, and abscesses forming in the cellular tissue of the pelvis. (*Boyer, Mal. Chir.* t. iv. p. 147.)

Louis relates a case, in which the os ilium of the right side was separated from the sacrum, so as to project nearly three inches behind it. The accident was caused by a heavy sack of wheat falling on a labourer.—(*Mém. de l'Acad. de Chir.* t. iv. 4to.)

A case, in which a dislocation of the left os innominatum upwards had a successful termination, was attended by Enaux, Hoin, and Chaussier, and is published in a modern work. (*Mém. de l'Acad. des Sciences de Dijon.*) As the reduction could not be accomplished at first, antiphlogistic treatment was followed for some days, when new attempts to replace the bone were made, but could not be continued, as they caused a recurrence of pain and other bad symptoms. A third trial, made at a later period, was not more effectual; and all thoughts of reduction were then abandoned. After the patient had been kept quiet some time, though not so long as was wished, he quitted his bed, and began to walk about on crutches, I do not understand, however, as is asserted, how the weight of the body could now bring about the reduction, which had been previously attempted in vain. Be this as it may, the result was the patient's recovery. The fact clearly proves, as Boyer observes, that, in cases of this description, the most important object is not to aim at the reduction, but rather to oppose, by every means in our power, inflammation and its consequences.

Frequently, the use of the catheter is necessary, and, sometimes an incontinence of urine, or the involuntary discharge of the feces, demands the strictest attention to cleanliness. In these cases, if the patient live any time, there is also another source of danger, consisting in a tendency to sloughing in the soft parts, on which the patient lies, and which, when they have been bruised, require still greater vigilance.

Sir A. Cooper has remarked, that some of these cases, complicated with fracture, are liable to be mistaken for dislocations of the thigh:—"When a fracture of the os innominatum happens through the acetabulum, the head of the femur is drawn upwards, and the trochanter somewhat forwards, so that the leg is shortened, and the knee and foot is turned inwards. Such a case, therefore, may be readily mistaken. If the os innominatum is disjointed from the sacrum, and the pubes and ischium are broken, the limb is slightly shorter than the other; but the knee and foot are not turned inwards. These accidents may generally be detected by a crepitus perceived in the motion of the thigh, when the surgeon applies his hand to the crista of the ilium, and there is greater motion, than in a dislocation of the thigh." (*Surgical Essays*, part i. p. 49.) In a subsequent article, I shall notice Mr. Earle's observations on this subject. See Fracture.

In a case, recorded by Sir A. Cooper, the posterior part of the acetabulum was broken off, and the head of the thigh-bone had slipped from its socket; the fracture extended across the os innominatum to the pubes, the bones of which were separated at the symphysis nearly an inch asunder. The ilia were separated on each side, and the left os pubis, ischium, and ilium broken. (*Surgical Essays*, part i. p. 50.) In the same work may be perused another case of fracture of the body of the os pubis and ramus of the ischium, combined with a luxation of the right os innominatum from the sacrum, and laceration of the ligaments of the symphysis of the pubes.

Dislocations of the Coccyx.—The os coccygis is not so easily dislocated as fractured. Boyer had seen it displaced in a man, who had extensive ulcerations, by which it was laid bare. There was an interspace of nearly two inches, between the sacrum and base of the os coccygis. In proportion as the man regained his strength, the bone recovered its right position, and at length united to the sacrum, notwithstanding the action of the levatores ani, which are inserted into it. This case, however, was not an accidental luxation; but arose from the destruction of the ligaments by disease.

Authors mention two kinds of dislocation, to which the os coccygis is liable; one, forwards; the other, backwards. The first, which is the most frequent, is always occasioned by external violence; the second, by the pressure of the child's head in difficult labours. Pain, difficulty of voiding the fæces and urine, tenesmus and inflammation, sometimes ending in abscesses, which implicate the rectum, are symptoms said to follow such dislocations.

[The nature and extent of the displacement may be ascertained by the introduction of the finger into the rectum; but it will be difficult, and, no doubt, often impossible to distinguish a dislocation from a fracture. The latter is by far the more frequent injury of the two. For the reduction, the finger may be introduced into the rectum, and then the thumb being applied externally, the dislocated bone may be held between the two, and pressed back into its place.] Much handling, however, of the painful and injured parts should be avoided, as likely to increase the subsequent inflammation and produce abscesses. Strict quietude should be enjoined, and antiphlogistic measures adopted.

Dislocations of the Hip-joint.

According to Sir A. Cooper, the head of the thigh-bone may be dislocated upwards on the dorsum of the ilium; backwards, into the ischiatic notch; downwards and forwards, on the foramen ovale; upwards and forwards on the body of the os pubis.

Sir A. Cooper's observations led him to believe that the relative proportion of cases would be in twenty as follows:—twelve on the dorsum ilium; five in the ischiatic notch; two on the foramen ovale; and one on the pubes.

[But besides these four varieties described by Sir A. Cooper, several other, though much rarer, forms have since been observed; in fact, the head of the thigh-bone has been found displaced from its socket in almost every conceivable direction.

The classification of these injuries therefore requires several additions and modifications.

In the first place, it seems advisable, in accordance with several eminent modern authorities, to combine the two first dislocations of Sir A. Cooper, above mentioned, into one form, which may be called the *dislocation backwards and upwards.* This is by far the most frequent injury to which the hip-joint is liable.

Secondly, the head of the femur may be displaced directly *backwards*, in the direction of, or resting upon, the spinous process of the ischium.

Thirdly, it may pass directly *downwards*, or *downwards and slightly backwards*, resting upon or behind the tuberosity of the ischium.

Fourthly, it may pass *downwards and slightly forwards*, towards the perineum, or on to the ascending ramus of the ischium.

Fifthly, it may pass *forwards and downwards* into the foramen ovale.

Sixthly, it may pass *forwards and upwards* on to the pubes, and rest upon that bone between the anterior inferior spinous process and the pectineal eminence.

Seventhly, it may pass *directly upwards*, and become placed beneath the anterior superior spinous process of the ilium.

The order of frequency of these dislocations is as follows: — 1. The dislocation backwards and upwards, which includes more than three-fourths of all the dislocations of the hip. 2. The dislocation forwards and downwards, in to the foramen ovale. 3. The dislocation forwards and upwards on the pubes. These are the ordinary varieties, and answer to the four dislocations of Sir A. Cooper. The remainder may be considered as more or less exceptional, but they may probably be arranged thus as to comparative frequency:— 4. The direction backwards on to the spine of the ischium. 5. The dislocation directly upwards, beneath the anterior superior spinous process. 6. The dislocation directly downwards, on the tuberosity of the ischium. 7. The dislocation towards the perineum.]

1. *Dislocation backwards and upwards.*—[This will be understood to include the two first-mentioned dislocations of Sir A. Cooper, viz. that on the dorsum, and that into the ischiatic notch, which have many points of resemblance; in fact, their only difference consists in a slight alteration of the position of the head of the bone in the upward or backward direction. Several modern writers have therefore thought it more convenient to classify them together. M. Nélaton has described this variety under the name of *ilio-ischiatic.*" Mr. Erichsen calls it the *ilio-sciatic*, and M. Malgaigne the *iliac* dislocation. Such an arrangement has the advantage of simplifying the subject, and another reason for adopting it is found in the circumstance that between the point assigned by Sir A. Cooper to the dislocation of the dorsum of the ilium, and that assigned to the dislocation in the ischiatic notch, the head of the bone may occupy any intermediate position without material or essential modification of the symptoms.

The position of the bone, too, is not unfrequently altered within the above limits subsequently to the occurrence of the accident. Thus, the head of the bone, originally on the dorsum ilii, may, during the attempts at reduction, be drawn downwards opposite to the ischiatic notch; or, on the other hand, when it has been originally displaced backwards, it may be pushed upwards in consequence of the patient attempting to bear the weight of the body upon the limb, and possibly also it may be drawn upwards by muscular contraction.

It is still desirable, however, to call attention to the distinguishing features of these injuries as described by Sir A. Cooper. According to this authority—]

The dislocation upwards on the dorsum of the ilium is attended with the following symptoms:— The limb is from one inch and a half to two inches and a half shorter than its fellow, the thigh a little bent, and carried inwards. The knee inclines more forwards and inwards than the opposite one; the leg and thigh are turned inwards, and the foot points in this direction; the toe resting against the tarsus of the other foot. (*Surgical Essays*, part iv. p. 27.) If the bone be not concealed by extravasation of blood, the head of it can be perceived moving upon the dorsum ilii during rotation of the knee inwards, and the trochanter major may be felt much nearer than natural to the anterior and superior spinous process of the ilium. It is also less prominent than that on the opposite side, and the natural roundness of the hip has disappeared. The natural length of the limb cannot be restored, without using force sufficient to reduce the luxation; the foot cannot be turned outwards, without great difficulty, and any attempt to do so causes pain; but the inclination of the foot inwards may be increased. When an attempt is made to draw the leg away from the other, it cannot be accomplished; but the thigh may be slightly bent across its fellow.

This dislocation may be caused by a fall when the knee and the foot of the patient are turned inwards, or by a blow whilst the limb is in that position; but it most commonly occurs in consequence of the person falling whilst carrying a heavy weight on his shoulders; or from a heavy weight, such as a mass of earth, falling on the back whilst the body is bent forwards in a stooping posture.

In general, a dislocation on the dorsum of the ilium is at once readily discriminated from a fracture of the neck of the thigh-bone, within the capsular ligament, by *the rotation of the limb inwards;* a position which is unusual in a fracture of any part of the os femoris. "In a fracture of the neck of the thigh-bone, the knee and foot are generally turned outwards; the trochanter is drawn backwards; the limb can be readily bent towards the abdomen, although with some pain; but, above all, the limb, which is shortened from one to two inches by the contraction of the muscles, can be made of the length of the other by a slight extension, and when the extension is abandoned, the leg is again shortened. If, when extended, the limb is rotated, a crepitus can often be felt, which ceases when rotation is performed under a shortened state of the limb. The fractured neck of the thigh-bone, within the capsular ligament, rarely occurs but in advanced age, and often is the effect of the most trifling accidents, owing to the interstitial absorption which the cancellated texture of this part of the bone undergoes at advanced periods of life. Fractures, external to the capsular ligament, occur at any age, but generally in the middle periods of life; and these are easily distinguished by the crepitus which attends them, if the limb is rotated and the trochanter is compressed with the hand. The position is the same as in fractures within the ligament. The proportion of fractures of the neck of the thigh-bone, which I have seen, is at least four cases to one of dislocation." (*Sir A. Cooper, Surg. Essays,* part i. p. 28.) The rotation of the limb inward, in cases of fracture of the neck of the thigh-bone, is uncommon, though sometimes met with. (See *Fractures.*)

In the dislocation of the thigh backwards on the ischiatic foramen, the head of the bone is placed on the pyriformis muscle, between the edge of the bone which forms the upper part of the ischiatic notch and the sacro-sciatic ligament, being behind the acetabulum, and a little above the level of the middle of that cavity. The limb is generally not more than half an inch shorter than its fellow. The trochanter major is behind its usual place, but is still remaining nearly at right angles with the ilium, with a slight inclination towards the acetabulum. The head of the bone is so buried in the ischiatic notch, that it cannot be felt, except in thin persons, and then only by rolling the thigh-bone forwards, as far as the comparatively fixed state of the limb will allow. The knee and foot are turned inwards, but less than in the dislocation upwards; and the toe rests against the ball of the great toe of the other foot. When the patient is standing, the toe touches the ground, but the heel does not quite reach it. The knee is not so much advanced as in the dislocation upwards, but is still brought a little more forwards than that of the opposite side, and is slightly bent. The limb is so fixed that flexion and rotation are in a great degree prevented.

This species of dislocation is produced by the application of force, when the body is bent forward upon the thigh, or when the thigh is bent at right angles to the abdomen; in which positions, if the knee be pressed inwards, the head of the bone is thrown behind the acetabulum.

Sir A. Cooper considers this dislocation as the most difficult both to detect and reduce: difficult to detect, because the length of the limb, and the position of the knee and foot, are but little changed; difficult to reduce, because the head of the bone is placed deeply behind the acetabulum, and requires to be drawn over the edge of the socket, as well as towards it. (*On Dislocations, &c.* p. 71.)

[As an instance of the alteration in position which the head of the bone may undergo after the accident has occurred, may be mentioned a case of dislocation backwards and upwards, described by M. Malgaigne, in which the dissection of the parts showed that the head of the bone had escaped through a rent in the lower part of the capsule, and had subsequently ascended into the usual position. This case was under the care of M. Lisfranc, who found it impossible to reduce the dislocation, and the patient died from profuse suppuration around the joint. The capsule was found uninjured at its posterior and superior portions, and it was this unusual condition of the parts, no doubt, which prevented the head of the bone returning into its socket. (See *Malgaigne,* t. ii. p. 829, and Pl. xxvi.) But besides these variations in their direction, these displacements differ also in their extent; thus the head of the femur may rest upon the margin of the acetabulum, or be removed to a considerable distance from it. M. Malgaigne has described them as being *complete* or *incomplete*, and he considers them incomplete when the head of the femur rests upon the margin of the acetabulum in such a manner that a portion of its articular surface still overlaps the articular cavity. This, however, is scarcely incomplete, in the usual acceptation of that term, since the articular surfaces are altogether removed from contact with each other, and the bone is entirely out of the socket. The terms complete or incomplete may nevertheless be convenient, as expressing the degree of displacement which the bone has undergone.

When the dislocation takes the more backward direction, the bone does not always sink into the ischiatic notch, in the manner described by Sir A. Cooper, but rests upon that portion of the os innominatum which is between the acetabulum and the notch; and when this is the case, there will not be much difficulty in feeling the head of the bone, nor will the fixed condition of the limb, and the greater difficulty of reduction to which he refers, be necessarily met with. The rotation of the limb inwards was believed by Boyer to depend upon the anterior portion of the capsular ligament remaining entire. M. Malgaigne coincides in this opinion, and believes that, in consequence of the integrity of this portion of the capsule, the rotation inwards becomes more considerable according as the head of the bone is further removed from the cavity. According to him it is not, as Sir A. Cooper believed, the position of the head of the bone on the ilium or in the ischiatic notch which causes the degree of the rotation to vary, but the variation depends rather upon the *extent* of the dislocation: when it is "incomplete," there is less rotation, and the great toe may point towards the opposite toe; when "complete," the rotation is greater and causes the toe to point towards the opposite metatarsus, the tarsus, or even the heel, according as the head of the femur is removed to a distance from the cavity. M. Malgaigne thinks the degree of rotation a valuable symptom in distinguishing the complete from what he calls the incomplete dislocation. In estimating the rotation, and also the shortening of the limb, attention must be paid to the position of the pelvis, for if the injured side of the pelvis is carried more forwards than the sound side, the rotation is apparently increased; and in like manner, if the injured side of the pelvis is drawn upwards, the shortening becomes apparently greater. The real shortening depends of course upon the ascent of the femur, and is therefore greater when the bone takes a more upward than when it takes a more backward direction. It is seldom, however, so great as the maximum, mentioned by Sir A. Cooper, of two inches and a half. It may perhaps reach an inch and a half when the dislocation is upwards, but rarely exceeds half an inch, and may often be scarcely appreciable in the dislocation opposite the notch. Proportionate to the ascent of the femur, an elevation of the cutaneous fold of the nates has also been noticed. The loss of prominence of the trochanter and flattening of the hip, mentioned by Sir A. Cooper, are not always well marked; indeed, Boyer and many others have noticed an increased prominence in this region. The increased prominence may arise partly from inflammatory effusions, and partly from the bulging of the muscles, caused by the approximation of their attachments. The sinking of the trochanter is proportionate to the rotation inwards of the limb. Another symptom worthy of notice is the depression which may be felt below Poupart's ligament, in consequence of the absence of the head of the femur from its proper situation.]

Mr. C. H. Todd had an opportunity of dissecting the hip-joint of a man after the femur had been dislocated on the dorsum of the ilium, the patient having died on the day after the accident from an injury of the head. The luxation had been reduced. "On raising the gluteus maximus, a large cavity, filled with coagulated blood, was found between that muscle and the posterior part of the gluteus medius. This was the situation, which had been occupied by the dislocated extremity of the femur. The gluteus medius and minimus were uninjured. The pyriformis, gemelli, obturatores, and quadratus, were completely torn across. Some fibres of the pectineus were also torn. The iliacus, psoas, and adductors were uninjured. The capsular ligament was entire at the superior and anterior part only, and it was irregularly lacerated throughout the remainder of its extent. The inter-articular ligament was torn out of the depression on the head of the femur. The bones had not sustained any injury." Mr Todd conceives that, when this dislocation takes place, the force is applied to the inferior and external part of the limb, the thigh being at the time in the state of demiflexion; the head is thus pushed through the posterior and upper part of the orbicular ligament, passes under the posterior edge of the gluteus minimus, separating it from the pyriformis, and forms a cavity for itself under the gluteus maximus, or between the gluteus medius and minimus." (See *Dublin Hospital Reports*, vol. iii. p. 396—401.)

In an old unreduced partial dislocation on the dorsum of the ilium, dissected by Mr Wallace, and of which he has published many interesting particulars, the posterior edge of the gluteus medius ran exactly over the head of the femur. The case had been attended with a fracture of the superior edge of the acetabulum. In consequence of the interruption of the natural movements of the limb, its muscles had become generally wasted, especially the rotators of it outwards, and the obturator internus had been transformed into a peculiar substance, resembling a mixture of fat and fibro-cartilage. It appeared to Mr. Wallace from what was noticed in this instance, that "nature does not appear to possess the power of forming articular cartilage in those accidental joints, which result from unreduced dislocations. The new articular surfaces are always covered by a lamina of bone, which resembles in appearance that ivory-like substance sometimes found on natural articular surfaces. As a cartilaginous surface cannot play easily on a bony surface, the original cartilage, which may have covered the head of the dislocated bone, becomes absorbed, and its situation occupied by the same kind of tissue as that which forms the new surface, upon which the head of the bone may be applied. In accidental joints, the result of disunited fracture, the ends of the bones appear to be covered by an articular cartilage of original formation; it corresponds in its character to the temporary cartilage of bones, or, more properly speaking, it is bone in a state of imperfect formation." (*W. Wallace, in Trans. of King's and Queen's College, Ireland*, vol. v. p. 250.) The usual change in the shape of the unreduced head of the femur is noticed by this gentleman: in the case adduced by him, one remarkable circumstance was the considerable elevation of the pelvis on the injured side; a fact which seems not to agree with a common description of the cause of the opposite kind of obliquity in the position of the pelvis in disease of the hip. With respect to the changes which take place in the head of a dislocated bone, and the kind of accidental joint which often follows, Sir Astley Cooper has adverted to certain differences depending on the texture, whether muscular or osseous, on which the head of the bone is lodged.

Dr. James Scott had an opportunity of dissecting a hip, in an example of dislocation of the femur backwards and upwards, where the patient had died, in consequence of a laceration of the intestines, forty-eight hours after the accident, and forty hours after the reduction. Amongst other particulars, the following are recorded:—"The gluteus maximus being raised from its origin, a considerable extravasation was found in the loose cellular tissue under the gluteus medius. A cavity, capable of containing a pullet's egg, was also brought into view. This cavity was situated directly where the great ischiatic nerve passes under the pyriform muscle; it contained fluid blood; its boundaries were, the pyriformis above, the sciatic nerve before (supposing the body upright), the trochanter major and insertion of the gluteus medius external and posterior. Here the displaced head of the bone had been lodged. The fleshy substance of the gemini and quadratus muscles was found torn across. The pyriformis and obturator internus were perfect. The internal and upper part of the capsular ligament was ruptured ; the external portion remained unbroken." The ligamentum teres was torn from its insertion into the dimple of the head of the femur, but not itself ruptured. The same fact was exemplified in Mr. Todd's case. The brim of the acetabulum at the upper part was fractured to the extent of about an inch; and the fragment lay loose, and nearly unconnected. A fracture also traversed the acetabulum.

[Allusion has already been made to a case of dislocated hip, in which Lisfranc carried the attempts at reduction so far, that suppurative inflammation took place around the joint, and the patient died on the 11th day, the dislocation remaining unreduced. In the dissection, which has been described by M. Malgaigne, the head of the bone was situated between the cotyloid cavity and the ischiatic notch, scarcely reaching so high as the summit of the notch. It rested partly upon the bone, partly upon the pyriformis and lower edge of gluteus medius, the latter being slightly pushed upwards. The capsule, uninjured above and behind, was open below, and the head of the femur had evidently escaped downwards through the aperture in its lower part, and had subsequently mounted upwards behind it. Direct extension brought the bone opposite to its cavity, but the capsule then became stretched tensely across it, and constituted an insuperable obstacle to the reduction, which was only practicable on the dead body, by bending the thigh until it was nearly in contact with the abdomen. (*Traité des Fract. &c.* t. ii. p. 817, and Pl. xxvi.)

In the Museum of St. Thomas's Hospital is a specimen of dislocation towards the ischiatic notch, which was met with accidentally by Sir A. Cooper, in a subject brought for dissection. The dislocation had probably existed many years. The original acetabulum is entirely filled with a ligamentous substance, so that the head of the bone could not have been returned into it. The capsular ligament is torn from its connection with the acetabulum at its anterior and posterior junction, but not at its superior and inferior. The ligamentum teres is broken, and an inch of it still adheres to the head of the bone. The head of the femur rests behind the acetabulum on the pyriformis muscle, at the edge of the notch, above the sacro-sciatic ligaments. The trochanter major is placed rather behind the acetabulum, but inclined towards it. (*On Dislocations*, p. 53, 10th ed.)]

Reduction of the dislocation backwards and upwards.—To reduce this dislocation, the patient should be placed on his back upon a table firmly fixed, or a large four-posted bedstead. A sheet, folded longitudinally, is first to be placed under the perineum; and one end being carried behind the patient, the other before him, they are to be fastened to one of the legs or posts of the bed. Thus the pelvis will be fixed, so as to allow the necessary extension of the thigh-bone to be made. Great care must be taken during the extension to keep the testicles, or the pudenda in women, from being hurt by the sheet passed under the perineum. The patient must be further fixed by the assistants.

In France, Germany, and Ireland, the extending force is applied to the inferior part of the leg, in order that it may be as far as possible from the parts which resist the return of the head of the bone into its natural situation. In this country surgeons generally prefer making the extension by means of a sheet, or the strap of a pulley, fastened round the limb just above the condyles of the os femoris. The direction in which Sir A. Cooper makes the extension, is in the line made by the limb, when it is brought across the other thigh a little above the knee. As soon as the head of the bone has been brought on a level with the acetabulum by the assistants, who are making the extension, the surgeon is to force it into this cavity by pressing on the great trochanter; or by rotating the knee and foot gently outwards.

The extension should always be made in a gradual and unremitting manner: at first, gently, but afterwards more strongly; never violently. The difficulty of reduction arises from the great power and resistance of the muscles, especially the glutei and triceps, which will at length be fatigued, so as to yield to the extending force, if care be taken that it be maintained the necessary time, without the least intermission. Sometimes, when there is difficulty in bringing the head of the bone over the lip of the acetabulum, Sir A. Cooper raises it by placing his arm under it near the joint.

For the dislocation into the ischiatic notch Sir A. Cooper recommends the extension to be made downwards and forwards across the middle of the other thigh, so as to dislodge the head of the bone, while the surgeon, with a napkin, placed just below the trochanter minor, pulls the upper part of the femur towards the acetabulum. In this case pulleys are preferable for making the extension.

[The principle to be followed is to draw the bone towards the acetabulum in the opposite direction to that in which it has passed in escaping from it ; therefore, if it has passed upwards towards the dorsum ilii, the extension may be made nearly in the straight line downwards, or across the opposite knee ; while in proportion as it has passed backwards towards the ischium, the extension should be made across the middle or upper part of the opposite thigh, or even nearly at a right angle with the trunk of the body. When the line chosen for the extension nearly corresponds to the axis of the trunk of the body, the patient may lie upon his back; but when the thigh is to be flexed upon the pelvis, it is more convenient to place him on his sound side.

When the extension is made across the opposite thigh, it may be found advantageous, in order to lift the head of the femur over the edge of the acetabulum, to make use of the opposite limb as a fulcrum, over which, by acting upon the lower end of the dislocated limb and pressing it inwards, the upper end may be tilted outwards with considerable force, and more effectually than by merely lifting it with a towel or napkin.]

The disappearance of all the symptoms, and the noise made by the head of the bone, when it slips into the acetabulum, denote that the reduction is effected. This noise, however, is not always made when pulleys are used or the patient is faint. The bone is afterwards to be kept from slipping out again, by tying the patient's thighs together with a bandage placed a little above the knees. The patient should be kept in bed at least three weeks; live low; and rub the joint with a camphorated liniment. Due time must be given for the lacerated ligaments to unite, and the sprained parts to recover; for premature exercise may bring on irremediable disease in the joint.

For the purpose of facilitating the reduction, surgeons often endeavour to produce a temporary faintness by a copious venesection, immediately before the extension is begun; a practice which, when the patient's state of health does not forbid it, is advisable, as materially lessening the resistance of the muscles. Sir A. Cooper gives it his general approbation, as well as the warm bath, and nauseating doses of tartarised antimony. After taking away from twelve to twenty ounces of blood, he places the patient in a bath heated to 100 degrees, and gradually raised to 110 degrees, until faintness is induced. While in the bath the patient is also to take a grain of tartarised antimony every ten minutes, until nausea is excited, when he is to be removed from the bath, put in blankets, and placed between two strong posts, in each of which a staple is fixed, or he may be placed on the floor, into which two rings may be screwed. Of Mr. Hey's plan, especially the direction of the limb in it, he entertains an unfavourable opinion, as little calculated to answer where the reduction has been at all delayed. (*On Dislocations*, p. 45.) In this sentiment I fully concur. In all cases of difficulty, the above-mentioned debilitating means, the intoxicating effect of a liberal dose of opium, and the use of pulleys for the reduction, deserve recommendation.

[For producing muscular relaxation, chloroform is in the present day of course universally preferred to the measures above described, which may now be considered to belong to the history rather than to the present practice of surgery.]

An instance of dislocation of the thigh-bone on the dorsum of the ilium, with fracture of the former bone, is recorded by Sir Astley Cooper: the dislocation was not at first detected, and afterwards no attempt to reduce the bone was considered prudent:—" The probability is that dislocation, thus complicated with fracture, will generally not admit of reduction, as an extension cannot be made until three or four months have elapsed from the accident, and then only with strong splints upon the thigh, to prevent the risk of disuniting the fracture." (*On Dislocations, &c.* p. 62.)

A case is recorded by Sir Astley Cooper, where a portion of the edge of the acetabulum was broken off. Dr. James Scott thinks it probable, that, in many instances of dislocation upwards, the brim of the acetabulum is fractured, and to this circumstance he ascribes the occasional tediousness of the recovery after reduction. (See *Dublin Hospital Reports*, vol. iii. p. 389.) Probably, if the head of the femur had been replaced soon after the occurrence of the injury, it would have been exceedingly difficult to maintain it in this state; but, as Mr. Wormald has remarked, the difficulty would have depended upon the size of the portion of the acetabulum broken off.

[Milder measures than those above recommended have sometimes been adopted of late years. In a case under the care of Mr. Morgan, in Guy's Hospital, in 1839, the reduction was attempted with the heel against the perineum, on the same plan as in dislocation of the humerus into the axilla, extension being made from a bandage attached to the knee. On making very moderate extension, the head of the bone returned into the acetabulum. (See *Sir A. Cooper*, *On Dislocations*, *&c.* ed. by *B. Cooper*. 1842, p. 57.) Since the discovery of chloroform such a method is still more likely to prove successful. Three cases of dislocation backwards and upwards, under the care of Mr. Birkett in Guy's Hospital, and recorded in the *Lancet*, vol. ii. 1855, p. 105, appear to have been reduced in this manner with the greatest facility. The dresser, placing his heel and foot against the pubes, and grasping the limb just above the ankle, made direct extension and gentle rotation outwards, when almost immediately the head of the bone slipped into its place.

Another method, by "*manipulation*" of the limb without the employment of any but a very slight degree of force, has been brought prominently into notice in this country of late years by the surgeons of Guy's Hospital, and has been practised frequently and very successfully both there and elsewhere. The manipulatory movements consist in first flexing the thigh upon the abdomen, then abducting it by pressing the knee outwards, at the same time slightly rotating it outwards, when the head of the bone is found usually to slip into the acetabulum. (See *Record of Cases under Mr. Birkett*, *Med. Times and Gaz. March* 4, 1854, p. 210; and *Lancet*, *Aug.* 4, 1855, *p.* 105 ; *also under Mr. Cock*, *Med. Times and Gaz. June* 30, 1855, p. 644; and *under Mr. Wormald*, *in same Journal*, *Aug.* 16, 1856, p. 170, &c. &c.) Movements of this kind have several times succeeded in cases where extension with the pulleys had been previously ineffectual. On the other hand, it should be stated that dislocations have not unfrequently been reduced in the old fashion with the pulleys after the manipulatory movements had failed.

Dr. W. Reid of Rochester, N. Y., had previously published a paper on this subject in the *Buffalo Medical Journal* for August 1851. The instructions which this gentleman gave in the paper in question are as follow :—" Let the operator stand or kneel on the injured side, seize the ankle with one hand, the knee with the other, then flex the leg on the thigh, next strongly abduct" (*adduct ?*) " it, carrying it over the sound one, and at the same time upward over the pelvis by a kind of semicircular sweep as high as the umbilicus ; *then abduct the knee gently*, turn the toes outwards, the heel inwards, *and carry the foot across the opposite and sound limb, making gentle oscillations of the thigh*, when the head of the bone will slip into its socket." (*Buffalo Med. Journ.* 1851.) " When the thigh is flexed on the trunk, say at an angle of 45°, and is gently abducted, and the head of the bone thus brought close to the lower edge of the acetabulum, if while gentle oscillations of the thigh are made at the knee, it—the head—does not immediately enter the socket, the knee should be alternately elevated and depressed, thus varying the angle of the thigh." (See *N. Y. Journ. of Med.* July, 1855, p. 66. Dr. Reid believes the success of this method depends upon the relaxation of the abductor and rotator muscles by the movements recommended; the distended or stretched condition of these muscles constituting, in his opinion, the chief impediment to reduction. Much force is not required, and should not be employed. Dr. Markoe of New York, who published an account of eleven cases in the New York Hospital, eight of which were successfully treated by this method, remarks that nothing was accomplished by proceeding in a direction where great force was required to continue the movement, but he always succeeded by finding a direction in which the mere continuance of the movement *without force* brought the head into the proper position. The method followed in the New York Hospital, however, varied a little from that described by Dr. Reid, for Dr. Markoe states that the oscillating movement, while the thigh remained flexed over the abdomen, failed in the hands of himself and his colleagues, and that they were therefore "led to add the bringing down of the thigh to the straight position in a state of abduction, still keeping up the rocking motion, and it was uniformly in the act of bringing down the limb that the reduction was accomplished. (See *N. Y. Journ. of Med. Jan.* 1855.) Dr. Reid, however, was not the first to suggest this method of reduction by manipulatory movements, for an account of a very similar proceeding was published in France by M. Desprez in 1835, who succeeded with it in a case in which the most powerful extension applied by the ordinary method had failed. The patient being placed upon his back, M. Desprez flexed the leg on the thigh and the thigh on the pelvis, rotated the limb outwards so as to disengage the head of the femur, and then brought the thigh gently downwards and inwards. (See *Bulletin de la Soc. Anat.* April, 1835, p. 45.) This movement, says M. Nélaton, is described by Pouteau in his *Mélanges de Chirurgie* (1760), who attributes it to an army surgeon named Maison Neuve; but the latter only applied it to dislocations into the foramen ovale. (See *Nélaton, Elem. de Pathol. Chir.* t. ii. p. 451, 1847.)

Dr. Fischer of Cologne published an account of a mode of reducing dislocations of the hip, by flexing the femur to an acute angle with the trunk, and impressing upon it gentle rotatory movement while in a state of adduction, if dislocated on the pubes, and of abduction if dislocated on the ilium. (*Casper's Wochenschrift,* Nov. 1, 1849—*quoted in N. Y. Journ. of Med.* 1852, p. 270.)

Sir A. Cooper was of opinion that eight weeks was the period beyond which it would be imprudent to attempt the reduction of dislocation of the hip-joint, except in persons of extremely relaxed fibre or of advanced age; and though aware that dislocations had been reduced at a more distant period than that mentioned, he believed that the reduction had often proved rather an evil than a benefit, from the violence of the extension. M. Malgaigne refers to cases of reduction at a much later period; one at the end of six months, others after the lapse of a year. One most remarkable case is recorded by Sir A. Cooper of *accidental reduction, five years after the occurrence of the injury.*]

2. *Dislocation backwards, on to the spine of the ischium*—[*Luxation ischiatique, Nélaton, Malgaigne.*—This form of injury to the hip is uncommon, and was unnoticed by Sir A. Cooper; nevertheless, several well-authenticated cases are on record, and M. Malgaigne refers to as many as twenty-eight observations. It appears to be produced in a very similar way to the dislocation backwards and upwards, but at the moment of its occurrence the thigh is probably more flexed towards the abdomen, and consequently the head of the femur passes more directly backwards, and rests upon the base of the spine of the ischium, partly opposite the greater, and partly opposite the lesser sciatic notch. The symptoms are slight rotation inwards, with adduction and flexion of the limb; in some instances it has been found flexed to a right angle with the trunk of the body. The limb is most frequently stated to have been shortened, but the shortening has been variously estimated; by some it has been found apparently considerable, while others, on the contrary, have noticed an elongation. When shortening to any extent has been observed, it must necessarily have been from some defect in the mode of measurement, or inattention to the position of the pelvis. From the position of the head of the bone, which is posterior to, but on the same level with the acetabulum, if there is any real shortening it must necessarily be very slight, assuming that the limb is placed in a straight line with the trunk, though if it is raised to a right angle the shortening would of course become considerable. The head of the bone may be felt in its new situation, its lower part being situated but a slight distance above the ischial tuberosity.]

Mr. B. Travers, jun., mentions two preparations in the Museum of St. Bartholomew'sHospital, exhibiting the head of the dislocated femur in this unusual situation. "In the first, which was removed one week after the receipt of the injury, the head of the bone is seen resting upon the sciatic spine, and lesser sciatic opening. The lower border of the cervix femoris being partially in contact with the upper and outer edge of the tuberosity, the small rotator muscles are lacerated. The lesser glutei and pyriform muscles are entire at their place of insertion." In this case, a fracture of the os innominatum traverses the bottom of the acetabulum. The trochanter lies considerably higher than the head of the bone. In the second specimen the bone had been reduced, but the rent is manifest at the back and outer part of the capsule, through which the head of the bone had passed to, and been found moveable upon, a spot corresponding to the root of the spine of the ischium. (See *Med.-Chir. Trans.* vol. xx. p. 115)

[A carefully-detailed account of the dissection of a case of this form of dislocation has been given by Mr. Quain.' (See *Med.-Chir. Trans.* vol. xxxi. 1848, p. 337.) His description is too too long for quotation, but it is worthy of remark that the head of the femur had passed beneath the great sciatic nerve, which was stretched over the posterior surface of its neck. Mr. Quain assumes that this nerve was similarly situated in another case of this dislocation which came under his notice, and which was attended with pain of unusual severity, and with inability to void the urine until the dislocation was reduced. In a case recorded by Dr. Scott, the nerve is supposed to have been situated *in front* of the head of the femur, for before the bone was replaced every attempt at rotation outwardly caused extreme pain in the groin, at the hip, and in the course of the sciatic nerve. (See *Dublin Hospital Reports,* 1822, vol. iii.) These facts, the latter especially, Mr. Quain thinks would lead to the conclusion that in this instance the nerve was between the head of the femur and the pelvic bone. It was found in this latter situation in another case observed by Mr. Wormald, who has described the dissection of the parts. In this instance the head of the bone occupied a rather lower level than has been assigned to this form of dislocation, for its lower edge rested against the upper border of the ischial tuberosity. Mr. Wormald describes the limb as being considerably shortened and inverted, and forming about half a right angle with the trunk of the body. The shaft of the femur crossed the symphysis pubis, and was fixed immovably in this situation. (See *Lond. Med. Gaz.* vol. xix. 1837, p. 657.) In like manner, in a case seen by Mr. Adams, of Dublin, the dislocated limb was bent to a right angle with the trunk, and could be further flexed until it came in contact with the abdomen, while extension beyond the right angle was impossible. (See *Dublin Hosp. Gaz.* 1845, vol. i. p. 146.]

This dislocation may be reduced in the same way as the dislocation backwards and upwards, but the extension should be made with the thigh bent to a right angle with the trunk. Mr. Quain thinks it is also advantageous that the extension should be made with the thigh in a state of abduction, so that the head of the femur shall be drawn in a degree away from the side of the pelvis. To effect this, the pulleys connected with the limb should be fixed at a point higher than the patient's body, which rests upon its sound side, while the counter-extending force is fixed at a lower level (loc. cit. p. 350).

Before proceeding to make forcible extension, however, the method by manipulation as decribed for the dislocation backwards and upwards, should be tried; but as in this case the head of the bone is situated opposite to, and not higher than the acetabulum, it would not be desirable to flex the thigh so far on to the abdomen. The limb should be bent to a right angle only, and then abducted and gently rotated outwards.]

3. *Dislocation downwards, on to the tuberosity of the ischium*—[*Sub-cotyloid, Malgaigne.*]—A dislocation on the tuber ischii is exceedingly uncommon. The particulars of such a case were published a few years ago by Mr. Keate. A gentleman's horse fell with him into a ditch, and he lay under the animal for some time. It seems that during his efforts to release himself, the head of the femur, which had been first thrown upon the obturator foramen, was forced upon the tuberosity of the ischium, where it could be plainly felt. The limb was unusually elongated, at least from three to three inches and a half. The thigh was much flexed upon the pelvis; the leg as much bent on the thigh. The whole limb was carried outwards more than Mr. Keate had ever observed in a case of luxation. The knee and the foot were much everted, the trochanter extremely sunk, the soft parts being elevated in a circle around it. The head of the bone was felt lying close to and on a level with the tuberosity of the ischium, where it was capable of being freely moved under the fingers. In the reduction the head of the bone was brought first on the obturator foramen, and thence into the acetabulum, without any particular difficulty. The patient was aware after the first step of the reduction into the foramen ovale, that the bone was not properly replaced, and stated that the luxation had taken place by the same route, first into the foramen ovale, and afterwards, during his struggles, into the situation in which it was found by Mr. Keate. (See *Lond. Med. Gaz.* vol. x. 1832, p. 19.)

[In the above case, the dislocation on to the tuberosity was consecutive to dislocation into the thyroid foramen. M. Malgaigne mentions two instances, in which it succeeded to the dislocation backwards on to the ischium, and took place during the attempts at reduction. In one of these, which occurred in his own practice, the limb was slightly elongated, the thigh was abducted and rotated outwards, the great trochanter was remarkably depressed, but the head of the bone could not be felt. Rotation outwards reproduced the original dislocation. The other case, observed by M. Lenoir, presented nearly the same symptoms, excepting that there was no rotation either outwards or inwards. In this instance, it was during the attempts at reduction by manipulation, according to the method of M. Desprez, that the head was carried downwards on to the tuberosity. (*Malgaigne, Traité des Fract. &c.* t. ii. pp. 839, 872.)

Two cases have been recorded by Mr. Gurney, of Camborne, Cornwall, which appear to afford examples of this kind of dislocation occurring primarily. Both were attended with elongation and slight eversion of the limb; but in one the head of the bone was probably dislocated downwards and a little forwards, in the other downwards and a little backwards. It is remarkable that both these patients were able to walk some distance before the dislocation was reduced. (See *Lancet*, vol. i. 1845, p. 412.)

In a case observed by M. Bouisson the head of the bone was displaced downwards and backwards, on a level with the tuberosity of the ischium. The prominence of the trochanter was effaced, the limb was lengthened two inches, flexed and slightly abducted, with a tendency to rotation outwards. Reduction was accomplished by traction upon the thigh in the flexed position, direct extension downwards having failed. (See *Bouisson, Gaz. Méd.* 1853, p. 664; and *Malgaigne, Traité des Fract. &c.* t. ii. p. 874.)

In another case, under the care of M. Roux, the dislocation was downwards and a little inwards, on the anterior surface of the ischium. The accident appears to have been caused by forcible abduction of the thigh, for the patient had fallen with his right leg in a hole about a yard deep, the left leg resting on the surface, and bent outwards. The left limb was elongated nearly two inches and a half, slightly flexed, and abducted. The trochanter was nearly two inches and a half below the level of that on the opposite side, deeply sunk in the soft parts, and difficult to be felt. By flexing the thigh on the pelvis, the head was obscurely felt upon and a little internal to the ischium. The reduction was accomplished by forcibly flexing the thigh on the pelvis, adducting it, and rotating it outwards. Powerful direct extension had been previously ineffectual. (See *J. Roux, Rev. Méd. Chir.* t. v. p. 364; and *Malgaigne*, loc. cit. p. 874.) A case described by Mr. Wormald as dislocation on to the tuberosity, has already been referred to in speaking of the dislocation backwards, to which both on account of the position of the head of the bone, which was above the tuberosity, and the inversion of the limb, it appears more properly to belong.

Eversion and abduction seem to be the characteristics of the dislocation on the tuberosity; inversion and adduction of the dislocation on the spine of the ischium.]

[4. *Dislocation into the perineum.*—Three cases of this remarkable displacement have been recorded. One is reported by Professor Parker, in the *New York Med. Gaz.* for 1841. The patient, æt. 35, was at work under the bottom of a canal boat, which was supported on props; he was standing with his body bent forwards, and his feet far astride, when the props gave way, and the boat fell, forcing him down by the side of a piece of timber, over which he was standing, in such a manner that the left thigh was placed between it and the bottom of the boat. On being extricated, the left limb was found standing at a right angle with the trunk, the toes were turned a little inward, the natural form of the nates lost, and the head of the bone distinctly felt in rotation in the perineum behind the scrotum, and near the bulb of the urethra. Extension was made downwards and outwards, accompanied by moderate rotation, and in this way the head of the bone was made to surmount the ramus of the ischium, and to pass into the foramen ovale. From this position it was replaced in the acetabulum, by carrying the luxated limb strongly across the sound one. The patient soon recovered the use of the joint.

Another case is reported by Professor Pope, of the St. Louis University, in the *St. Louis Medical and Surgical Journal* for July, 1850. A man, æt. 40, was engaged in excavating earth, some of which unexpectedly slipped and fell upon his back, catching him in a bent position, with his legs stretched widely asunder. When examined, the left thigh was found thrown quite to a right angle with the body, and somewhat forward. The normal site of the great trochanter offered a cavity in which the fist could easily be placed, while the head of the bone was both seen and felt below the skin, and raising the raphé of the perineum. On rotation, which was difficult and caused intense suffering, the movements of the caput femoris were distinctly visible. The patient was unable to void his urine, no doubt in consequence of the pressure of the head of the bone upon the urethra. Extension was made with the pulleys transversely to the axis of the body; and after a short time the bone glided into its socket with an audible snap. (See *N. Y. Journ. of Med.*, March, 1852, p. 198.)

A third instance, which was noticed by M. d'Amblard in 1821, is mentioned by M. Malgaigne; the head of the femur was prominent in the perineum, opposite the junction of the rami of the pubes and ischium. The limb, though flexed, appeared elongated, and the foot was pointed outwards. There was retention of urine, and great difficulty in the introduction of a catheter. In this case, as in that first mentioned, the head of the bone was first brought into the foramen ovale, and from thence replaced, by a second effort, into the acetabulum. (See *Traité des Fract. &c.* t. ii. p. 876.)

The direction of the displacing force in these cases appears to be similar to that which produces dislocation into the foramen ovale; but the violence being probably greater than usual, the head of the bone is forced onwards, past the foramen ovale, and over the rami of the ischium and pubes, towards the perineum.]

5. *Dislocation forwards and downwards upon the obturator foramen* — [*Ischio-pubic, Malgaigne, Nélaton.*]—This is next in frequency to the dislocation backwards and upwards. The accident is facilitated by the great extent to which the abduction of the thigh can be carried, and by the weakness of the orbicular ligament in this direction. According to Sir A. Cooper, "The dislocation into the foramen ovale is generally caused by a heavy weight falling upon the pelvis whilst the back is bent forwards, and the thighs are separated from each other. The ligamentum teres and the lower part of the capsular ligament are torn through, and the head of the bone becomes placed in the anterior and inner part of the thigh, upon the obturator externus muscle. It has been erroneously supposed that the ligamentum teres is not torn through in this dislocation, because in the dead body, when the capsular ligament is divided, and in the living body, in certain cases of relaxation, the head of the bone can be drawn over the lower edge of the acetabulum without tearing the ligamentum teres. But this ligament is of necessity torn through in the ordinary dislocation from violence."

The symptoms are as follow:—"The limb is two inches longer than the other. The head of the bone can be felt by pressure of the hand upon the inner and upper part of the thigh towards the perineum, but only in very thin persons. The trochanter major is less prominent than on the opposite side. The body is bent forwards by the tension of the psoas and iliacus internus muscles. The knee is considerably advanced if the body be erect; it is widely separated from the other, and cannot, without great difficulty, be brought near the axis of the body so as to touch the other knee, in consequence of the extension of the glutei and pyriformis muscles. The foot, though widely separated from the other, is generally neither turned outwards nor inwards, although I have seen it varying a little in this respect in different instances; but the position of the foot does not in this case mark the accident. The bent position of the body, the separated knees, and the increased length of the limb, are the diagnostic symptoms. The position of the bone is below, and a little anterior to the axis of the acetabulum; and a hollow is perceived below Poupart's ligament." (*On Dislocations, &c.* p. 44. ed. 10, 1839.)

[A case of simultaneous dislocation of both thighs into the foramen ovale has been recorded by Dr. Sigonovitz. It occurred in a sailor, who was sitting astride a plank, when a wave suddenly forced him up against a cross beam, which struck his back violently, while the plank was still between his legs. Both dislocations were reduced. (From the *Preussiche Medicine Zeitung*; see *Lond. Med. Gaz.* Sept. 29, 1838, p. 31.)

On the other hand, external violence may incline the trunk laterally upon the two thighs in such a manner as to dislocate them simultaneously, but in *opposite* directions. (See *Malgaigne, Traité des Fract. &c.* t. ii. p. 856.)

In the collection at St. Thomas's Hospital is a preparation of an old dislocation into the foramen ovale, dissected by Sir A. Cooper: "The head of the thigh-bone was found resting in the foramen ovale, but the obturator externus muscle was completely absorbed, as well as the ligament naturally occupying the foramen, now entirely filled by bone. Around the foramen ovale bony matter was deposited, so as to form a deep cup, in which the head of the thigh-bone was enclosed, but in such a manner as to admit of considerable motion. The original acetabulum was half filled by bone, so that it could not have received the head of the thigh-bone if an attempt had been made to return it into its natural situation." M. Malgaigne gives a representation (see pl. xxvii. figs. 4. and 5.) and minute description of an old dislocation of this kind, which he considers as *incomplete.*]

Reduction.—In general, dislocations on the obturator foramen are easy of reduction. The pelvis having been fixed, the extension is to be made downwards and outwards, so as just to dislodge the head of the bone. The muscles then generally draw it into the acetabulum, on the extending force being gradually relaxed, if the upper part of the bone be pulled outward with a bandage, and the ankle be at the same time inclined inwards. Thus the limb is used as a lever, with very considerable power.

Mr. Hey says that "in this species of dislocation (forwards and downwards), as the head of the bone is situated lower than the acetabulum, it is evident that an extension made in a right line with the trunk of the body, must remove the head of the bone farther from its proper place, and thereby prevent, instead of assisting, reduction. The extension, he conceives, ought to be made with the thigh at a right angle, or inclined somewhat less than a right angle, to the trunk of the body. When the extension has removed the head of the bone from the external obturator muscle, which covers the great foramen of the os innominatum, the upper part of the os femoris must then be pushed or drawn outwards; which motion will be greatly assisted by moving the lower part of the os femoris at the same moment, in a contrary direction; and, by a rotatory motion of the bone upon its own axis, turning the head of the bone towards the acetabulum." (*Hey*, p. 316.)

[In the plan recommended by Sir A. Cooper, the extending force is made to act directly upon the upper part of the dislocated thigh, in the upward and outward direction. His instructions are, "to place the patient on his back, to separate the thighs as widely as possible, and to place a girth between the pudendum and the upper part of the luxated thigh, to which is fixed the hook of the pulleys, which are to be attached to a staple, placed on the same side as the injured limb of the patient; while the counter-extending force for fixing the pelvis is composed of a girth, which is completely to surround both ilia; and one end of which is to be admitted through the noose formed by the girth attached to the dislocated limb. It then being attached to the opposite staple, the two girths, during the application of the extending power, are made to fix each other. This apparatus being properly adjusted, the surgeon should direct that extension should be gradually made with the pulleys until the head of the femur can be felt moving from the foramen ovale. He is then to pass his hand behind the ankle of the sound limb, and to grasp the ankle of the dislocated extremity, and draw it inwards towards the middle line of the patient's body. He thus acts upon the dislocated femur with the most powerful lever of the first order, and usually reduces the dislocation." It is important, in drawing the ankle inwards, to pull from behind, and not from in front of the sound limb; for if the leg be advanced in any considerable degree, the head of the femur may pass beneath, instead of into the acetabulum, and be thrown in the direction of the ischiatic notch—an accident which has occasionally happened. (*On Dislocations, &c.* ed. by *B. Cooper*, p. 62.)

Sometimes this form of dislocation is reduced with very little difficulty. Sir A. Cooper considered it the most favourable in this respect of all the dislocations of the hip. M. Malgaigne mentions one instance in which it was reduced by the patient himself, by pressing the head of the bone outwards with one hand, while with the other he attempted to carry the thigh inwards; and another, in which the bone was replaced spontaneously while the patient was turning himself in bed. A third case is also recorded, in which spontaneous—or rather, *accidental*—reduction took place after a lapse of considerable time. (*Traité des Fract. &c.* t. ii. pp. 31, 33.)

In all cases, previous to making powerful extension with the pulleys, the *manipulation* method should be tried, as it has been found quite as effective in this as in the dislocation backwards and upwards. In consequence, however, of the diametrically opposite position which the head of the bone occupies, the movements will require some modifications: thus, when the thigh has been flexed upon the pelvis, it should be adducted instead of abducted, and the rotatory movements should have an inward instead of an outward direction. Probably also it will not be necessary to flex the thigh to the same extent upon the abdomen; the effect of that movement being to throw the head of the bone downwards, which is not desirable in this case, as it is already situated below its natural level. Flexion to a right angle with the abdomen, therefore, will be quite as much as is necessary.

In a case in which movement of this description failed to reduce the dislocation, Dr. Markoe succeeded by rotating the thigh *outwards*, and at the same time strongly *adducting* it in a direction which carried the knee behind the other one. This, accompanied with the rocking motion, accomplished the reduction on the first trial, and without the slightest violence or excess of force. The idea was, by rotating the thigh outwards, to *throw up* the head of the bone towards the acetabulum. (See *N. Y. Journ. of Med.* Jan. 1855, p. 34.)]

6. *Dislocation forwards and upwards, on the Pubes* — [*Ilio-pubic, Nélaton, Malgaigne.*— This dislocation is usually the result of forced extension of the thigh backwards upon the trunk, or of the trunk backwards upon the thigh. Thus, says Sir A. Cooper, "it happens when a person while walking puts his foot into some unexpected hollow in the ground; and his body, being at the moment bent backwards, the head of the bone is thrown forwards upon the os pubis." The same effect may also be produced by a blow, or by violent pressure applied posteriorly, as when the wheel of a carriage passes over the posterior and upper part of the thigh. Forcible rotation outwards, combined with abduction of the limb, is another, though less frequent, cause of this dislocation. (See *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 841.)]

The symptoms are as follow:—The whole limb is turned outwards, and cannot be rotated inwards: it is shortened by one inch; the trochanter major is nearer the anterior superior spinous process of the ilium than natural; the head of the bone forms a tumour in the groin above the level of Poupart's ligament, on the outer side of the femoral artery and vein, where it can be perceived to move when the thigh bone itself is moved. Sir A. Cooper remarks that there is a slight flexion of the limb forwards and outwards. (*Surgical Essays*, part i. p. 45.) By the stretching of the anterior crural nerve, which lies over the neck of the bone (see *Sir A. Cooper*, *On Dislocations*), great pain, numbness, and even paralysis, are liable to be produced. The knee is generally carried backwards.

[In a case under the care of Mr. Morgan, in Guy's Hospital, the head of the bone was felt pressing Poupart's ligament upwards, and was placed upon the femoral artery so as to stop the pulsation; while the pressure at the same time upon the anterior crural nerve produced numbness of the thigh. (*Sir A. Cooper*, *On Dislocations*, ed. by *B. Cooper*, case lviii. p. 89.)

The dislocation forwards and upwards might, by an inattentive observer, be mistaken for a fracture of the neck of the thigh-bone, as shortening and eversion are characteristic of both; but the head of the bone felt in the groin, the absence of crepitus, and the diminished mobility of the joint, will decide the nature of the accident.

The head of the femur rests in the notch between the anterior inferior spinous process of the ilium and the pectineal eminence. The term ilio-pubic, therefore, is correctly applicable to this dislocation. M. Malgaigne believes it to be most frequently incomplete—that is, that some portion of the head of the bone is still placed opposite to the articular cavity; and in this case there is an appreciable interval between the upper margin of the head of the bone and Poupart's ligament; but the incomplete dislocation may and does often subsequently become complete, from the attempts made to bear the weight of the body upon the limb. The shortening of an inch, mentioned by Sir A. Cooper, does not appear to be constant, for cases have been observed where the length was very little altered, and others in which, instead of shortening, there was absolute elongation; in one instance, observed by Mr. Morgan, even to the extent of two inches. M. Malgaigne believes that neither the shortening nor the elongation are real, but that the appearances depend partly upon the degree of abduction of the thigh, but chiefly upon the oblique position of the pelvis, which in some cases is inclined upwards, and in some downwards; while in others it preserves its natural position, without any obvious reason for the difference (loc. cit. p. 843.). Retention of urine has been noticed occasionally to accompany this dislocation.

The following is Sir A. Cooper's account of the dissection of an old unreduced dislocation of this kind:—"The original acetabulum was partly filled by bone, partly occupied by the trochanter major, and both were much altered in their form. The capsular ligament was extensively lacerated, and the ligamentum teres was torn through. The head of the thigh-bone had torn up Poupart's ligament, so as to penetrate between it and the pubes. The head and neck of the bone were thrown into a position under the iliacus and psoas muscles, the tendons of which, in passing to their insertions over the neck of the bone, were elevated by it, and put on the stretch. The crural nerve passed on the fore part of the neck of the bone upon the iliacus and psoas muscles. The head and neck of the thigh-bone were much flattened and changed in their form. Upon the pubes a new acetabulum had been formed for the neck of the thigh-bone, the head of the bone being above the level of the pubes. Poupart's ligament stretched across it on the forepart, whilst the femoral artery and vein were placed on its inner side, so that the head of the bone rested between the crural sheath and the anterior and inferior spinous process of the ilium." (*On Dislocations*, ed. by *B. Cooper* p. 86.)

Reduction.—The reduction by forcible extension is to be conducted, according to Sir A. Cooper, in the following manner:—The patient is to be placed on his sound side on a table; a girth is to be carried between the pudendum and upper part of the thigh, and fixed in a staple a little in front of the line of the body. The pulleys are to be fixed above the knee, as in the dislocation backwards and upwards, and then the extension is to be made in a line behind the axis of the body, so as to draw the thigh-bone backwards. After this extension has been for some time continued, a towel is placed under the upper part of the thigh, and an assistant, pressing with one hand upon the pelvis, lifts the head of the bone, by means of the towel, over the pubes and edge of the acetabulum.

In the method by manipulation, the thigh should be flexed over the abdomen, adducted, and rotated inwards. This plan should be invariably tried before more severe measures are resorted to.]

7. *Dislocation upwards*—[*Supra-Cotyloid, Malgaigne.*—Dislocation directly upwards has been occasionally observed. The head of the bone may rest upon the margin of the acetabulum immediately beneath the anterior inferior spinous process of the ilium, or it may be situated higher up, in the notch between the anterior superior and the anterior inferior spinous process. The former is described by M. Malgaigne as an *incomplete* and the latter as a *complete* dislocation.

Of the former kind an instance was observed in St. George's Hospital in 1841. The subject of it had been thrown from a cart, and suffered other injuries, from which he died soon after his admission. The outer part of the left hip joint was much flattened, and the usual prominence of the trochanter wanting. About an inch below, and a little external to a line drawn perpendicularly downwards from the anterior superior spinous process of the ilium, was situated the head of the femur—which could be distinctly felt to move on flexing or rotating the limb. The eversion of the foot was so considerable that the great toe might be said to point outwards and slightly backwards. On examination after death it was found that the head of the bone had been dislocated directly upwards, the head lying on the anterior inferior spinous process, and a little to its outside. The trochanter major was situated posteriorly, and rested upon the dorsum of the ilium; the trochanter minor resting on the outer edge of the acetabulum. (See *Lancet*, 1840-41, vol. ii. p. 281.)]

Mr. Wormald has published the following case, in which there was a dislocation of the head of the femur upwards, with displacement of a portion of the cotyloid ligament, without rupture of the ligamentum teres:—In the summer of 1829 a man about forty years of age was admitted into St. Bartholomew's Hospital, for pneumonia, of which he died. On examining his body, Mr. Wormald noticed that the left lower extremity was somewhat everted, a little separated from the right, and shortened to the extent of half an inch: and, on dissection, the head of the femur was found resting upon the ilium, between the acetabulum and the anterior inferior spine, in a cavity formed partly by a growth of bone and partly by what seemed to Mr. Wormald to be the upper portion of the original cotyloid ligament; the acetabulum was contracted, and filled up by a fibrous substance. The ligamentum teres was entire, elongated, and flattened. Fourteen years before the patient died, he had met with the injury of his hip by a fall from a ladder; but eventually recovered from the accident, and was able to follow the employment of carrying out beer. Mr. Wormald thinks it probable that a portion of the acetabulum had been separated, as well as the cotyloid ligament. (See *Lond. Med. Gaz.* for 1836, 1837. p. 658.)

[Three other examples of this slighter degree of displacement are referred to by M. Malgaigne.

The reduction would probably be effected without much difficulty by the methods recommended for the dislocation upwards and forwards.]

Of the more *complete* dislocation upwards, Mr. B. Travers has published the following example. It was produced by a fall into the hold of a ship. The "buttock is flattened; the trochanter is felt rather below, and to the outer side of the anterior and superior spinous process of the ilium. The neck of the bone lies apparently between the two anterior spinous processes, so that, when the patient is erect, the limb appears slung or suspended from this point. The head of the bone cannot be felt; it is invested by an abundance of bony matter, &c. There is complete eversion, slight mobility, and imperfect progression with the aid of a crutch." (See *Med. Chir. Trans.* vol. xx. p. 113.) A similar case has been recorded by Mr. Morgan. (See *Guy's Hospital Reports.*)

[A very perfect example of this unusual accident has been published by Dr Cummins. The limb was shortened by fully three inches. The knee and toes were turned out, and any attempt to rotate the thigh inward caused exquisite pain. Abduction and adduction were nearly equally difficult and painful, but flexion could to a certain extent be performed. The hip was flattened and the trochanter major not to be discovered. Close below the anterior superior spine of the ilium, between it and the inferior, there was a very distinct hard round tumor, which moved in unison with the movements of the thigh. The head of the bone, it was believed, lay between the anterior superior and anterior inferior spinous processes; the neck of the bone, at its junction with the head, resting on the ridge between these points, while the trochanter major rested upon the dorsum ilii above the acetabulum. This dislocation was reduced by extension with the pulleys in a direction downwards and backwards. (*Guy's Hospital Reports*, vol. iii.)]

Congenital Dislocations of the Hip-joint.—The subject of congenital, or original, dislocations of the thigh-bone was first taken up by Palletta (*Adversaria Chirurgica Prima; et Exercitatio de Claudicatione Congenita, &c.* ab. Ed. Sandifort, edit. 8vo. Lugd. 1788.) Delpech afterwards made some observations upon it (*De l'Orthomorphie, &c.* 2 tomes, 8vo. 1828); but the most important article yet extant on congenital or original dislocations of the hip, is that by the celebrated Dupuytren. (See *Répertoire Gén. d'Anat.* t. ii.; also *Clin. Chir.* t. iii. art. 8.) Cruveilhier has given the engraving of a skeleton in which, amongst other peculiarities, is exhibited a congenital displacement of the thigh-bones. (*Anat. Pathol.* livr. ii. pl. 2.) The case consists in a displacement of the head of the femur from the acetabulum to the dorsum of the ilium, existing from birth, and appearing to be the result of a want of depth, or of the incomplete formation of the acetabulum, rather than of any accident or disease. The displacement would appear sometimes to prevail in certain families. (See *Clin. Chir.* t. iii. p. 216.) According to Dupuytren, the characters of this dislocation are: a shortening of the limb; an ascent of the head of the bone upon the external fossa of the ilium; a projection of the great trochanter; a retraction of almost all the muscles of the upper part of the thigh towards the crista of the ilium, where they form round the head of the femur a kind of cone, the base of which is in the os ilium, and the apex at the great trochanter. The tuberosity of the ischium, quitted by these muscles, is nearly uncovered. The limb is rotated inwards, and consequently the heel and ham are turned outwards, and the knee and toes inwards. The position of the thigh is oblique from above downwards, and from without inwards; which obliquity is greater, the older the individual is, and the wider the pelvis. Hence, there is a tendency in the thigh-bones to cross one another below. There is a meagreness of the limb, and especially of its upper part, out of all proportion to the trunk and upper extremities.

The separate movements of limbs, with this conformation, are generally very limited, and, in particular, those of abduction and rotation. As the patient is standing still, one is struck with the want of proportion between the upper and lower parts of his body, with the imperfection of his lower limbs, and the attitude which he assumes. The trunk is fully developed, while the lower extremities are short and slender, as if they belonged to another person. This appearance of the lower limbs is rendered still more conspicuous by the breadth of the pelvis. One is also struck with the projection of the great trochanters. The upper part of the trunk inclines a good way back, while the lumbar portion of the spine advances far forwards, and is very much excavated behind. The pelvis is placed almost horizontally on the thigh-bones; and the ground is only touched with the point of the foot. It appears from Dupuytren's observation, that a person, with congenital dislocation of the hips, runs and jumps with less difficulty than he walks. When he is placed upon his back, the signs of the malformation diminish, and are nearly effaced; because in this posture of repose the muscles no longer draw the thigh-bones upwards, and the weight of the upper parts of the body ceases to press the pelvis down between the heads of those bones. In this posture the limbs may be lengthened or shortened with perfect facility; and this from one to three inches, according to the age and stature of the individual, and the extent of displacement. These changes in the length of the limb are not only made with great ease, but without any pain; so as to prove the absence of every kind of disease, as well as of a cavity proper for receiving and retaining the head of the bone.

In twenty-six cases met with by Dupuytren, the luxation existed on both sides, with the exception of two or three. Most of the individuals who have had the infirmity have been females; and, in the above twenty-six, there were only three or four males. (*Clin. Chir.* t. iii. p. 251.)

[The appearances on dissection presented by these congenital dislocations at the hip joint, as might be expected, vary considerably according to the date at which they are examined. In the first few months after birth, the acetabulum, head of the femur, and capsule of the joint are but little altered; as time proceeds, however, they are considerably modified — *the acetabulum* loses its cup-like form, becomes triangular, and nearly filled up—*the head of the bone* becomes flattened, loses its cartilaginous crust, and ultimately becomes absorbed—the *capsular ligament* is by degrees elongated, assumes an hour-glass shape, and at last, gradually thinned by pressure, becomes perforated, and allows the upper end of the femur to protrude through it. The *ligamentum teres* remains entire for many years, and is in some cases found greatly thickened; it, however, in the course of years gives way. The distortion which the bones of the pelvis are gradually made to undergo, depends chiefly upon the removal of the pressure from the acetabula, and its transference to the dorsum of the ilium; also, to some extent, upon the altered direction of the action of the principal muscles and tendons. Thus the groove for the iliacus and psoas tendon is soon deeply marked, and the anterior inferior spine consequently made more prominent. The ilia appear to be forced upwards and backwards. The antero-posterior diameter of the inlet and outlet of the pelvis are narrowed, and the transverse diameter of the entire pelvis increased—the thyroid foramen having its longer diameter in the transverse instead of in the vertical direction. These peculiarities are of course more marked the longer the dislocation has existed. It should also be observed that in some of these cases the neck and head of the thigh-bones are twisted in the direction forwards on the shaft, and that in such cases the posterior, instead of the anterior, surface of the head and neck, would rest upon the dorsum of the ilium, and that consequently the toes and knee of the affected limb would not be directed so much inwards as in the ordinary dislocation.]

Of course the treatment can be but palliative. As the weight of the trunk aggravates the displacement, repose may be useful; but it is not necessary to keep the patient in the recumbent position; because, in the sitting posture, there is no stress upon the thigh-bones, the body resting entirely on the tuberosities of the ischia. Let these individuals, therefore, choose a profession which will keep them a good deal in the sitting posture. Dupuytren also commends cold bathing, and a bandage, or belt, round the pelvis, by which the trochanters may be combined and kept steadily at a uniform height. (See *Dupuytren*, op. et vol. cit. art. 8.) Besides the sources of information already quoted, I refer to *Caillard Billonière sur les Luxations originelles, ou Congénitales des Femurs*, 8vo. Paris, 1828; John North, in *Med. Chir. Trans.* vol. 19. *Rolade Lafonde; sur les Principales Difformités du Corps Humain, &c.* 2 vols. 4to. Paris, 1819; and to *W. Coulson on Disease of the Hip-Joint*, p. 68. 4to. Lond. 1837.

[Since the time of Dupuytren, several surgeons have attempted the reduction of these dislocations. In 1835, M. Humbert de Morley published five examples of confirmed cure. The replacement was effected by gradual extension, continued for 55 minutes in one case, in others for three or four days, and in one for as long a period as 75 days; and, after the reduction, the patients were submitted to extension for a considerable period longer, to guard against the danger of a relapse, so that the duration of the treatment was not less than a year. The reality of the reduction in these cases has been called in question, and some surgeons who saw the patients believed the head of the bone had been drawn into the sciatic notch, and not into the acetabulum. All were agreed, however, that they were much benefited by the treatment. Subsequently, M. Pravaz published several cases, the result of which was less equivocal, but the treatment was very tedious and protracted. In the first instance, the patient was submitted to a *preparatory* extension, lasting from four to six months, by means of weights attached to the limbs—counter-extension being made from the perineum and axillæ. At the end of this period, when the head of the bone appeared to have approached the acetabulum, the reduction was completed by more powerful extension made with pulleys; the operator, at the same time, with one hand pressing the trochanter downwards and inwards, and with the other abducting the limb. To maintain the reduction, firm pressure round the pelvis was applied, and maintained for five or six months, the patient being kept almost motionless: during this time, under the influence of the pressure, the head of the bone was found to sink into its cavity, sometimes by slow degrees, sometimes more suddenly. The limb was then exercised by passive movements for four or five months longer, the patient still recumbent; and it was only at the end of this period that the erect position was permitted, and he was allowed to walk about with the assistance of crutches. M. Malgaigne states, however, that in one of M. Pravaz's best cases the cure was not permanent. and he thinks it probable that in the majority of them the reduction was imperfect, and the displacement liable to recur.

M. J. Guérin has published several cases of cure by extension, combined with subcutaneous section of the muscles and tendons, and if necessary, of the ligaments around the joint. The division of these structures enables the reduction to be effected more rapidly than by extension alone; but it still requires to be maintained for a lengthened period by pressure with suitable apparatus. The probability of success in these cases will of course be greater in proportion as they are undertaken at an early period of life, and before the changes in the bones and ligaments have had time to become far advanced. On the subject of congenital dislocations of the hip-joint, the following works may be consulted, in addition to those already mentioned:—*Humbert*, *Essai sur les Lux. Spontan. du femur*, 1835; *Pravaz*, *sur les Lux. Congén. du femur; Bulletin de l'Acad.*, 1839, t. iii. and 1841, t. vii. *Bouvier*, *Mém. sur la Reduction des Lux. Congén. du femur*, 1838. *Carnochan*, *On Congen. Disloc. of the head of the femur.* New York, 1850; and *Dublin Quart. Journ. of Med. Science*, Feb. 1851. p. 173. *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 887, 1855.]

DISLOCATIONS OF THE PATELLA.

[The patella may be dislocated *outwards*, *inwards*, or *vertically*; in the latter case, it is turned half round upon its axis, and is supported by its outer or its inner edge, on the anterior surface of the condyles of the femur. Instances are even recorded in which the bone was turned round completely on its axis, so that its articular surface was directed towards the skin, and its cutaneous surface towards the articulation. The dislocation outwards is the most common; the vertical dislocation is next in frequency; the dislocation inwards is exceedingly rare. Dislocation *upwards* from rupture of the ligamentum patellæ has been described, but as this case so much resembles fracture of the patella, both in its symptoms and in the treatment required, it will be treated of in connection with that injury. (See FRACTURES.)]

Dislocation outwards.— The patella is thrown on the external condyle, where it produces a projection; and this circumstance, with an incapacity of bending the knee, is evidence of the nature of the injury. (*Sir A. Cooper*, *Surgical Essays*, part i. p. 66.) The accident is most common in persons whose knees incline inwards; a condition that accounts for the tendency of the patella to be drawn outwards by the action of the extensor muscles.

[The dislocation outwards may be *complete* or *incomplete*. It may be caused by direct violence, such as a fall on the knee, or a blow on its inner side; or it may be the effect of the violent contraction of the extensor muscles. Out of eleven cases of complete dislocation referred to by M. Malgaigne, seven were produced by direct violence, and four by muscular action; and out of twelve cases of the incomplete kind, eight were due to the former, and four to the latter cause. A relaxed condition of the ligaments is a predisposing cause of dislocation of the patella, and when this condition exists, it may be drawn upon the external condyle of the os femoris by very slight accidents, or sudden action of the muscles. (*Sir A. Cooper*, *On Dislocations.*)

In the *complete* dislocation the patella is absent from the front of the knee, but may be felt upon the outer side of the external condyle of the femur, with its inner edge directed forwards, and its articular surface turned inwards. The tendon of the quadriceps extensor is directed obliquely outwards towards the displaced patella, and the ligamentum patellæ is in like manner oblique, but in the opposite direction. The axis of the patella is not parallel to the axis of the femur, but its point is usually directed slightly backwards, and its upper extremity forwards. The leg is sometimes extended, sometimes slightly flexed, but all movement is extremely difficult and painful.

In the *incomplete* dislocation, the inner portion of the patella is placed in front of the external condyle, and its outer edge is prominent under the skin; but in consequence of the sloping direction of the surface of the condyle, its outer edge is turned a little forwards, and its inner edge backwards. The position of the patella, therefore, is oblique, its anterior surface looking forwards and inwards. During extension of the knee, the patella is naturally placed somewhat higher than the articular surface of the condyles, and M. Malgaigne has shown that in the incomplete dislocation the upper part of the inner margin of the patella is, to a certain extent, implanted in the supra-condyloid depression on the front of the femur, and this circumstance, he thinks, is the principal cause of difficulty in the reduction. In this dislocation the knee is usually extended, while in the complete kind it is more commonly slightly flexed.

A very remarkable case of dislocation outwards has been recorded by Mr. Mayo:— "The patella rested with its inner edge upon the outer surface of the external condyle, the fore part of the patella facing obliquely forwards and inwards. The patella admitted of a slight degree of motion forward or backward, turning upon its inner edge, which seemed caught behind the prominent margin of the articular surface of the condyle." (*Lond. Med. Gaz.* 1828, vol. ii. p. 754.) Another case, in which the patella was found in precisely the same position, was seen by Mr. Hoskings. (See *Lond. Med. Gaz.* 1838, vol. iii. p. 125.)]

Reduction.— In either the complete or incomplete dislocation, when the extensors of the leg have been completely relaxed by position, the reduction is, for the most part, easily accomplished by pressing the patella towards its right place with one or both thumbs. It is not sufficient merely to straighten the knee-joint, but the thigh must also be flexed upon the pelvis, in order that the rectus, as well as the other portions of the quadriceps extensor may be fully relaxed. In a case under Mr. George Young, success could not be obtained, except by extending the leg, and placing the heel on the surgeon's shoulder, who, with the limb thus fixed, was enabled to make the requisite pressure on the patella advantageously with both his thumbs. Owing to a lax state of the ligaments of the patella, or other predisposing causes, it is sometimes difficult to keep the bone in its proper situation, unless a roller be applied. The inflammatory affection of the joint is to be opposed by the use of evaporating lotions, and the usual antiphlogistic treatment. The joint must be kept quiet a few days, and then gently moved, in order to prevent stiffness. When the relaxation of the ligaments is such that a relapse is likely to ensue from slight causes, a laced knee-cap, with a strap and buckle, above and below the patella, should be worn, as recommended by Sir Astley Cooper. (*On Dislocations*, p. 81.)

[Should the reduction not be obtainable in the extended position of the limb, the effect of forcible flexion of the knee may be tried. This position seems especially applicable to the incomplete dislocation in which sometimes great difficulty has been experienced, in consequence, as M. Malgaigne believes, of the bone becoming wedged in the supra-condyloid depression in the manner already alluded to. In such a case flexion of the knee will cause the patella to descend and to become placed in front of the smooth articular surface of the condyles, on gaining which position it will readily slip round into its place. In the case under Mr. Mayo, after various other methods had been tried and failed, the knee was suddenly bent to the utmost, and the motion was hardly completed when the patella audibly returned to its socket. (*Lond. Med. Gaz.* 1828, vol. ii. p. 754.)].

Dislocation inwards.—[Displacement of the patella in this direction is exceedingly rare; so much so, that two or three observations only have been recorded. In Sir Astley Cooper's work is mentioned the case of a lady who frequently dislocated her right patella inwards, by touching her toe against a carpet, by turning in bed, or dancing. She was in the habit of replacing it herself by straightening the limb, and by pressing it towards the joint with her thumb. The pain was excessive, and she was unable to move when it was out. (*On Dislocations, &c. edited by B. Cooper*, p. 196.) The following case is narrated by Mr. Aston Key:—A young woman, æt. 20, slipped and fell whilst carrying a pail. On attempting to rise from the ground she found that her left knee was painful, and was unable to bear her weight. She was taken to Guy's Hospital, and the patella was found resting upon the inner condyle, the outer part of its articular surface being supported obliquely by the projecting edge of the trochlea of the femur. Gentle pressure on the inner edge of the patella, as the limb lay on the bed, restored it to its natural position. The joint, however, became inflamed, suppuration took place within and around it, and the patient died. (*Guy's Hosp. Reports*, vol. i. p. 260.) In this instance the dislocation was *incomplete.*

M. Putegnat has recorded a case of *complete* dislocation inwards of both patellæ. The subject of it was a girl, 13½ years old. Three years previously she had fallen on her knees, and from that moment both patellæ had become subject to displacement, so much so, that she was in the habit of amusing herself by dislocating and reducing them. The right patella was most easily displaced outwards, the left inwards, but both could be thrown so completely inwards that their anterior surfaces became parallel, and could be applied exactly one against the other when the knees were brought together. This case, though traumatic originally, appears rather to represent a dislocation from relaxation of ligaments, and was considered as such by M. Putegnat. (See *Journ. de Chir.* 1843, p. 307; and *Malgaigne*, loc. cit. p. 919.)

A preparation in the museum at Berlin, described by Walther, is referred to by M. Malgaigne as an example of dislocation inwards, but whether complete or incomplete, is not very clear from the description. The preparation is further remarkable from the circumstance of the leg being flexed to a right angle with the thigh (loc. cit. p. 91.)]

[*Vertical dislocation of the patella.*—In this form of displacement the patella undergoes a semi-revolution upon its axis, and rests by one of its edges upon the anterior surface of the femur. It is more common to find it resting upon its inner edge, with the articular surface directed outwards, but several cases of displacement upon its outer edge have also been recorded. M. Malgaigne has named these two varieties the *external vertical* and *internal vertical* dislocations. In either case the outer or inner angle of the patella rests in the supra-condyloid depression on the front of the femur, in which it is more or less firmly wedged by the contraction of the extensor muscles. It may be observed, that an exaggeration of the oblique position assumed by the patella in the partial dislocation outwards would produce the external vertical dislocation. The knee is extended, or very slightly flexed, and all attempts at movement are attended with severe pain.

The nature of the case will be readily seen by the remarkable projection in front of the knee, and by the sharp edge of the patella, which can be distinctly felt through the skin. It may not be so easy to discover in which direction the bone has been displaced, and whether it is its inner or its outer edge which is turned forwards; but an examination of the ligamentum patellæ and of the extensor tendon, which will have become twisted by the movement of the patella, and which will have their inner or their outer edges raised, according to the direction in which the bone has been displaced, will usually settle the question. These dislocations, like those already described, may be caused either by a blow on the patella, or by some sudden and violent muscular effort.

Reduction.—The reduction of these displacements has sometimes been accomplished readily by pressure with the fingers, the limb having been previously placed in such a position as to relax the extensor muscles. Sometimes, however, great difficulty has been met with, and other manœuvres have become necessary. Mr. Vincent succeeded in two cases, after other methods had failed, by slightly flexing the knee and rotating the leg. (*Obs. on Surg. Practice*, p. 75.) Forcible flexion of the knee has also succeeded in some instances. In obstinate cases, subcutaneous section of the ligamentum patellæ has been practised, but even this has proved unavailing. In one case, even after the division of the ligamentum patellæ and extensor tendon, the bone remained as immovable as ever. This patient died from diseased knee-joint and abscesses in the thigh thirty-one months after the accident. The patella was found ankylosed by its edge to the extremity of the femur. (See *Sir A. Cooper, On Dislocations, edited by B. Cooper*, p. 199.) M. Malgaigne mentions two cases in which the bone was successfully replaced by means of an elevator introduced into the joint through a lateral opening in the capsule.

A case in which the patella had undergone complete revolution upon its axis, was observed by M. Castara, and is related by Malgaigne. The bone had been twisted round from within outwards, so that its articular surface was turned forwards, and the two articular facets could be recognised through the skin. The tendon of the extensors and the ligamentum patellæ formed above and below a thick, hard rounded cord. M. Castara seized the patella between his thumb and forefinger, and by a movement of rotation from behind forwards and from without inwards, gently turned it round into its place. The reduction took place slowly, and the movement of the bone could be distinctly followed, so that there was no doubt that its position had been completely reversed by the accident. Two other cases of the same kind, excepting that the bone had been turned round in the opposite direction, or from without inwards, are referred to by M. Malgaigne, but there is some doubt as to their authenticity. (See *Traité des Fract.* t. ii. pp. 918, 921.)]

DISLOCATIONS OF THE KNEE.

The head of the tibia may be luxated *backward*, *forward*, or to *either side*. Complete dislocations are rare; because the articular surface of the condyles of the femur is so extensive that the tibia cannot be entirely removed from it, especially in the lateral direction, without a prodigious laceration of the ligaments, tendons, and all the rest of the soft parts.

[To the four dislocations above mentioned may be added *subluxations* of the knee *inwards* or *outwards*, the result of rupture of the internal or external lateral ligaments; *dislocation by rotation* of the tibia on the femur; and *dislocations of the semilunar cartilages*.]

Dislocation backwards. — In this dislocation the condyles of the femur are disposed in such a manner that in the extreme flexion of the leg, the articular cavities of the upper end of the tibia are still in contact with those bony eminences; and this circumstance, together with the resistance made by the ligament of the patella, the patella itself, and the tendon of the extensor muscles of the knee-joint, renders a sudden dislocation of the tibia backwards so difficult, that Boyer seems even to question the possibility of the accident, notwithstanding the case recited by Heister. (*Traité des Mal. Chir.* t. iv. p. 366.) That this accident, however, sometimes really happens, no longer admits of dispute: the case is noticed by Sir A. Cooper as producing the following appearances:— A shortened state of the limb; a projection of the condyles of the os femoris; a depression in the situation of the ligament of the patella; *and a bending of the leg forwards:* which last statement differs from that of Boyer, who declares that the leg is bent to a very acute angle, and cannot be extended again. (*Mal. Chir.* t. iv. p. 369.) It appears, further, from the particulars of an example of this accident, communicated to Sir A. Cooper by Dr. Walshman, that the dislocation may even be complete, the head of the tibia being thrown behind the condyles of the femur into the ham. The tendinous connection of the patella to the rectus muscle was ruptured; and, probably, without a laceration of that tendon, or of the ligament of the patella, such a degree of displacement could scarcely have happened. (*Surgical Essays*, part ii. p. 74.)

But, if a sudden dislocation of the tibia from the femur backwards is uncommon, the same remark cannot be said respecting a displacement in that direction, gradually produced by the effects of disease. Several cases of the latter kind have fallen under my own observation.

[The dislocation backwards is commonly the result of direct violence applied to the anterior aspect of the leg at its upper part; but it may also be caused, supposing the tibia to be fixed, by force operating against the posterior and lower part of the femur. Of twelve examples of dislocation backwards to which M. Malgaigne refers, six were *complete*, and six *incomplete*. The degree of deformity, the increase in the antero-posterior diameter of the knee, and the presence or absence of shortening, would usually serve to distinguish the one from the other, but another mode of distinguishing them will be found, according to M. Malgaigne, in the position of the patella, which, when the leg is extended, is placed horizontally beneath the condyles of the femur in the complete, but is inclined at an angle of 45 degrees in the incomplete dislocation. In the complete dislocation the leg has been found either in the extended position, or bent at an angle forwards, as Sir A. Cooper stated; in the incomplete kind it is sometimes extended, sometimes slightly flexed.

In an example of complete dislocation backwards under M. Robert, the popliteal artery was ruptured, and it became necessary to amputate the limb. An opportunity was thus afforded of examining the condition of the joint, and the dissection showed the mischief to be much less than might have been anticipated. "All the ligaments were entire; the capsule alone presented, behind the femoral condyles, two lacerations of rather more than an inch in extent, through which the tibial tuberosities had escaped, and another of about equal extent in front of the femoral attachment of the external lateral ligament. The popliteus muscle was slightly torn at its outer part; all the other muscles, as also the popliteal vein and nerve, were uninjured." (See *Malgaigne, Traité des Fract.* t. ii. p. 945.)]

These accidents are easily reduced by making gentle extension, and pushing the head of the tibia in the proper direction. [Should any difficulty occur after the necessary extension has been made, the effect of flexing the knee may be tried; or the knee may be bent round the bed-post, or over the left arm or knee of the operator.] The grand object, after the reduction, is to avert inflammation of the knee, and promote the union of the torn ligaments. The first demands the rigorous observance of the antiphlogistic plan — low diet, opening medicines, and a cooling evaporating lotion; and in exceptional cases bleeding and leeches. Both require the limb to remain perfectly motionless. With respect to splints, I conceive that their pressure would be objectionable; the limb should be well supported in a suitable apparatus, and fixed in a slightly flexed position. As soon as the ligaments have grown together, and the danger of inflammation is over, the joint should be gently bent and extended every day, in order to prevent stiffness. Liniments will afterwards be of service.

Dislocation forwards.—A dislocation of the head of the tibia forwards, from the condyles of the femur, cannot happen without the greatest difficulty; for the accident would be likely to be attended with a laceration of the lateral, crucial, and oblique, or posterior ligaments, all which tend to prevent the leg from being too far extended; and in addition to all this injury, Boyer calculates that the heads of the gastrocnemius, the popliteus, and the extensor tendons of the leg would be immoderately stretched, and even torn. However, it deserves notice, that in one compound luxation of the knee, where the os femoris was thrown behind the outer side of the head of the tibia, the external condyle being dislocated backwards and outwards, and the internal one thrown forwards upon the head of the tibia, the dissection proved that "neither the sciatic nerve, the popliteal artery and vein, the lateral nor the crucial ligaments were ruptured." Both heads of the gastrocnemius were lacerated, and the back part of the capsular ligament extensively torn. (*Sir A. Cooper*, *On Dislocations*, p. 197.) In 1802, an instance of luxation of the tibia forwards was seen in Guy's Hospital. According to Sir Astley Cooper, while the tibia projects forward the thigh-bone is depressed, and thrown somewhat laterally as well as backwards. The os femoris makes such pressure on the popliteal artery, as to prevent the pulsation of the anterior tibial artery on the instep; and the patella and tibia are drawn forwards by the rectus muscle. (*Surgical Essays*, part ii. p. 73.)

[This dislocation is rather more frequent than the last. It may be caused by forced extension of the knee-joint, or by direct violence so applied as to drive the femur backwards or the tibia forwards. It may be *complete* or *incomplete*, but is much more frequently the former; for out of twenty-six examples, M. Malgaigne could only find two or three of the incomplete kind.

In the *complete* dislocation the limb is shortened, sometimes to a considerable extent. In a case under Mr. Mayo, in the Middlesex Hospital, "the extremity of the condyles was fully four inches below the level of the articular surface of the tibia." (*Lond. Med. Gaz.* vol. xxvi. p. 869.) According to M. Malgaigne, in the complete dislocation the patella is usually placed horizontally upon the head of the tibia, with its cutaneous surface turned upwards; while in the incomplete dislocation it is placed obliquely, with the cutaneous surface looking upwards and forwards. The position of the knee is not constant, it is sometimes extended, sometimes slightly flexed. In the dissection of a case of complete dislocation forwards, described and figured by M. Malgaigne, the following condition of parts was found: there was an enormous laceration on the outer side of the patella, comprising the capsule, the external lateral ligament, and the aponeurosis of the vastus externus; the capsule was likewise torn internally and posteriorly, and also the internal lateral and anterior crucial ligaments. The biceps and the outer head of the gastrocnemius were torn across; the inner head of the gastrocnemius, the soleus and the vastus internus also presented some lacerations. The popliteal nerve was raised over the internal condyle of the femur, the vessels were lodged in the condyloid notch, and were apparently uninjured. (*Traité des Fract.* t. ii. p. 939, pl. xxix.)

The *reduction* is generally accomplished without difficulty by extending the limb and making pressure upon the displaced bones in opposite directions. Or the leg may be bent over the knee of an assistant, slight extension being made at the same time. In case of compound dislocation, however, under the care of Mr. Birkett, in Guy's Hospital, reduction was found impracticable, and the limb was amputated.]

Dislocation inwards.—In the dislocation inwards, which is almost invariably *incomplete*, the inner condyle of the os femoris is thrown upon the external semilunar cartilage, and the tibia projects at the inner side of the joint, so as at once to disclose the nature of the accident; and a depression may be felt under the external condyle. Such a case was brought into University College Hospital in the autumn of 1836; and was easily reduced by Mr. Hallam, then one of the house surgeons.

Sir A. Cooper states that the tibia is rather twisted upon the os femoris, so that the condyle of the latter bone is thrown somewhat backwards as well as outwards.

[Two cases of this dislocation are mentioned in Sir A. Cooper's work; and a third has been recorded by Mr. Aston Key. In this latter the tibia was not only thrown inwards, but the leg formed a remarkable angle with the thigh, having a direction inwards; and was so far twisted that the spine of the tibia faced, in a considerable degree, towards the other leg; at the same time, the inner side of the leg faced upwards, and the sole of the foot faced towards the other leg. The patella was thrown very much inwards, following the course of the tibia. The limb was bent nearly at right angles. (See *Guy's Hosp. Reports*, 1836, vol. i. p. 257.)

In another case, which is mentioned by M. Malgaigne, the leg was bent at an angle *outwards* from the thigh, but it had undergone the same movement of rotation inwards which was observed in Mr. Key's case, and which is mentioned by Sir A. Cooper.

Reduction.—This will be effected without much difficulty by extending the limb, and by making pressure upon the tibia and femur in opposite directions. If the leg has been twisted inwards, it should be rotated outwards at the same time that the extension is being made. In Mr. Key's case, he first attempted to reduce the dislocation by carrying the limb round a bed-post, but the direction thus given to it appeared to oppose the reduction. Extension was then made from the ancle, and counter-extension from the thigh, at the same time bringing the limb to a straight line; and as he rotated the foot and leg outwards by grasping the toes, by pressing the outer condyle inwards, the luxation was easily reduced, but in a gradual manner, and without any audible snap. This patient was kept perfectly quiet for a considerable time, but was able to return to his work three months after the accident, and at the end of six or eight months the limb was not at all deficient in strength. (*Guy's Hosp. Reports*, vol. i. p. 257.) In one of the cases mentioned by Sir A. Cooper, the patient himself reduced the dislocation by getting one of his fellow-workmen to extend the limb, while he pushed the head of the tibia outwards into its natural place. (*On Dislocations*, p. 205. *B. Cooper's* ed.)]

I have stated that lateral luxations of the tibia from the femur are almost always incomplete; but the possibility of a complete dislocation inwards seems to be established by the 402d Observ. of Lamotte.

[A case of *complete* compound dislocation inwards was observed by Messrs. Miller and Hoffman, in 1825. A man, æt. 28, in mounting a carriage engaged his leg between the spokes of the wheel and the carriage started before he was able to disengage himself. The femur was completely separated from the tibia, and thrown outwards and downwards; the external condyle escaped through a laceration in the integuments of three inches in extent; this laceration exposed the joint and also the popliteal artery, which, however, was otherwise uninjured. The reduction was effected at once, and without difficulty, and in a few months' time the patient was able to walk tolerably well, without the aid of crutches. (*Lond. Med. Repos.* vol. xxiv. p. 346; and *Malgaigne*, loc. cit. p. 958.)

Another instance, also compound, was communicated to M. Malgaigne by M. Galli. The accident was caused by a fall from a horse. The lower end of the femur had passed almost entirely through the skin on the outer side of the joint; the ligamentum patellæ was ruptured. The reduction was in this case also successfully accomplished. By degrees the patient was able to walk, and at the end of two years to ride on horseback; but the knee was liable to attacks of inflammation, and was also subject to frequent displacements, which it became necessary to guard against by mechanical apparatus (loc. cit. p. 958).]

Dislocation outwards.—In the luxation of the head of the tibia outwards, the external condyle of the os femoris is thrown upon the inner semilunar cartilage, or, as Sir Astley Cooper says, rather behind it; the tibia in this case, as in the dislocation inwards, being somewhat twisted upon the femur, and the condyle thrown a little backwards, as well as laterally.

[This, like the dislocation inwards, is almost always *incomplete*, only one case of complete dislocation having, we believe, been hitherto recorded. According to M. Malgaigne, there are two varieties of the incomplete dislocation; in the first there is an incomplete displacement outwards of the tibia, with displacement outwards, likewise incomplete, of the patella; here, the centre of the head of the tibia corresponds to the under surface of the external condyle of the femur: in the second variety there is a more considerable displacement of the tibia, with *complete* dislocation of the patella. Here the external condyle of the femur rests in the internal concavity of the head of the tibia. He believes that when the external condyloid fossa of the tibia is completely disengaged from the femur, the complete dislocation outwards of the patella is inevitable. M. Malgaigne refers to seven cases of each variety.

A good example of the first kind is recorded by Dr. Hargrave, of Dublin. The inner condyle of the femur was very prominent, and the integuments over it tense; there was a hollow below it into which the finger could be placed; the patella was pushed outwards, projected over the external condyle, and was slightly moveable. The leg was bent outwards from the thigh, and could be made to form nearly a right angle externally without causing much pain; the tibia was partially dislocated outwards from the femur, and its articular surfaces were directed obliquely upwards and inwards. Flexion and extension of the leg were perfect. The reduction was effected without difficulty, but suppuration took place in and around the joint, and the patient died seven weeks after the accident. Examination of the joint showed that the internal lateral ligament was completely ruptured at its origin; the external lateral ligament was partially torn. The anterior crucial ligament was ruptured across about its centre, but the posterior was entire and uninjured. The patella and its ligaments were sound. (See *Dublin Quart. Journ. of Med. Science*, May 1850, p. 473.) The bending outwards of the leg is not constant, M. Malgaigne found it inclined in the opposite direction, while the articular surfaces of the two bones were separated externally. The same position of the leg was met with in a case observed by M. Bruch.

Of M. Malgaigne's second variety of incomplete dislocation, an example was observed by Mr. Morgan in Guy's Hospital. The accident had happened three years and a half previously, and had not been reduced. Mr. Morgan found the external condyle resting upon the inner part of the head of the tibia and internal semilunar cartilage, while the thigh-bone was at the same time somewhat twisted outwards. The patella was thrown with its ligament on the outer side of the external condyle, and the articular surface on which it formerly rested was easily felt through the integuments. Soon after the accident attempts had been made to reduce the dislocation, but they proved unsuccessful, and no further trial was made. When seen by Mr. Morgan, the motion of the joint was very limited, the powers of the extensors being lost, and that of the flexors very confined; but his principal inconvenience was, that the joint frequently gave way inwards, causing him immediately to fall to the ground. (See *Lancet*, 1826, vol. ix. p. 843.) For another well-marked example, observed at St. Bartholomew's Hospital, see *Lancet*, Aug. 1833, p. 732. In this case there was no difficulty in the reduction.

Reduction.—It will generally be accomplished easily, by extension and coaptation, combined with rotation of the limb, if necessary, on the same principle as in the dislocation inwards.

The following is an outline of the case before alluded to of *complete* dislocation outwards of the knee, which was observed at the London Hospital:—The dislocation of the tibia from the femur was complete, the articular surfaces not being in the slightest degree in contact. The tibia and fibula were thrown to the outer side of the condyles, and formed there a remarkable tumour a little above the level of the articular surface of the femur. The condyles of the latter bone were equally prominent internally. The patella was thrown over the outer condyle. The direction of the axis of the tibia was altered, the foot being carried towards the opposite, and rotated a little inwards. The reduction was accomplished by Mr. Luke, without difficulty, by extension of the leg and slight lateral pressure on its outer surface. The tendency to inflammation in the knee was effectually checked by the daily application of a considerable number of leeches. This patient recovered, notwithstanding a severe compound fracture of the opposite leg; but the skin on the inner side of the joint became firmly adherent to the internal condyle, and the movements of the knee seem to have been very materially impaired. (See *Lond. Med. Gaz.* 1831, vol. vii. p. 703.)]

[*Lateral subluxations of the knee.*—It sometimes happens that one or other of the lateral ligaments of the knee are ruptured without any actual dislocation of the tibia from the femur, although the rupture permits a separation of the surfaces of the bones from each other on the side on which it has occurred. Sir C. Bell gave the name of subluxation to the rupture of the internal lateral ligament, but the same thing may take place also on the outer side. (See *Malgaigne, Traité des Fract.* t. ii. p. 946.) Any force tending to bend the knee outwards or inwards produces tension of the external or internal lateral ligament, and may cause its rupture. The same kind of force, if more powerful or long continued, may then cause a real displacement of the tibia from the femur outwards or inwards; and this is doubtless the way in which the lateral dislocations are sometimes produced, the subluxation being in that case the first stage of the true dislocation.

The internal lateral ligament is more frequently ruptured than the external. In a case seen by Mr. Aston Key, at Guy's Hospital, the following were the appearances noticed:—There was no evident deformity about the knee, but "the internal lateral ligament was found completely torn through, as was also, in some measure, the tendon of the vastus internus muscle. On turning the foot and leg outwards, a fissure could be felt between the inner condyle of the femur and the head of the tibia, into which the finger might be depressed." (See *Guy's Hosp. Reports*, 1836, vol. i. p. 256.)

In a case of recent injury of this nature which M. Malgaigne had an opportunity of dissecting, he found the internal lateral ligament completely ruptured, and the capsule torn across, from the inner head of the gastrocnemius behind to the attachment of the vastus internus to the patella in front. The laceration also extended some distance upwards through the fascia lata on the inner side of this muscle.

M. Malgaigne could only meet with one recorded case of the external subluxation which was observed by Dr. Norris. There was great pain, and inability to move the knee, but no appearance of derangement of the joint, until, in raising the leg, it was found that it could be carried more inwards than was natural, and that there was a marked separation on the outer side; the separation disappeared when the leg was brought back to its normal position. (*Malgaigne*, loc. cit. p. 949.)

Treatment.—The treatment is obviously to place the bones in their proper position, and to maintain them in the same for a sufficient length of time for the torn ligaments to become firmly united. Mr. Key placed a straight splint on the outside, extending from the leg to the foot; this, however, did not keep the bones in proper apposition; the limb was therefore placed on an inclined plane, which appeared to answer better, but in order to hinder all motion, two or three layers of plaster were applied to the joint, and this with the whole bound firmly to the inclined plane. In six weeks the patient left the hospital, and resumed his occupation, with the power and motion of the limb but little impaired. (See *Guy's Hosp. Reports*, 1836, vol. i. p. 250.)

In two cases, however, which came under M. Malgaigne's observation, the result was not so satisfactory, for the leg remained permanently bent outwards, producing considerable deformity, and the usefulness of the limb was much impaired. He recommends that a broad and long external splint should be applied, bearing upon the leg and thigh by means of cushions placed between it and those parts, but not touching the outer side of the knee; then bandages should be applied, embracing the inner side of the knee, and fixed to the splint in such a manner as to bring the bones and the ruptured ligaments into as perfect contact as possible.

In Dr. Norris's case of rupture of the *external* ligament, the limb was placed in a fracture apparatus, the joint being kept extended. Its use was perfectly restored, but not till after an interval of five months. (See *Malgaigne*, loc. cit. p. 947.)]

[*Rotatory dislocation of the tibia.*—A purely rotatory displacement of the tibia is rare, some half-dozen cases only having been recorded; although some degree of rotation is, as has been shown, not unfrequently present in the lateral dislocations, and also, in a slighter degree, in the dislocations backwards and forwards. The dislocation by rotation outwards appears to be more frequent than that by rotation inwards. This may perhaps be accounted for by the arrangement of the crucial ligaments; for it will be found, after all the *other* ligaments of the joint have been divided, that the crucial ligaments will oppose a strong resistance to rotation inwards, but will permit rotation outwards till the tibia is turned almost completely round.

A very complete case of dislocation by rotation *outwards* was observed in the practice of M. Malgaigne. The leg, which remained in an extended position, was turned outwards, and the foot rested on the bed by its external border. The tibia had undergone a movement of rotation upon its axis which had carried the internal tuberosity forwards under the femoral trochlea, and the external tuberosity backwards under the intercondyloid notch, while the head of the fibula was prominent opposite to what should have been the popliteal space. The anterior tuberosity, which had become external, had carried with it the patella, which was completely dislocated outwards. The condyles of the femur were prominent externally and internally, and there was a depression beneath them. In spite of the complication of a fracture of the tibia and fibula, the dislocation was easily reduced by extension and rotation in the opposite direction. The fracture, however, confined the patient to her bed for more than four months, and then the knee was stiff, painful, and incapable of supporting the weight of the body, and a year and a half after the accident no sensible amelioration had taken place.

In the above instance the tibia had undergone a movement of rotation upon its central axis; this, however, does not appear to be always the case, but it may rotate upon an axis passing through the centre of one of its articular concavities, so that one tuberosity is displaced backwards while the other remains in contact with and supports the corresponding condyle of the femur. This appears to have been the condition of the parts in a case of rotatory dislocation outwards observed by M. Petrequin, in which the displacement was thus limited to the external condyle. The spine of the tibia was here situated under the anterior part of the external condyle of the femur. The patella was completely dislocated outwards. The limb was extended, abducted, and rotated outwards.

M. Malgaigne thinks the first kind of displacement mentioned might be described as a *complete*, and the last as an *incomplete* rotatory dislocation.

The same authority refers to two cases of dislocation by rotation *inwards*, similarly incomplete; the inner portion of the tibia being partially displaced backwards from the internal condyle. (*Traité des Fract.* t. ii. p. 961.)]

Dislocation of the Semilunar Cartilages.—I have next to notice the cases which were first described by the late Mr. Hey, and are named by Sir A. Cooper *partial luxations of the thigh-bone from the semilunar cartilages.* Mr. Hey observes, that the disorder may happen either with or without contusion. When no contusion has occurred, or the effects of it are removed, the joint, with respect to shape, appears uninjured. If there is any difference from its usual appearance, it is that the ligament of the patella seems rather more relaxed than that of the sound limb. The leg is readily bent, or extended by the hands of the surgeon, and without pain to the patient; at most, the degree of uneasiness, caused by this flexion and extension, is trifling. But the patient himself cannot freely bend, nor perfectly extend the limb in walking; and he is compelled to walk with an invariable and small degree of flexion. Yet, though the leg is stiff in walking, it may be freely moved while the patient is sitting down.

Mr. Hey ascribed this complaint to any causes which had the effect of hindering the condyles of the os femoris from moving truly in the hollow formed by the semilunar cartilages, and articular depressions of the tibia; an unequal tension of the lateral or crucial ligaments, or some slight derangement of the semilunar cartilages. (*Pract. Obs.* p. 333. ed. 2.) Sir A. Cooper says, the most frequent cause of the accident is the point of the foot, while everted, striking against any projection, when pain is immediately felt in the knee, and the patient becomes incapable of perfectly extending the leg. He has also known the case produced by a person suddenly turning in bed, and the clothes not suffering the foot to turn as quickly as the rest of the body. A sudden twist of the knee inwards may also displace the semilunar cartilages.

Sir A. Cooper gives the following explanation of the case:—The semilunar cartilages are united to the tibia by ligaments which, when relaxed, allow the cartilages to be easily pushed from their natural situation by the condyles of the femur, which then come into contact with the head of the tibia; and now, upon an attempt being made to extend the leg, a complete movement of this kind is prevented by the edges of the semilunar cartilages. (*Surgical Essays,* part ii. p. 76.)

In several examples recorded by Mr. Hey, a cure was effected by placing the patient upon an elevated seat, extending the joint, while one hand was placed above the knee, and then suddenly moving the leg backwards, so as to make as acute an angle with the thigh as possible. (*Pract. Obs.* p. 337, &c.) This manœuvre seems to have the effect of restoring the semilunar cartilages to their natural position. Sometimes, however, it will not answer; and, in one such case, mentioned by Sir A. Cooper, the patient used to accomplish the reduction by sitting upon the ground, and then bending the thigh inwards and pulling the foot outwards. A knee-cap, laced tightly, and furnished with a strong leather strap just below the patella, was requisite in this instance for preventing a return of the displacement. In another case, subject to frequent relapses, these were at length hindered by a bandage with four rollers attached to it, which were tightly applied above and below the patella. (*Sir A. Cooper, Surg. Essays,* part ii. p. 77.)

[Neither Mr. Key nor Sir A. Cooper appear to have observed any projection externally caused by the displaced cartilages. This, however, has been noticed in several instances, and it is almost invariably the *internal* cartilage which has been affected. This, perhaps, might have been expected, from its more semilunar shape, the wider separation of its extremities, and the circumstance of its covering so much less of the articular cavity of the tibia than the external cartilage. In a case of this kind, seen by M. Malgaigne, there was a prominence at the inner side of the knee, which seemed to be caused by the internal semilunar cartilage. In another, under M. Dequevauviller, in which there had been frequent relapses, there was a slight projection internally and posteriorly, which seemed due to the cartilage. (*Malgaigne,* t. ii. p. 968.) Mr. Vincent speaks of having had several of these cases under his management, and in his experience the injury always involved the internal cartilage. "They are marked," he says, "by the joint becoming, on some quick motion of the trunk about the axis on one leg, locked. Often there is great pain, and a slight projection of the anterior edge of the cartilage beyond the margin of the head of the tibia." "The pain is often excruciating, and will continue, yet the moment the cartilage is reduced no pain, or even tenderness, will remain." Mr. Vincent thinks "the true mode of manipulating here is to place the patient on his affected side, with the limb bent, and then to rotate gently the tibia on its axis. In this position the joint is loose, making no pressure on the cartilage, and it has the best chance of quietly slipping into its place." (*Obs. on Surg. Practice,* p. 75, 1847.)

A case occurring at the London Hospital has been recorded as a dislocation of the *external* semilunar cartilage. From the description, however, it appears more to resemble the incomplete dislocation from rotation outwards. "The toe was turned a little outwards, and the tibia inclined in the same direction, the inner part of its head bore its natural relation to the inner condyle of the femur; the outer part, however, was carried a little backwards, leaving a hollow under the corresponding condyle, and forming a slight projection behind, not discoverable except by pressing on the part with the finger." These symptoms afford no evidence of displacement of the cartilage, but are nearly conclusive of a partial rotatory displacement outwards. In this case various attempts at reduction were made by Mr. Luke, first by extension, then by adduction of the limb, and then by flexion of the knee over a rolling-pin placed in the ham, but all were ineffectual, and the patient left the hospital in a month, unable to bring her heel to the ground or to extend the knee beyond a certain point. (See *Lond. Med. Gaz.* vol. vii. p. 704, 1831.)]

Compound Dislocations of the Knee-Joint.—Compound dislocations of the knee generally demand immediate amputation.

[According to Sir A. Cooper, there are scarcely any accidents to which the body is liable which, generally speaking, more imperiously demand amputation than these.

If, however, the wound in the skin is not large, and the bones can be replaced and maintained in their proper position without much difficulty—if the muscles are not much lacerated, and the vessels and nerves are entire—if the patient is young, and his constitution appears good—the attempt may be made to save the limb. Several cases have been recorded in which this practice has been resorted to with success; and some of these have been already referred to. In one instance Mr. Anthony White sawed off the articular end of the femur, and a very useful limb is stated to have been the result. If resection were resolved upon, it would probably be better to go further, and to saw off the articular surface of the tibia as well, when union between the cut surfaces could more readily take place.]

[*Congenital dislocations of the knee.* — Cases of this kind have been observed by MM. Cruveilhier, J. Guerin, Bouvier, Kleeberg, and others. The bones of the leg are in the great majority of instances dislocated *forwards* on the thigh. When this is the case, the bones of the leg are bent forwards at an angle, and the deformity may even be so great that the articular surface of the tibia looks downwards towards the ground, and the foot touches the abdomen. Cases of displacement of the leg backwards and laterally have also been recorded, but these appear to be much more rare.

With respect to treatment, attempts should be made to straighten the limb by the gradual and careful application of force, and it should then be fixed in its proper position by splints or other suitable apparatus, until the tendency to displacement is overcome. (See *Chatelain*, *Bibl. Méd.* t. lxxv. p. 85; *Savon*, *des Lux. Congén. thèse de concour*, 1841; *Bard*, *Amer. Journ. of Med. Science*, 1835; *Cruveilhier*, *Atlas d'Anat. Pathol.* 2^e livr.; *Wutzer*, *Muller's Archiv. für Anat. und Physiol.* 1825, part iv. p. 365; *Kleeberg*, *Hamburger*, *Zeitschrift*, vol. vi. part ii.; *Bouvier*, *Bulletin de l'Acad.* t. ii. p. 301; *Robert*, *de Vices Congén des Artic. &c. &c.*)]

DISLOCATIONS OF THE UPPER EXTREMITY OF THE FIBULA.

According to Sir A. Cooper, luxations of the upper end of the fibula, from relaxation of the ligaments, are more frequent than those from violence. The head of the bone is thrown backwards. The bone is easily replaced, but immediately slips behind the tibia again. When the case is attended with disease, repeated blisters are recommended; and afterwards a strap, to confine the bone in its natural situation. (*Surg. Essays*, part ii. p. 105.) In dislocations from injury, a roller, a compress applied over the head of the fibula, and a splint along this bone, would be proper. (*Boyer*, *Mal. Chir.* t. iv. p. 374.) The latter author has seen a displacement of the fibula upwards, accompanying a dislocation of the foot outwards. This case must be exceedingly unfrequent, as it is resisted not only by the ligaments of the upper joint of the fibula, but also by those very strong ligamentous bands which bind the malleolus externus to the astragalus and os calcis. In all the cases which I have seen, the pressure of the astragalus, when driven outwards, has broken the fibula. In the instance mentioned by Boyer, the double luxation of the fibula was readily reduced by rectifying the position of the foot, and bringing the astragalus into the proper place again with respect to the tibia.

[Dislocations of the upper extremity of the fibula are very rare, but they have been met with occasionally, both in the *backward* and *forward* direction.

Dislocation backwards. — A case of dislocation backwards was admitted into Guy's Hospital under Mr. Bransby Cooper. The accident was caused by a waggon wheel passing over the limb. The fibula, when traced upwards, seemed to pass more backwards than natural. It was also more movable than usual, and the upper part of the bone was felt in the popliteal space. There was scarcely any pain given by motion of the limb, and the man possessed the power of extending it perfectly, and of flexing it to a considerable extent; but whether he could completely flex it was not ascertained. The dislocation was reduced by bending the leg to relax the biceps muscle, and then grasping the head of the fibula and pressing it into its natural situation. Moistened pasteboard and a bandage were then applied, but were found insufficient to keep the bone in its place, in consequence of the biceps drawing it back; a tourniquet pad was therefore applied over the pasteboard, and by means of this the head of the fibula was forcibly pressed forwards. This was continued for nearly two months, at the end of which time the fibula remained rather behind its usual situation, but was perfectly fixed. (*Sir A. Cooper*, *On Dislocations*, *edited by B. Cooper*, p. 222.)

A remarkable case of dislocation backwards, from muscular contraction, has been recorded by M. Dubreuil. The patient had made a sudden effort to save himself from falling, and his limb was at the same time forcibly abducted. At the same moment a sharp pain was felt in the situation of the head of the fibula, which was carried backwards an inch behind the external tuberosity of the tibia. The foot was thrown outwards, and the whole peroneal region became cold and numb. The leg being semi-flexed, the dislocation was reduced by pressing the head of the fibula from behind forwards. But the leg being placed in the extended position, the next day the bone was again found displaced, and it became necessary to apply a leather knee-cap to retain it in its place. There seems no reason to doubt that the action of the biceps produced the dislocation in this instance, and was also the cause of the relapse after the reduction. The case, as M. Malgaigne observes, clearly indicates the propriety of keeping the knee moderately flexed until the ligaments are consolidated. (*Traité des Tract.* t. ii. p. 986.) The displacement of the foot outwards in this case seems an approach to the injury described by Boyer, and already alluded to.

In a case where there was much difficulty in retaining the bone in its place, it might perhaps be a question whether subcutaneous section of the tendon of the biceps should not be resorted to.

Dislocation forwards.—A case of dislocation forwards, caused by a fall into a sawpit, was seen by Mr. Thomson of Greenock. The head of the fibula was thrown forwards upon the anterior and outer aspect of the tibia. Mr. Thomson endeavoured to replace it with the fingers, but without success, until the leg was flexed on the thigh, so as to relax the biceps, when the bone immediately slipped back into its place with an audible snap, and the part resumed its natural appearance. A compress and bandage were applied, but no difficulty appears to have been met with in this case in the retention of the bone in its place. The patient was able to resume his work in a fortnight. (*Lancet*, vol. i. 1850, p. 385.) M. Malgaigne refers to two cases in which he thinks the dislocation forwards must have been produced by muscular action, the muscles in operation being the extensors which arise from the anterior surface of the fibula. In one of those recorded by M. Jobard the patient fell while mounting a staircase, and heard a snap before he reached the ground. Here the tendon of the biceps was found to describe a curve from behind forwards to reach the dislocated head of the bone; and here, also, the reduction was found impracticable until the leg had been flexed upon the thigh. In the other case there was no difficulty in reduction in the extended position, but care was taken to relax the muscles which arise from the anterior surface of the fibula.

Dislocation *upwards* of the head of the fibula associated with fracture of the tibia has been occasionally seen; the fracture being oblique downwards and inwards, so as to permit the fragments of the tibia to override each other.]

[DISLOCATION OF THE LOWER EXTREMITY OF THE FIBULA.]

[The case observed by Boyer of dislocation of the whole fibula upwards must, of course, have been attended with some displacement of the inferior as well as of the superior tibio-fibular articulation. With this exception, however, only one instance of dislocation of the lower end of the bone, uncomplicated by some further displacement affecting the ancle-joint, has been recorded. The case in question was under M. Gerdy, in the Hôpital St. Louis. The accident was caused by the wheel of a carriage passing obliquely over the inferior part of the leg, in such a manner as to push the malleolus directly backwards. The malleolus was found in contact with the outer border of the tendo Achillis; the external surface of the astragalus, abandoned by the fibula, could be felt throughout nearly its whole extent; the foot had preserved its normal position. The patient did not present himself till thirty-nine days after the accident, and it was not judged expedient to make any attempt at reduction. He was able, by taking some precautions, to walk tolerably well. (See *Nélaton, Elém. de Pathol. Chir.* t. ii. p. 474.)]

DISLOCATIONS OF THE ANCLE-JOINT.

[Dislocations of the ancle-joint may take place either backwards, forwards, or laterally; the great majority are complicated with fracture of one or both malleoli, or of the fibula within three or four inches of the joint.]

I think the profession is much indebted to Sir A. Cooper for his application of terms to dislocations of the ancle, which are liable to no mistake or confusion. Thus, when he speaks of a dislocation of the tibia, inwards or outwards, backwards or forwards, the case spoken of is immediately known. On the contrary, when authors write about dislocations of the ancle or foot in any named direction, their meaning may be various and misinterpreted. We find this exemplified in Dupuytren's valuable memoir on fractures of the lower end of the fibula associated with dislocation of the foot; for, instead of terming the above case a dislocation of the foot *outwards*, as the generality of writers have done, he thinks it should be named a dislocation of the foot *inwards*, on account of the direction in which the articular surface of the astralagus is turned. (*Annuaire Méd. Chir.* p. 3, 1819.)

[The confusion has arisen chiefly with reference to the lateral dislocations of the ancle, in which it will be found that the same injury which some call dislocation of the *tibia inwards, and of the foot outwards*, is described by others as dislocation of the *foot inwards*, because the foot has undergone a sort of rotation (abduction) which causes the upper surface of the astralagus to *face* more or less obliquely inwards. Several recent writers, (see *Nélaton, Elém. de Pathol. Chir.* t. ix. p. 478; *Chelius, Syst. of Surgery, translated by South*, vol. i. p. 807; *Erichsen, Science and Art of Surgery*, p. 244) following Dupuytren and Boyer, have adopted this latter view, and have perpetuated the confusion which Sir A. Cooper's description had gone far to remove. All, however, singularly enough, together with Dupuytren, in speaking of this form of dislocation, describe the internal malleolus as prominent internally, and stretching the skin almost to bursting. Surely, when this is the case, it must be the tibia and not the foot which is dislocated inwards; and if the tibia is dislocated inwards, it follows, one would think necessarily, that the foot must be dislocated outwards. The converse of these remarks is of course equally applicable to the opposite case, in which the foot is displaced inwards, and the bones of the leg outwards.

The dislocations of the ancle-joint may be correctly classified in the following manner, which will, it is hoped, leave no room for misapprehension:—

1. Dislocation of the tibia inwards, or of the foot outwards, with fracture of the fibula.
2. Dislocation of the tibia and fibula outwards, or of the foot inwards; sometimes without any fracture of either bone, but most frequently with fracture of one or both malleoli.
3. Dislocation of the tibia forwards, or of the foot backwards, usually accompanied by fracture of the fibula.
4. Dislocation of the tibia and fibula backwards, or of the foot forwards.
5. Dislocation upwards of the astragalus between the tibia and fibula.]

1. *Dislocation of the tibia inwards, or of the foot outwards, with fracture of the fibula.*—This is the most frequent dislocation to which the ancle-joint is liable; the foot being thrown outwards, and its inner edge resting upon the ground, while the fibula is broken two or three inches above the joint.

[This dislocation may be complete or incomplete, but is most frequently the latter.]

It was to this particular case, associated with fracture of the fibula, that Mr. Pott drew the attention of surgeons; and the injury is frequently still spoken of as Pott's fracture or Pott's dislocation. "By leaping or jumping," he observes, "the fibula breaks within two or three inches of its lower extremity. When this happens, the inferior fractured end of the fibula falls inwards towards the tibia; that extremity of the bone which forms the outer ancle is turned somewhat outward and upward; and the tibia having lost its proper support, and not being of itself capable of preserving its true perpendicular bearing, is forced off from the astragalus inwards, by which means the weak bursal, or common ligament of the joint, is violently stretched, if not torn, and the strong ones which fasten the tibia to the astragalus and os calcis are always lacerated; thus producing at the same time a perfect fracture and a partial dislocation, to which is sometimes added a wound in the integuments made by the bone at the inner ancle. By this means, and, indeed, as a necessary consequence, all the tendons which pass behind or under, or are attached to the extremities of the tibia and the fibula, or os calcis, have their natural direction and disposition so altered, that, instead of performing their appointed actions, they all contribute to the distortion of the foot, and that by turning it outward and upward."

When this accident is accompanied, as it sometimes is, with a wound of the integuments of the inner ancle, and that made by the protrusion of the bones, the danger and difficulties of the case are seriously increased.

According to Sir A Cooper, "the tibia has its internal malleolus thrown inwards, which so forcibly projects against the integuments as to threaten their bursting. The foot is thrown outwards, and its inner edge rests upon the ground. It rotates easily on its axis. There is a considerable depression above the outer ancle, much pain in the part, and considerable swelling; the foot can easily be moved laterally, and crepitus can be generally detected about three inches above the lower extremity of the fibula."

"Upon dissection, the internal appearances are as follow:—The end of the tibia rests upon the inner side of the astragalus, and if the accident has been caused by a jump from a considerable height, the lower end of the tibia, where it is connected to the fibula by ligament, is frequently split off and remains connected with the fibula, which is also broken from two to three inches above the joint; and the broken end of the fibula is carried down upon the astragalus, occupying the natural situation of the tibia. The malleolus externus of the fibula remains in its natural situation, with two inches of the fibula and the split portion of the tibia; the ligamentous fibres attached to the fibula at the malleolus externus, and the three strong external lateral ligaments remain uninjured." (*On Dislocations*, p. 175, ed. 10.)

[In the majority of cases the dislocation is incomplete, the tibia still remains partially in contact with the astragalus, and the skin is unbroken. But sometimes the tibia is thrown so far inwards as to be completely separated from the astragalus, and when this is the case, the dislocation is usually compound; the strain upon the integument being so great that it gives way on the inner side, and the lower end of the tibia escapes through the laceration. Mr. Pott's description refers to the incomplete dislocation, and so also, it would appear, does Sir A. Cooper's account of the symptoms of the accident. The description, however, of the appearances on dissection which has been quoted from the latter author, refers to a complete dislocation, and implies so great a derangement of the parts, that it would seldom happen without laceration of the integument and protrusion of the tibia.

The dislocation of the tibia inwards, or of the foot outwards, may result from *direct* or *indirect* violence, but the latter is by far the more frequent cause. If from direct violence, the external force is commonly a blow or the fall of a heavy weight against the outer side of the leg towards its lower part, which first fractures the fibula and then forces the tibia inwards. Sometimes the external force is expended in producing the fracture of the fibula, and the dislocation is caused subsequently by the patient bearing his weight on the limb after it has lost the support of the fibula.

The dislocation from indirect violence is most frequently produced by a twisting outwards (abduction) of the foot, as when in jumping from a height the inner edge of the foot comes to the ground; or by abduction combined with rotation of the point of the foot outwards, as when the foot is suddenly checked in its motion whilst a person is running with the toes turned outwards. Either of these movements may fracture the fibula two or three inches above the malleolus, and the weight of the body, then resting upon the inner side of the ancle, causes laceration of the internal lateral ligament and dislocation inwards of the tibia. This explanation is somewhat different from that given by Dupuytren, who believed that the internal lateral ligament first gave way, and that the fibula was subsequently fractured; the frequent occurrence, however, of fracture of the fibula without any displacement of the ancle, or with only a very slight rotation of the foot outwards, seems rather to indicate that the fracture is first in the order of time,—and this is in accordance with Mr. Pott's description of the mechanism of the accident.

Dupuytren believed that this dislocation might also be caused by inversion (adduction) of the foot, and several of his observations seem to show that this is the case. It is difficult to understand, however, how inversion or adduction of the foot can cause the tibia to become prominent internally, although it may undoubtedly produce the fracture of the fibula. (See FRACTURES.)

"How comes it, then," says M. Malgaigne, "that in Dupuytren's observations, fractures of the fibula by adduction are so often complicated with the displacement (*eversion*) of the foot. The facts answer for themselves: it is, that all the patients having had the fibula broken by a movement of adduction, have attempted to walk, and that then the foot was turned outwards and the abduction produced the dislocation." (*Traité des Tract*, t. i. p. 812.)

Sometimes, unfortunately, the observations of this great authority, Dupuytren, are so inconsistent with each other as to be almost unintelligible. Thus, for instance, in two cases, in which the position of the foot and leg are precisely the same, he describes one as a dislocation of the foot inwards, and the other as a dislocation of the foot outwards, because the one was caused by inversion and the other by eversion. (*Dupuytren, On Dis. and Inj. of the Bones*, Sydenham Society's translation, pp. 257, 259, cases vi. and vii.)

The degree of eversion met with varies in different cases. Boyer and others have described the articular surface of the astragalus as directed completely inwards, the outer edge of the foot raised and approximated to the malleolus externus. So great an eversion as this, however, must be very rare. M. Malgaigne has always noticed a rotation of the point of the foot outwards, in addition to the abduction; and he has given a representation of one case in which there was this rotation only, without abduction. Pl. xxx., fig. 1.

M. Huguier has recorded one case in which the dislocation was produced by a rotation of this kind, without abduction, and in this case the foot rested upon the bed by the whole of its external border, and the toes were pointed directly outwards, but there was no abduction. (*Mém sur les lux. du pied*, *Union Méd.* 1848.)

The dislocation, it has been already stated, is most frequently incomplete, that is, the articular surface of the tibia is partially in contact with that of the astragalus; sometimes, however, the tibia is completely separated from the foot, and the internal malleolus may then descend towards the sole, while the foot, with the external malleolus, is displaced *upwards* as well as outwards. In a case of this kind described by Dupuytren, the symptoms which most attracted attention were the shortness of the leg, together with the almost doubled interval between the malleoli and the prolongation of the tibia downwards to a level with the sole of the foot: the astragalus and outer malleolus, together with the whole foot, were drawn up on the outer side of the tibia, two inches above their normal position. When there is so great a displacement as this, the integument generally gives way on the inner side and the tibia protrudes, rendering the dislocation a compound one; but in this instance the skin remained entire, the dislocation was speedily reduced, and in less than six weeks the patient was able to walk with crutches, and there was not the slightest irregularity in the form of the injured limb. (See *Dupuytren*, Sydenham Society's translation, p. 282, case xvi.)

Of course in such a case, all the ligaments connecting the tibia and fibula must be ruptured. Frequently, however, instead of the internal lateral ligament giving way, the internal malleolus is broken off, and remains connected to the astragalus by the ligament. Sometimes the malleolus is detached from the tibia at its base, sometimes it is the point only which is torn off. If there is any considerable separation between the tibia and fibula, the strong tibio-fibular ligaments are torn through, or else, as Sir A. Cooper explained, a portion of the tibia is split off and remains connected with the fibula by ligament.]

Reduction. — In former times, great difficulty used often to be met with in reducing this dislocation, and in maintaining the bones in their place after their reduction. It was Mr. Pott who first explained the reason of this difficulty, and pointed out the necessity of placing the limb in such a position as to relax as much as possible all the resisting muscles. "All the trouble, pain, difficulty, and inconvenience," he observes, "are occasioned by putting and keeping the limb in such a position as necessarily puts the muscles into action, or into a state of resistance, which in this case is the same. This occasions the difficulty in reduction, and the difficulty in keeping it reduced; this distorts the foot, and by pulling it outward and upward, makes that deformity which always accompanies such accidents: but if the position of the limb be changed; if by laying it on its outside, with the knee moderately bent, the muscles forming the calf of the leg, and those which pass behind the fibula and under the os calcis, are all put into a state of relaxation and non-resistance, all this difficulty and trouble do in general vanish immediately; the foot may easily be placed right, the joint reduced, and by maintaining the same disposition of the limb, everything will in general succeed very happily, as I have many times experienced."—*Pott.*

[Sometimes, of late years, when much difficulty has been met with in reducing the dislocation, the tendo Achillis has been divided subcutaneously, and with excellent effect. Several instances in which this practice was followed, have been related by Mr. Cock. (See *Guy's Hosp. Reports*, 1855.)]

Dupuytren admits that Pott's method easily effects a reduction, but thinks it incapable of maintaining it, and consequently he prefers a method of treatment which will be explained in the part of the article FRACTURE relating to fractures of the fibula. Sir A. Cooper adopts Pott's principles; and directs that the patient "should be placed on the side on which the injury has been sustained; the surgeon is then to bend the leg at right angles with the thigh, so as to relax the gastrocnemii muscles as much as possible; and an assistant, grasping the foot, must gradually draw it in a line with the leg. The surgeon then fixes the thigh and presses the tibia downwards, thus forcing it upon the articular surface of the astragalus. Great force is required if the limb be placed in the extended position, from the resistance of the gastrocnemii; and it is pleasing to observe, after the most violent attempts by others, a well-informed surgeon gently bend the limb, and under a comparatively slight extension, return the parts to their natural situation." He then applies two splints, one to the inner and one to the outer side of the leg, each with a foot-piece, to give support to the foot, to prevent its eversion, and to preserve it at right angles with the leg. (*On Dislocations*, p. 176, ed. 10.)

I have no doubt that placing the limb on M'Intyre's apparatus, as done at University College Hospital, is quite as good a method of treating this and all other dislocations of the ancle, with fracture of the fibula, as any yet proposed, not excepting that of Dupuytren; which will be noticed in the article FRACTURE. [This plan is now adopted in most of the London hospitals, and is found to be in many respects much more convenient than that of placing the injured limb on its outer side, as recommended by Pott, Dupuytren, and Sir A. Cooper. The apparatus admits of relaxation of the muscles to any required extent, by increasing the angle opposite the knee-joint. The foot may be securely fixed and supported by the foot-piece, which corresponds to the sole, and if any pressure should be required to prevent the recurrence of the displacement of the tibia inwards or of the foot outwards, it may be obtained by placing pads in the proper situations between these parts and the sides of the apparatus. For a further description of these appliances, see FRACTURES OF THE LEG.]

2. *Dislocation of the tibia and fibula outwards; or of the foot inwards, sometimes without fracture, but most frequently with fracture of one or both malleoli.*— [This is much less common than the dislocation inwards, and, according to Sir A. Cooper, it is a more severe injury, and is attended with more contusion of the integuments, more laceration of ligament, and greater injury to the bones than either of the others. M. Malgaigne found that out of twenty-two cases, the records of which he investigated, as many as nineteen were compound dislocations. In reference to the frequency of its occurrence, he states, that no example of this injury, either simple or compound, has come under his own observation, that Dupuytren only met with three cases, and Sir A. Cooper with a like number, though the latter has recorded nine others which were communicated to him by his friends.

The injury to the bones is not so constant or uniform in this as in the dislocation of the tibia inwards, of which there is scarcely an example known without fracture of the fibula. In the dislocation outwards, however, M. Malgaigne found, that out of the twenty-two cases, as many as eight were unaccompanied by fracture of either bone; while six were attended with fracture of both bones; four with fracture of the fibula only; and two with fracture of the tibia only; one with fracture of the astragalus only; and one with fracture of the tibia, astragalus, and os calcis, the fibula remaining uninjured.

The dislocation of the bones of the leg outwards is caused either by a forced inversion of the foot, or by external violence, such as a heavy weight falling upon the ancle, or the wheel of a carriage passing over it. When produced by inversion, the fibula is probably, as Dupuytren explained, first fractured, and then either the internal malleolus breaks also, or the internal lateral ligament is torn. According to Sir A. Cooper, "the internal malleolus is obliquely fractured and separated from the shaft of the bone. The fractured portion sometimes consists only of the malleolus, at others the fracture passes obliquely through the articular surface of the tibia, which is thrown forwards and outwards upon the astragalus, before the malleolus internus. The astragalus is sometimes fractured, and the lower extremity of the fibula is broken into several splinters." Sir A. Cooper does not seem to have been aware that so large a proportion of these dislocations is unattended with any fracture whatever, or that not unfrequently the fibula is fractured alone. Two cases, however, are recorded by him of compound dislocation outwards without fracture of either bone. Another was observed by Mr. Liston, in University College Hospital. A similar case, unattended with wound in the skin, has been recorded by M. Keisser. (See *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 1006.)

With respect to the symptoms, "the foot is thrown inwards, and its outer edge rests upon the ground. The malleolus externus projects the integuments very much outwards, and forms so decided a prominence that the nature of the injury cannot be mistaken." (*On Dislocations*, p. 181, ed. 10.)

In the compound dislocation, the fibula, and sometimes the tibia also, protrude through the skin on the outer side of the ancle. If the fibula is fractured, the upper fragment protrudes, together with the tibia, and the outer malleolus remains attached to the astragalus.

This is the state of parts which Dupuytren and Boyer, and some modern writers have so strangely described as a dislocation of the *foot outwards*; although the fibula is invariably prominent externally, and if the dislocation is compound, it is invariably on the outer side that one or both bones of the leg are projected through the integuments.]

Reduction.—The reduction is accomplished by relaxing the muscles of the calf, making extension in the axis of the leg, and pressing the lower end of the tibia inwards towards the astragalus. When the dislocation is not compound, "the limb is to be laid on its outer side, resting upon a splint with a foot-piece, and a pad is to be placed upon the fibula just above the outer ancle, and extending a few inches upwards, so as in some measure to raise that portion of the leg, and prevent the tibia and fibula slipping from the astragalus, as well as lessen the pressure of the malleolus externus on the integuments." (*Surg. Essays*, part ii. p. 113.) Sir A. Cooper also enjoins paying the strictest attention to hindering the foot from being twisted inwards, or pointed downwards.

[M'Intyre's apparatus is as applicable to this as to the dislocation of the tibia inwards, and the reader is referred to the remarks already made on the subject in treating of that dislocation.

The reduction is sometimes attended with considerable difficulty. Mr. Cock relates a case in which the foot was perfectly immoveable, and refused to yield to any extension in any direction whatever. The tendo Achillis was tense, and there was pain in the calf of the leg. Mr. Cock divided the tendo Achillis, after which the same manipulation was resorted to, and the foot soon yielded and became straight. It was impossible, however, quite to complete the reduction, as the malleolus externus could not be brought into accurate apposition with the outer side of the astragalus. It was believed that the peronei tendons had been torn from their attachments to the lower extremity of the fibula, and had become placed on the inner side of the malleolus externus, so that they intervened between the two bones, and prevented their approximation. The patient recovered the use of the foot, and left the hospital in about seven weeks. (See *Guy's Hosp. Reports*, 1855.)]

3. *Dislocation of the tibia forwards, or of the foot backwards; usually accompanied by fracture of the fibula.*—[The dislocation of the tibia forwards may be complete or incomplete. The latter is the more frequent of the two. "The accident," says Sir A. Cooper, "arises from a fall of the body backwards whilst the foot is confined, or if a person jumps from a carriage in rapid motion, with the foot pointed forwards." M. Malgaigne thinks it probable that some lateral torsion of the foot, which facilitates the fracture of the fibula, may take place at the moment of, or immediately previous to, the dislocation.]

According to Dupuytren a complete dislocation of the lower end of the tibia forwards cannot happen without the fibula being first broken, and either the base of the malleolus internus fractured, or its point torn away. The foot being thus acted upon by the extensor and flexor muscles, and unretained by the malleoli and their ligaments, yields to the powerful operation of the muscles of the calf; the astragalus passing behind the tibia, while this projects forwards under the tendons and skin of the instep. (*Dupuytren*, *Annuaire Méd. Chir.* p. 187, 4to. Paris, 1819.)

"The foot," says Sir A. Cooper, "is of course much shortened, the heel lengthened and firmly fixed, and the toes point downwards. The lower extremity of the tibia forms a hard projection upon the upper part of the middle of the tarsus, under the displaced tendons, and there is a depression beneath the tendo Achillis. Upon dissection the tibia is found to rest upon the upper surface of the os naviculare and os cuneiforme internum, quitting all the articulatory surface of the astragalus, excepting a small portion of its fore part, against which the tibia is applied. The fibula is broken about three inches above the ancle, and its fractured end advances with the tibia, and is placed by its side; but its malleolus externus remains in its natural situation. The capsular ligament is torn through in its fore part. The deltoid ligament is only partially lacerated, and the three ligaments of the fibula remain unbroken." (*Sir A. Cooper*, vol. cit. p. 177, ed. 10.)

[Sir A. Cooper is scarcely correct in his statement of the position of the lower end of the tibia, for if any portion of it rests upon the articular surface of the astragalus it is impossible that it should at the same time rest upon the internal cuneiform bone. The real position of the tibia when the dislocation is complete is *opposite* the neck of the astragalus and the navicular bone; but the foot is in such an extended position that it is only its posterior part which really *rests upon* these bones.]

Besides the complete dislocation of the tibia forwards, a partial case is sometimes met with, when one half of the articular surface of the bone rests upon the os naviculare, and the other on the astragalus. According to Sir A. Cooper, the fibula is broken, the foot appears but little shortened, nor is there any considerable projection of the heel. The foot points downwards; it cannot be put flat on the ground, and is nearly stiff, and the heel continues drawn up.

[Sir A. Cooper refers to two cases of this injury in which a dissection of the parts was made, in one by Mr. Tyrrel, in the other by Mr. Douglas of Glasgow. The fibula was fractured, but the internal malleolus was entire in both instances.

An instructive account of the dissection of an old unreduced partial dislocation has also been given by Mr. Adams of Dublin. (See *Cyclop. of Anat. and Physiol.* art. *Ancle-joint.*) In this case, in addition to the fracture of the fibula, the internal malleolus was broken, and a small portion of the back part of the edge of the articular cavity of the tibia was detached, and both malleoli were retracted and carried backwards with the foot. In another case mentioned by Mr. Adams, the internal malleolus was uninjured, as in the cases mentioned by Sir A. Cooper; but the deltoid ligament had given way. One or other of these lesions must of course happen before any considerable displacement can occur. M. Malgaigne found an oblique fracture of the tibial malleolus, with a perpendicular fracture separating the posterior half of the articular surface of the tibia, as in Mr. Adams's case.

The fracture of the fibula is noticed by nearly all writers on the subject, and is certainly found in the great majority of cases. It is not, however, constant. Mr. R. W. Smith speaks of having seen two cases of this dislocation in which it was not present. It is not stated whether in these cases it was dislocated forwards with the tibia, or whether it remained attached by the external lateral ligaments to the astragalus and os calcis. (*Dublin Quart. Journ. of Med. Science*, May, 1852, p. 471.)]

Reduction.—This case is much more difficult of reduction than the instance in which the foot is thrown inwards; and the cause is owing to the powerful manner in which the muscles resist the extension of the parts, and the placing them in their natural position again. As Dupuytren observes, it is true that such resistance may be lessened by relaxing the muscles, and drawing the patient's attention from his limb; plans which fully answer for the reduction of the dislocation inwards, yet in that now under consideration they are insufficient, and here a greater effort is required to bring the foot from behind forwards, and place the astragalus under the tibia. And a still greater difficulty is to keep the parts reduced during the time necessary for the fibula and torn ligaments to be firmly united. In fact, the upper surface of the astragalus, which is convex from behind forwards, is so slippery that it is hard to make the tibia rest securely upon the articular pulley of that bone, which is itself incessantly acted upon by the extensor muscles of the leg, so as to have a tendency to slip behind the lower end of the tibia. In addition, therefore, to the bent position, Dupuytren deems it necessary here to employ an apparatus, which propels the foot forwards, and the lower end of the tibia backwards. (*Annuaire Méd. Chir.* p. 188.)

Sir A. Cooper prefers keeping the limb upon the heel, resting upon a pillow. A splint, with a suitable pad, and a foot-piece, is to be applied to each side of the leg, care being taken to keep the foot well supported at a right angle with the leg. (*Surg. Essays*, part ii. p. 110.)

[The apparatus already recommended for the lateral dislocations is equally appropriate for the dislocation of the tibia forwards; with it the heel can be well supported and the foot maintained at a right angle with the leg, and if necessary, pressure can be made by means of pads upon the anterior surface of the lower extremity of the tibia. Care must be taken, however, that the heel is not subjected to too severe a pressure, or sloughing of the integument will be very likely to occur.

If there is much difficulty in the reduction, chloroform should be used for the purpose of obtaining more complete muscular relaxation, and if there is much difficulty in maintaining the bones in their place, subcutaneous division of the tendo Achillis may be resorted to with advantage.

M. Malgaigne has, in two cases, used the apparatus devised by him for fractures of the leg, with which pressure is made upon the projecting bone by means of a pointed instrument inserted into it through the skin. (See Fractures of the Leg.) In the first case, although this was kept applied for a period of thirty days, the tibia began to move forwards again as soon as it was removed, and the dislocation remained permanently unreduced. In the second, the restlessness of the patient obliged him to remove it after eight days, and replace it by a case of plaster of Paris. This was kept on for twenty-four days; the bones were then found in good position, and the patient rapidly recovered.

M. Malgaigne says he knows of no dislocation in which the maintenance of the reduction is more difficult than in this, and he considers the incomplete dislocation more troublesome than the complete. (*Traité des Fract. &c.* t. ii. p. 1014.)

In a case in which the dislocation had repeatedly recurred after reduction, Mr. Cock divided the tendo Achillis, after which the bones were readily restored, and retained in their normal position without difficulty. (*Guy's Hosp. Reports*, 1855.)

A dislocation of the tibia *forwards and inwards* is sometimes met with. Dupuytren, indeed, considered it to be frequent, and spoke of having witnessed forty cases. M. Malgaigne, though he believes this to be an exaggeration, thinks it probable that it has not unfrequently been mistaken for a simple dislocation inwards. He has himself observed four cases. The symptoms consist of a combination of those of the dislocation inwards with those of the dislocation forwards, with a predominance sometimes of the one and sometimes of the other. The treatment requires to be modified accordingly. The inward displacement is easily corrected; but the displacement forwards is likely to prove troublesome. (See *Malgaigne*, loc. cit. p. 1015.)]

4. *Dislocation of the tibia and fibula backwards, or of the foot forwards.*—Sir A. Cooper had no opportunity of observing a dislocation of the tibia from the astragalus backwards—a proof of the rarity of the accident.

[Mr. Adams refers to a case which was under the care of Mr. Colles of Dublin (*Cyclop. of Anat. and Physiol.* art. *Ancle-joint*, p. 162); another is related by Nélaton (*Elém. de Pathol. Chir.* t .ii. p. 447); a third by Mr. Pirrie of Aberdeen (*Principles of Surg.* p. 337); and a fourth by Mr. R. W. Smith (*Dublin Journ. of Med. Science*, May 1852, p. 465). M. Malgaigne notices another by Delamotte, *Traité de Chir.* t. ii. 1771. Where the cause is mentioned, it has always been a forced flexion of the foot upon the leg, in consequence of which the tibia slides backwards from the astragalus, and becomes placed upon the upper surface of the os calcis. Mr. R. W. Smith observes that this dislocation is necessarily incomplete, for the passage of the tibia backwards is interrupted by the tendo Achillis, and the distance between the joint and the tendon is not sufficient to allow the articular surface of the tibia to clear the astragalus. In all the cases hitherto observed the fibula has not been fractured, but has been displaced backwards with the tibia. In Mr. Smith's case, in which the accident dated from three months previously, the internal malleolus had probably suffered some injury, for it was altered in form; in that of Mr. Colles there was evidence of a fracture at the lower and posterior part of the tibia; while M. Nélaton found a fracture of the anterior border of the same bone.

The symptoms noticed by Mr. Smith, and which he considered to constitute the proofs of the nature of the injury, were:—the shortening of the leg by half an inch, the double approximation of the lower end of the tibia to the sole of the foot upon the one part, and to the anterior surface of the tendo Achillis upon the other; the effacing of the curve of that tendon and of the prominence of the heel; the elongation of the anterior part of the dorsum of the foot; the exposure to the touch of the front of the upper surface of the astragalus, and the evidence of pressure upon the posterior tibial artery and nerve, derived from the coldness and numbness of the foot. That the injury which the fibula had sustained was a dislocation and not a fracture, was apparent from the approximation of the external malleolus to the posterior extremity of the os calcis. In this case the reduction had been attempted shortly after the accident by powerful extension, but without success. In the cases observed by Mr. Colles, Mr. Pirrie, and M. Nélaton, the dislocation was also of some months' standing before they were consulted; and it was too late to attempt to alter the position of the parts. In all, permanent and serious lameness was the result.

Reduction.—The most appropriate treatment would appear to be:—first, to flex the knee-joint, in order to relax the muscles, then to make extension upon the foot, and to endeavour to move it backwards into its place under the tibia. Should this prove successful, the reduction might be maintained by placing the limb in a M'Intyre's apparatus, but with the *heel and tendo Achillis unsupported*, for if the limb were allowed to rest upon these parts, the foot would probably again become displaced forwards from under the tibia.]

5. [*Dislocation of the astragalus upwards between the tibia and fibula.*—This, which is a very rare accident, has been described by M. Nélaton as a dislocation of the foot upwards. It might, as he observes, be also considered as a variety of the dislocation of the tibia inwards, in which the fibula, instead of being fractured, is separated from the lower extremity of the tibia, in such a manner as to allow the astragalus to ascend between the two bones of the leg. This, however, is not consistent with a statement made by him previously, to the effect that dislocation of the astragalus upwards necessitates a *fracture* of the fibula as well as a separation of that bone from the tibia. The foot, he states, does not deviate from its natural position; the astragalus, seized between the tibia and fibula, cannot be moved in any direction; the inter-malleolar space is considerably enlarged; the prominences formed by the malleoli descend towards the sole of the foot and nearly touch the ground. (See *Elém. de Pathol. Chir.* t. ii. p. 474.)

Such a case as this might be distinguished from a complete dislocation of the tibia inwards, with fracture of the fibula and ascent of the foot on the outer side, by observing that *both* malleoli are approximated to the sole of the foot, and that there is no deformity of the fibula indicating the seat of fracture. If the fibula were fractured, the external malleolus would ascend with the foot, the external lateral ligaments remaining entire, although those connecting the tibia with the fibula would be torn. The descent of the external malleolus is evidence that the fibula is not fractured, but that the external lateral ligaments, as well as the tibio-fibular ligaments, have given way.

Mr. Fergusson has recorded the following case, which appears to be a genuine example of the accident under consideration, without fracture of either bone. The mode in which the injury was occasioned is not satisfactorily explained. The patient, a young man, æt. 23, had met with a severe injury at the ancle, during a scuffle, and after he had fallen it was supposed that some one had trampled upon the injured part. The foot was twisted outwards, so that the toes were directly out from the malleolus externus. The malleolus internus could be felt as distinctly under the skin, which was here on the stretch, as if on the skeleton, and so also could be the anterior margin of the articular surface of the tibia. The outer malleolus could be distinctly felt, but somewhat lower on the foot than natural, and the distance between it and the internal malleolus was remarkable. The astragalus could not be very distinctly made out; but it seemed as if jammed between the ends of the two long bones. On extension being made, under chloroform, reduction was very easily effected, and during, as also after the process, Mr. Fergusson was satisfied that the principal feature of the injury was a luxation of the foot upwards, between the two bones of the leg. The ligaments which bind these bones together had given way, and allowed the astragalus to slip between. There was *no fracture that could be perceived*. A bandage was applied, and then a common side splint was put on.

There did not appear the least tendency in the foot to slip upwards again, and a very speedy recovery ensued. (See *Practical Surgery*, p. 368, 3rd ed. 1852.)

In the museum of St. Mary's Hospital is the cast of an ancle-joint in which the injury is considered to have been of this nature. The accident took place five years before the cast was taken, and the dislocation remained unreduced. No further particulars are stated. The foot is in its natural position; but the malleoli are widely separated, and both are approximated to the sole of the foot. There is no angular inclination inwards of the fibula which would lead to the supposition of a fracture. In this case the position of the foot accords with M. Nélaton's description; but in that observed by Mr. Fergusson it was pointed outwards.]

Compound dislocations of the ancle-joint.—[Dislocations of the ancle-joint are more frequently compound than those of any other joint in the body. The wound leading to the joint may be caused by the force which produces the dislocation, or, what is far more frequent, the laceration of the skin is caused by the bones themselves. It is almost invariably the bones of the leg, and not those of the foot, which produce the laceration, and which make their appearance externally when protrusion takes place. Thus, — in the dislocation of the tibia inwards, the wound is almost always on the inner side, and the internal malleolus, or, if this has been broken off, the lower end of the tibia projects;— in the dislocation of the bones of the leg outwards, the wound is on the outer side, and the external malleolus, or if the fibula has been fractured, the lower end of the upper fragment, is protruded, often accompanied by the lower end of the tibia also;—in the dislocation forwards, the tibia escapes through a wound on the fore part of the ancle. All the cases hitherto observed of dislocation backwards have been simple dislocations. The dislocation of the bones of the leg outwards appears to be compound in a larger proportion of cases than either of the other forms of dislocation.

The treatment of these cases, and the question of resection of the bones, and of amputation, has been fully discussed in the section of this article relating to compound dislocations; the greater part of which refers to compound dislocations of the ancle.]

Dislocations of the Astragalus.

A luxation of the astragalus, either simple or complicated with a laceration of the integuments, as Mr. Hey has remarked, is an accident which does not often occur. Above, the astragalus is articulated with the tibia and fibula, to which it is united by powerful ligaments; below it is united, by means of a capsular and strong interosseous ligament, to the os calcis; while in front, it is connected to the os naviculare by a capsular and broad internal lateral ligament. Thus situated it is evident that its displacement is not likely to happen with great frequency; yet this observation must be received only as a comparative one; for the cases of dislocation of the astragalus now on record are rather numerous.

[The dislocations of the astragalus have of late years received a considerable share of attention. Mr. Turner of Manchester, has published a memoir, founded on a collection of fifty cases. (See *Trans. of Prov. Med. and Surg. Association*, 1843.) Another was published by M. Broca in 1852, containing an analysis of as many as 130 cases. (See *Mém. de la Société de Chir.* t. iii. 1853.) The subject has also been investigated by MM. Hancock, Nélaton, Malgaigne, and others.

From these data it appears, that dislocations of the astragalus occur in a variety of ways. They may be divided in the first place into two principal classes; those in which the astragalus is displaced from the os calcis and scaphoid bone, the ancle-joint being unaffected; and those in which it is dislocated not only from these bones, but from the tibia and fibula also.

The first has been described as an *incomplete*, and the second as a *complete* dislocation; the one has also been called the *sub-astragaloid* (Broca), and the other the *double* dislocation, which name was first applied to it by Boyer. The latter nomenclature has been adopted by M. Malgaigne. In the description of both the sub-astragaloid, and the complete or double dislocation, further subdivision becomes necessary, according to the direction in which the bone is displaced.

Sub-astragaloid dislocations; or dislocations of the astragalus from the os calcis and scaphoid bone.

These may take place in four different directions, forwards, inwards, outwards, and backwards. They are frequently complete as regards the astragalo-scaphoid, but incomplete as regards the calcaneo-astragaloid articulation; that is, the head of the astragalus is completely removed from the cavity of the scaphoid, but the astragalus still remains partially supported by the os calcis. A partial displacement, however, of the head of the astragalus from the scaphoid may occur separately, without any, or with very slight, movement of the astragalus on the os calcis; and this kind of sub-luxation may be considered as the first stage of the sub-astragaloid dislocation. Cases have been noticed by Boyer, Richerand, Roux, and others. The following instance, recorded by Mr. Adams, of the London Hospital, is a good example of the injury. A heavy bag of rice had fallen on the outside of the patient's ancle, and had driven the head of the astragalus inwards, and slightly upwards from its connection with the navicular bone. The foot presented very slight apparent deformity, being merely thrust a little outwards, without any eversion of the sole. The head of the astragalus formed an unnatural projection on the inside of the tarsus, and a considerable depression beneath was very apparent. There was no fracture of the fibula. The reduction was easily accomplished. The knee being flexed upon the thigh, the foot was forcibly drawn inwards, while the head of the astragalus was pushed downwards and outwards, and it passed at once into its natural position. A leg splint, with a foot-piece, was placed outside the limb, and to this the foot was bandaged —a compress being placed over the head of the astragalus. Mr. Adams also mentions a case of dislocation of the head of the astragalus upwards and *outwards*, the preparation of which is in the museum of the London Hospital. (*Lancet*, vol. i. 1847, p. 183.) M. Malgaigne thinks the head of the astragalus may sometimes be completely dislocated from the scaphoid without any notable displacement upon the os calcis, although of course the calcaneo-astragaloid ligaments must be wholly or partially torn.]

1. [*Dislocation of the astragalus forwards from the os calcis and scaphoid bone.*—In this case the head of the astragalus completely leaves the cavity of the scaphoid bone, and is thrown forwards on to the upper surface of the scaphoid and cuneiform bones. The body of the astragalus is thrown more or less forwards also upon the os calcis; sometimes its posterior sharp edge rests in the groove which separates the two articular surfaces of that bone, and this circumstance Dupuytren thought might be the cause of the difficulty often met with in the reduction. The ancle-joint is uninjured. The head of the astragalus forms a striking prominence on the dorsum of the foot. The malleoli are carried forwards with the astragalus, and the heel, therefore, appears lengthened, while the anterior part of the foot is in a corresponding degree shorter than natural. The lengthening of the heel, M. Malgaigne observes, will distinguish this case from the sub-luxation of the astragalus on the scaphoid, which has been mentioned above, and by the degree of this elongation the extent to which the astragalus has been carried forwards upon the os calcis may be estimated. The head of the astragalus, instead of being thrown directly forwards, may pass in an oblique direction outwards or inwards, its head and neck in the one case resting on the cuboid bone, and in the other upon the inner part of the scaphoid. The cause of the dislocation forwards is usually a fall upon the anterior part of the foot while it is in the extended position, or a fall backwards while the anterior part of the foot is fixed. If the foot at the moment of the accident is abducted or adducted as well as extended, the disocation may take the oblique direction inwards or outwards which has just been alluded to.

A dislocation of the astragalus forwards occurred in the person of Mr. Carmichael of Dublin, and was caused by his horse falling with him, and throwing him with great violence on the anterior part of the right foot. The following symptoms were observed and recorded by Dr. Macdonnell, and afford a good exemplification of the appearances produced by the injury. The toes were turned outwards, the inner edge of the foot forming an angle of about thirty degrees with its natural direction; the sole was slightly turned outwards, and the outer edge slightly elevated. The concavity of the tendo Achillis posteriorly was increased, and the heel lengthened. On grasping the soft parts between the tendo Achillis and the tibia, the distance between them was found to be much greater than in the other leg. The absence of the hard projection, which would have been formed by the upper part of the astragalus, had it passed backwards with the rest of the tarsus, was evident. Each malleolus was perfectly defined, below and before the inner there was a hard prominence, over which the skin was tense, formed by the inner surface of the astragalus, brought into relief by the dislocation and the slight eversion of the sole of the foot. The most striking feature of the deformity consisted in a prominence on the dorsum of the foot. Immediately in front of the tibia this prominence presented a flat surface, broad, from the tibia forwards, about a finger's breadth, from which there was an abrupt descent to the anterior part of the tarsus. Over this projection, caused by the head of the astragalus thrown upon the upper surface of the scaphoid and cuneiform bones, the integuments were so tense, that it was evident a very small additional force would have driven the astragalus through them. Lastly, on taking the distance from the point of the internal malleolus to the extremity of the great toe, it was found to be almost an inch less than the distance between the same points in the other foot. The foot could be flexed and extended, but any movement occasioned severe pain. (*Lancet*, vol. i. 1847, p. 222.)]

Reduction. — In some cases of this description the reduction has been found to be impracticable. Desault believed the impediment to depend upon the head of the bone being constricted in the narrow opening of the capsule; and an example is recorded by him of the *complete* or double dislocation in which the reduction was accomplished by dividing the skin, and then extending the incision through a part of the ligaments. He, therefore, recommended a similar practice in the partial dislocation also. However, in his *Journ. de Chir.* a case is related of simple dislocation of the astragalus from the os calcis and os naviculare, where the reduction was easily performed by common means. Boyer thought the difficulty arose rather from the impossibility of making the extending force and the pressure of the surgeon's hand operate with much effect upon the displaced bone, and that the luxated astragalus may be so wedged between the tibia, os calcis, and os naviculare, that its reduction is impossible, as Boyer has actually seen. In the case here referred to things were left to take their course, except that every possible means was employed to keep off inflammation. The result was, that the skin covering the projection of the astragalus at the inner and upper part of the foot sloughed, and amputation was at length deemed necessary. (*Mal. Chir.* t. iv. p. 400.) A similar example is recorded by Sir A. Cooper. (*On Dislocations*, p. 360.) In another case, pressure was made with a tight bandage on the prominence of the astragalus, and the soft parts over it became gangrenous, yet a recovery followed without amputation, all the projecting portion of the astragalus having gradually come away in fragments. (*Hey's Pract. Obs.* p. 384. 2nd ed.)

[Another cause of difficulty which has been suggested is the slipping of the head of the astragalus between the tendons, by which its neck may then be constricted. Thus, when the head passes obliquely forwards and inwards, it may become engaged between, and be firmly held by, the tendons of the tibialis anticus and posticus.

M. Malgaigne suggests, that as it is very difficult to know in the first instance what the obstacle may be, it is better first to try simple pressure, without extension, the thumbs being placed on the head of the astragalus and the fingers crossed under the heel, the leg being flexed to the utmost upon the thigh. Should this not succeed stronger measures may then be adopted. (*Traité des Fract.* t. ii. p. 1035.)

In Mr. Carmichael's case, Drs. Hutton and Macdonnell, after flexing the leg strongly on the thigh, and making extension and counter-extension at the foot and knee, endeavoured to press the heel forward, and the astragalus and tibia backward, while the toes were drawn inward, and the outer edge of the foot somewhat depressed. This not having the slightest effect, more powerful extension with the pulleys was resorted to. For this purpose a strap, on the part of which corresponding to the sole was a pad with an iron ring firmly attached to it, was buckled round the foot, immediately in front of the astragalus; and a piece of girth web was then placed on the heel, with its ends crossed on the dorsum of the foot, and made fast to the ring, to which latter the pulleys were attached. The counter-extension was made from the lower part of the thigh, the knee-joint being kept strongly flexed. Gradual and continued extension was kept up for about ten minutes, and while Messrs. Hutton and Macdonnell were engaged in the guidance of the bones, in the manner above mentioned, Mr. Carmichael himself made a sudden and violent effort, and the bone slipped into its place. A rapid recovery took place, and in little more than a month after the accident he was able to stand upon the injured foot without pain. (See *Dublin Journal of Med.* Nov. 1838, p. 235.)

In the simple dislocation means such as the above will in the majority of cases, with the assistance of chloroform, accomplish the reduction; should they not suffice, subcutaneous section of the tendo Achillis should be practised, and any other tendon (the tibialis anticus, for instance,) which seemed to interfere with the return of the bone to its place, might also be divided. If, notwithstanding all this, the bone is still irreducible, nothing further should be done, but the parts should be left to themselves, and in all probability the patient will recover a very useful limb, though of course the deformity will remain. Certainly, no attempt should be made *in the first instance, and in a simple dislocation*, to remove the dislocated bone. It may be, that the skin will slough, and the bone protrude, and a part or the whole of it may then be removed without adding to the mischief, and with much less risk than would be incurred by at once making incisions and converting a simple into a compound dislocation. Cases have been already referred to in which the bone protruded, and was allowed to separate spontaneously.

If the dislocation is *originally compound*, however, the case is different, though here also the reduction should be attempted in the first instance, on the same principles as in the simple dislocation, and the wound in the skin may be enlarged, and the tendons divided if it appears to be necessary. The compound, however, is much more frequently irreducible than the simple dislocation. In seventeen cases of sub-astragaloid dislocation, says M. Broca, reduction was only possible in five. In the irreducible cases, the removal of the astragalus should be immediately practised, and the foot should be at once adjusted as well as may be to the articular extremities of the tibia and fibula. In some cases it will be sufficient only to saw off the projecting portion of the bone, and to leave the remainder, but when the entire bone or the greater part of it protrudes through the skin, and when it is much loosened from its surrounding connections, it is better to take away the whole.

Some authorities recommend the removal of the bone, even when not irreducible, if it has been much separated from the surrounding parts, fearing that the loss of vascular supply would occasion its necrosis. It must be remembered that the astragalus is peculiarly circumstanced in this respect, by far the greater part of its surface being articular, and a very small portion, comparatively with other bones, being available for the entrance of blood vessels. On this point M. Malgaigne observes, that the question of reduction in compound dislocation of the astragalus depends entirely, in his opinion, upon the connections which the bone has preserved with the surrounding parts; and it is important to remember that the portion of the bone forming the ancle-joint contributes nothing to its nutrition, the elements of which reach it chiefly by its inferior surface. When, therefore, the astragalus has escaped entirely by the wound, even though it may have preserved its connections with the tibia and fibula, the reduction would be followed by an almost certain necrosis. He refers to eight cases of reduction, of which three were fatal, and one was followed by a caries, probably incurable. (*Traité des Fract. &c.*, t. ii. p. 1065.)

Taking into consideration the severity of the injury, the results of excision of the astragalus are very satisfactory. According to Mr. Turner's tables, in eighteen cases in which the whole bone was taken away, a useful foot was obtained in thirteen; in one there was ankylosis, and the remaining four died. In six cases of partial excision, there remained a useful foot in three; ankylosis in one, more or less lameness and deformity in the other two. A movable joint, therefore, appears to be the rule, and ankylosis the exception.

The remarks here made respecting the treatment of compound dislocations, are applicable to the lateral dislocations, as well as to that specially under consideration.]

2. [*Dislocation of the astragalus inwards from the os calcis and scaphoid bone.*—M. Malgaigne refers to as many as ten cases of this kind of dislocation of the astragalus, of which four were *simple* and six were *compound*. They may be caused by a fall on the heel, the foot being in a position of abduction, or by direct violence operating against the outer side of the leg. The astragalus with the tibia and fibula is carried inwards, sometimes directly, sometimes slightly forwards or backwards at the same time. In several cases the fibula has been fractured a little above the ancle-joint. The appearances are explained by the following case, which was observed by Mr. H. Cline, in St. Thomas's Hospital, in 1815. Some heavy stones had fallen on the patient, and had caused a compound fracture of the left leg, and a dislocation of the right astragalus from the other bones of the tarsus. The whole foot was somewhat displaced outwards; the os calcis projected much beyond the outer ancle, the prominence of which was nearly lost; there was a remarkable depression below the outer ancle, between it and the displaced os calcis; whilst there was an equally remarkable projection below the inner ancle, produced by the dislocated astragalus. It thus appeared that the astragalus was dislocated inwards from the navicular bone and os calcis, so as to have its inferior articulatory surfaces resting on the inner edge of the os calcis. (See *Sir A. Cooper*, *On Dislocations*, p. 329, ed. by *B. Cooper*, 1842.) In former editions of Sir A. Cooper's work, the prominence of the heel is said to have been diminished in this case; if so the astragalus must have been displaced slightly backwards as well as inwards. In another case, carefully recorded by Mr. Hancock, the fibula was fractured three inches above the ancle: the axis of the tibia, instead of falling in the centre of the foot, was thrown inwards and slightly for-

wards. The position and direction of the foot were not materially altered, further than by its projecting considerably on its outer side, and the toes turning slightly outwards, but its dorsum looked upwards, as in the natural condition. On the outer side of the foot, the anterior extremity of the os calcis, where it unites with the cuboid bone, could be very distinctly felt, whilst above there was a considerable cavity, instead of the prominence formed by the astragalus and external malleolus. By pressing with the fingers on the dorsum of the foot, a cavity could likewise be distinguished behind the posterior margin of the scaphoid bone. On the inner side of the foot was a prominence corresponding to the internal malleolus, of which the inferior margin could be distinctly defined, and anteriorly and inferiorly another projection more prominent, evidently caused by the head of the astragalus, over which the skin was tense, thin, and vesicated. (See *Lancet*, Oct. 1844. p. 36.)

A dislocation of the astragalus inwards was dissected by M. Nélaton, and a representation of it is given by M. Malgaigne. (See pl. xxx. fig. 3.) The foot was displaced outwards, without eversion of the sole, the astragalus was carried inwards and a little forwards, so that its head rested upon the inner surface of the scaphoid. The groove of the neck of the astragalus received the edge of the cavity of the scaphoid; and the posterior angle of the astragalus was engaged in the groove which separates the two articular surfaces of the calcaneum. There was rupture of that part of the internal lateral ligament which passes from the astragalus to the os calcis, of the interosseous ligament, and of the astragalo-scaphoid ligament. The external lateral ligament was entire, but the posterior and external part of the malleolus was torn off, which is equivalent to a rupture of the ligament.

Reduction.—In Mr. Cline's case the dislocation was reduced by fixing the knee, having the thigh bent at a right angle with the body. Extension was then made, by taking hold of the metatarsus and protuberance of the os calcis, and drawing the foot gently and directly from the leg. During the extension, Mr Cline put his knee against the outside of the joint, and the patient's foot being pressed against it, the os calcis and navicular bones slipped into their place, carrying with them the rest of the foot, and the deformity disappeared.

In Mr. Hancock's case the difficulty was much greater. Pressure with the knee against the outer edge of the foot was first tried, and then extension was made with the pulleys, but equally without success. Six days afterwards, an apparatus having been constructed for the purpose of holding the foot firmly during the extension, the pulleys were again applied, and traction was kept up for an hour and a quarter, but no effect was produced till arrangements were made to draw the foot *forwards* and to press the tibia backwards, when the bone immediately returned into its place. In this case the integuments over the point of pressure, and the internal calcaneo-scaphoid ligament sloughed, and allowed the head of the bone to protrude, it was therefore sawn away, to the extent of about three-quarters of an inch. This patient recovered perfectly, and after a time was able to walk as well as before the accident happened. (See *Lancet*, Oct. 5, 1844, p. 35.)

The question of treatment in cases of compound dislocation has already been discussed in speaking of the dislocation forwards.]

3. [*Dislocation of the astragalus outwards from the os calcis and scaphoid bone.* — This appears to be less frequent than the displacement already described, for M. Malgaigne could only discover four well authenticated examples; two of which were observed by himself. In three the cause was a fall on the external border of the foot; in the fourth a cart had fallen upon the leg. In all four the tibia and fibula were uninjured. He thus describes the symptoms:—The foot is inverted, its internal border raised, the sole looking inwards, the point turned towards the same side. The head of the astragalus causes a prominence upwards and outwards upon the cuboid, but the body of the bone is also carried outwards with the malleolus externus, and beneath is a depression which testifies to the displacement of the calcaneum inwards. On the inner side, on the contrary, the tibial malleolus is so deeply placed that it can scarcely be felt; beneath it is an elongated projection, caused by the internal border of the os calcis, of which the lesser process can be distinctly felt, and the ancle is widened in consequence. More forward the prominence of the scaphoid can be felt, nearer to the os calcis than natural, which explains the inclination of the foot inwards.

In the two cases seen by M. Malgaigne the dislocation was simple; in both the astragalus was displaced somewhat forwards as well as outwards. In the other two cases, seen by M. Letenneur, the dislocation was compound: in one the head of the astragalus corresponded to the external border of the foot, and protruded entirely through the wound, while posteriorly a portion of its large articular facette could be seen projecting more than an inch beyond the corresponding surface of the os calcis; in the other the head was less prominent, its internal portion being still covered by the integuments, but posteriorly the large articular surface had completely quitted the os calcis. The projection of the *body* of the astragalus outwards would distinguish this case from that in which the bone is dislocated forwards, but with its *head* directed obliquely outwards.

Reduction.—One of the cases under M. Malgaigne was not seen by him till two months after the accident, the dislocation was, therefore, suffered to remain unreduced. The other was reduced by the *internes* of the Hôpital St. Louis in the following manner, twenty-four hours after the accident, with the aid of chloroform. One held the inferior part of the leg, while another made extension by placing one hand on the heel and the other on the front of the foot; a third then made pressure with his thumbs upon the head of the astragalus to push that bone inwards, backwards, and downwards, raising at the same time the outer border of the foot and carrying its point outwards; at the first attempt the bone returned with a snap into its place.

In the two cases of compound dislocation under M. Letenneur, reduction was found impracticable, and the astragalus was therefore removed. (See *Malgaigne, Traité des Fract.* t. ii. p. 1045. *Letenneur Rev. Med. Chir.* 1854, t. xii. p. 19.)]

4. [*Dislocation of the astragalus backwards from the os calcis and scaphoid bone.*—M. Malgaigne

only mentions one case of this displacement, observed by M. Parise. The accident was caused by forced flexion of the foot upon the leg. In consequence of the swelling the nature of the accident was not recognised, and reduction was not attempted. Nine months afterwards the following was the condition of the parts:—The foot was bent to a right angle on the leg, its point a little turned inwards, its internal border slightly depressed. The anterior part of the foot was lengthened, the bones of the leg having passed backwards with the astragalus, so that the external malleolus nearly touched the tendo Achillis. By pressing on the instep the extensor tendons were felt to be tense; on the outer side was an osseous prominence, which appeared to be the head of the astragalus, and immediately in front of it a deep depression. Posteriorly the prominence of the heel was completely effaced, and the leg flattened; the posterior surface of the leg was interrupted at the level of, and a little beneath the malleoli, by an osseous projection, which raised the tendo Achillis and overlapped the os calcis posteriorly by nearly half an inch. Above this projection was another, less prominently marked, formed by the posterior border of the articular surface of the tibia. There was no trace of fracture or separation of the malleoli. The leg was shortened about a quarter of an inch. The toes were much flexed, the great toe in both phalanges, the four other toes in the two last phalanges only, the first phalanges being, on the contrary, raised at an angle upon the metatarsal bones, indicating thus the elongation which both flexor and extensor tendons had undergone. (See *Malgaigne, Traité des Fract.* t. ii. p. 1047, and *Parise, Annales de la Chir.* 1845, t. xiv. p. 467.)]

[*Double or complete dislocations of the astragalus.*

In these cases the astragalus is displaced from *all* its articular connections; from the tibia and fibula, as well as from the scaphoid and os calcis. These, like the sub-astragaloid dislocations, may take place in various directions, and it is necessary, as in those cases, to speak of a dislocation forwards, inwards, outwards, and backwards, with the addition of two others; viz. a *rotatory* dislocation (*luxation par rotation sur place—Malgaigne*), in which the bone remains between the tibia and os calcis, but undergoes a movement of rotation, more or less extensive, on its vertical axis; and a dislocation "*par renversement,*" in which the bone may become turned completely upside down.]

[1. *Double or complete dislocation of the astragalus forwards.* — In this case the astragalus is thrown forwards from between the tibia and os calcis, and rests upon the upper surface of the tarsus. This kind of displacement has been repeatedly observed. The astragalus may pass directly forwards, or obliquely forwards and outwards, or forwards and inwards. M. Malgaigne mentions as many as twenty-six examples; in seven of these the dislocation was directly forwards, in fifteen forwards and outwards, and in four forwards and inwards. Of the twenty-six, nine were simple, and seventeen were compound dislocations. The *degree* of displacement varies somewhat; the astragalus may be thrown completely forwards from between the tibia and the calcaneum, or its posterior portion may still be engaged between these bones, to a greater or less extent. Forced extension of the foot appears to be the most frequent cause of the dislocation of the astragalus forwards, and if the extension is combined with inversion or eversion of the foot, the dislocation takes an oblique direction outwards or inwards. Extension of the foot, it will be observed, is the common cause, of the dislocation of the tibia forwards at the ancle-joint, of the sub-astragaloid dislocation forwards, and of the double dislocation now under consideration; but there is, no doubt, some difference in the degree, and in the mode of operation of the dislocating force, not easily to be explained or appreciated, which determines the nature of the displacement in each case.

A case of complete simple dislocation forwards, under the care of Mr. Gaskell, in the Manchester Infirmary, is mentioned in Mr. Turner's essay. The accident occurred in a middle aged man, in consequence of a fall from a considerable height. The astragalus was dislocated forwards, and lay under the integuments and tendons of the foot. The dislocation was apparently perfect, many of the projecting points and surfaces of the astragalus being perceptible through the skin. The bone was reduced after persevering for some time in drawing down and flexing the foot, and also in making pressure upon the astragalus. It passed into its place suddenly, and with an audible snap; the patient in three weeks was able to walk, and ultimately recovered the perfect use of his limb. (*Turner*, *Transact. of the Prov. Med. and Surg. Association*, 1843, p. 403.) It was in a case of this nature that Desault, failing to obtain reduction by other means, divided the skin, and enlarged the opening in the capsular ligament of the head of the astragalus, after which he was able to return the bone into its place. Suppuration, necrosis, and the separation of several fragments of the bone took place, and the patient did not recover for eighteen months. The double dislocation of the astragalus forwards would be distinguished from a sub-astragaloid dislocation in the same direction by the trochlear surface of the astragalus being felt under the skin, or if the swelling prevented this point being clearly made out, by observing that the distance between the tibia and the tendo Achillis is not increased.

A case of complete simple dislocation *forwards and outwards* is recorded by Desault, and another by Dupuytren. Two others are related by Mr. Guthrie. The bones of the leg were entire in the two first cases, but in the two latter the fibula was fractured. When the displacement takes this direction, the head of the astragalus is directed towards the outer border of the foot, and rests upon the cuboid and external cuneiform bones. The foot is adducted, and the sole is directed inwards; the point of the foot also is turned inwards and the heel outwards; the inner border of the foot is shortened by the approximation of the scaphoid bone to the calcaneum.

In Desault's and Dupuytren's cases the reduction was accomplished. Those related by Mr. Guthrie were not seen by him till some time after the accident, they therefore remained unreduced, but the lameness was greatly relieved by an apparatus for supporting the foot, which Mr. Guthrie devised for the purpose. (See *Hancock*, *Lancet*, Oct. 12th, 1844, p. 71.)

When the astragalus is dislocated obliquely *forwards and inwards*, the sole of the foot is directed outwards, and the outer edge of the foot is raised. In three cases of compound dislocation in this direction, mentioned by Malgaigne, the head of the astragalus was directed considerably downwards towards the sole of the foot.

An account of the dissection of an old unreduced dislocation of this kind has been given by Dr. J. Neill of Pennsylvania. The position of the foot in this case was different from that usually noticed when the astragalus has passed obliquely forwards and inwards, for it was much inverted, and presented the appearance of a case of talipes varus. A small portion of the posterior border of the astragalus had been detached by fracture from the rest of the bone, and the tibia had been forced between the fragments and widely separated them. The larger fragment was pushed forwards, and its anterior extremity turned inwards; in this position it was ankylosed to the os calcis. The smaller fragment was pushed backwards and remained movable. The tendon of the flexor longus pollicis still played in this smaller fragment. The articular surface of the tibia rested upon the upper surface of the os calcis, where there was some attempt at the formation of a joint. (*Amer. Journ. of Med. Science*, July, 1849, p. 119.)

The reduction should be conducted on much the same principle as in the sub-astragaloid dislocation. Extension should be made upon the foot, and counter-extension upon the leg, the knee being flexed to relax the muscles of the calf of the leg. The surgeon should then make direct pressure upon the prominent astragalus, to push it backwards, if possible, into its place. If necessary the tendo Achillis may be divided, and so also may any other tendons which appear to interfere with the replacement of the bone. Success may fairly be anticipated when the astragalus still remains partially engaged between the tibia and os calcis, but it is less likely to be attained when it has been thrown completely forwards on to the dorsum of the foot, and the tibia has descended behind it on to the os calcis. In a case of *simple* dislocation, when reduction cannot be obtained, nothing further should be done. In some cases the bone will adapt itself to its new position, and a tolerably useful foot will ultimately be obtained; in others, and what is more probable, the integuments will slough over the dislocated bone, and its removal, in whole or in part, will become necessary. In a case of *compound* dislocation, the astragalus should, as a general rule, be replaced if possible, and the wound closed; if, however, this cannot be accomplished, it will be better to dissect away the bone at once, rather than leave it protruding through the wound. There may be cases also in which, though the bone can be reduced, it has been so much separated from its attachments that it would be useless to return it; and if this is sometimes the case, as M. Malgaigne thinks, in the sub-astragaloid dislocation, *à fortiori* it is so when the bone has been separated from all its articular attachments.

In those cases of compound dislocation in which there is a fracture separating the head and neck from the body of the astragalus, and the body alone is dislocated, it seems especially advisable to remove it; it is isolated almost completely from its sources of vascular supply, and its necrosis is nearly certain to take place if it be allowed to remain. On several occasions where it has been returned its subsequent removal has become necessary, and the sufferings of the patient have been much increased, and the treatment prolonged in consequence.

In the museum of St. Mary's Hospital is a wax model of the body of an astragalus, removed by Dr. R. Hall of Torquay. The case was one of compound dislocation, and this portion of the bone could be felt loose through a wound on the dorsum of the foot. The head and neck of the bone were left in their natural position. The case did remarkably well, and the patient was able to walk almost as well as if no accident had happened.]

2. [*Double or complete dislocation of the astragalus inwards.*—M. Malgaigne refers to sixteen examples of this accident; of which six were simple, and the remaining ten were compound dislocations. The usual cause is a fall, in which the foot is violently twisted outwards, or the eversion may be combined with direct pressure, as when a horse falls on his side with the leg and foot of the rider against the ground.

M. L. Boyer met with a good example of this form of dislocation, and has carefully recorded the symptoms. The foot was carried outwards, so that its axis was placed external to the axis of the leg by about an inch and a quarter, but it was not everted. The os calcis, thus carried outwards, obscured the malleolus externus; underneath this latter was a deep gap, into which the integuments could be pushed. Internally the internal malleolus was prominent; underneath it could be felt a large osseous surface, raising the skin, and easily recognisable as the trochlear surface of the astragalus turned inwards. More anteriorly were felt the head and neck of the astragalus. The summit of the malleolus internus rested upon the external surface of the astragalus, now become superior. There was no fracture, and the tibia retained its connections with the fibula. In two other instances of simple dislocation the astragalus was turned in the same way as in the case just related; that is, with its superior surface looking inwards, and its external surface upwards; but in a case of which Sir A. Cooper has given a drawing, and in another which was observed by M. Malgaigne, this was not the case, the astragalus having been displaced directly inwards without undergoing inversion. In Sir A. Cooper's case the head of the astragalus was completely dislocated from the scaphoid, but the body was not completely removed from between the tibia and calcaneum. In M. Malgaigne's the dislocation of the astragalus was *incomplete* as regards all its articulations; the head was only slightly prominent inwards, and the internal border only of the trochlea projected. The projection formed by this latter was obscured by the malleolus internus, which was separated from the tibia by an oblique fracture, and carried inwards.

M. Boyer's case is the only one in which the reduction was effected. Chloroform having been administered, the limb was placed on its outer side with the leg semi-flexed. Two assistants then made counter-extension from the thigh, while two others made extension from the heel and fore-part of the foot, and the surgeon pressed the astragalus outwards with his thumbs. After several attempts the bone passed under the tibia, but still retained its inverted position. Finding this, M. Boyer, at the moment when the extension was greatest, pressed against the foot with his knee, so as to bring it into a position of forced adduction, and at the same time pressed with his thumbs strongly against the upper border of the displaced bone; the astragalus turned round, and slipped into its place with an audible noise. This patient recovered perfectly.

In three of the other instances of simple dislocation, in which the reduction could not be effected, the skin covering the prominent astragalus sloughed, and the bone was subsequently extracted and the patients recovered. In one, under M. Malgaigne, an eschar formed, but the patient died shortly after its separation, and without the bone having been extracted. In another, under M. Robert, the bone was exposed by a crucial incision, and removed five days after the accident, without waiting for the formation of a slough.

In the cases of compound dislocation inwards the neck of the astragalus has several times been found fractured. The bone has also sometimes been seen turned half round in the direction mentioned in M. Boyer's case. Once it was turned in the opposite direction, that is, its lower surface was turned inwards, towards the wound.

The treatment to be adopted in compound dislocation has already been sufficiently explained.]

3. [*Double or complete dislocation of the astragalus outwards.*— This is much less common than either of the preceding. M. Malgaigne refers to five recorded cases only; one of these was simple, the other four were compound dislocations. The case of simple dislocation outwards is recorded by Dupuytren. Forced inversion of the foot appears to have been the cause, for the patient, in going down stairs, caught his left foot in the bannister, while the weight of the body drew the leg in the opposite direction. The foot was strongly adducted, the sole looking inwards; the external malleolus was prominent externally, beneath it was felt another unequal, angular projection, continuous with a rounded prominence in front. The malleolus internus was depressed and could not be felt; the tibia and fibula were uninjured.

From this description it would appear that the astragalus was only partially disengaged from between the bones of the leg and the calcaneum, and the external malleolus must have rested upon its upper surface. Dupuytren attempted the reduction, and believed he had succeeded, but the following day the astragalus was again found projecting, and he attempted to press it inwards by means of compresses. An eschar formed, however, and compelled him to discontinue this treatment, and to confine himself to maintaining the foot in as good a position as possible. Two months afterwards the patient had a tolerably good use of his limb.

In three of the other cases the astragalus protruded through a wound beneath the external malleolus, and was turned half round, so as to present its trochlear surface outwards. In two of these the fibula was broken, in the other it was uninjured. In all three the astragalus was removed, twice because it was found impossible to reduce it, once because it was already almost completely detached, and it would have been useless to return it. (See *Malgaigne*, *Traité des Fract. &c.* t. ii. p. 1057.)

In another case, recorded by Dr. Norris of Pennsylvania, the astragalus was completely expelled through a wound on the outer side of the ancle, and was picked up from the ground. This patient died of tetanus. (See *Amer. Journ. of Med. Science*, Aug. 1837, p. 383.)]

4. *Double or complete dislocation of the astragalus backwards.* — Until Mr. B. Phillips recorded two instances of complete dislocation of the astragalus backwards, no account of such a displacement had been published. One case happened in a gentleman who threw himself from a carriage in consequence of the horses becoming unmanageable, and he alighted on his feet, but immediately fell. A projection presented itself just above the os calcis, the tendo Achillis was pressed backwards by the displaced astragalus, and at one point had reached to so near the surface that vesication subsequently occurred directly over it. There was no fracture of the tibia or fibula; the tibia was slightly displaced forwards upon the foot, and the os calcis retained it natural position. The reduction was found impracticable; but in the end an articulation was formed between the bones of the leg and the os calcis, and the patient was able to walk nearly upright. The second example occurred in a gentleman, who, as he was running with great rapidity after a cricket ball, placed his foot in a gutter. The toe rested upon the further side of this gutter, while the heel was jammed directly into it, and he fell forward. The appearances were very similar to those in the preceding case. Some attempts at reduction having proved ineffectual, and the foot being much swollen, Mr. Phillips declined to repeat them, and treated the case with leeches, quietude, &c. In the end scarcely any lameness remained, though, at the time the particulars were written, the patient was obliged to wear a shoe, the hinder part of which was constructed so as not to make pressure upon the projecting astragalus. (See *Lond. Med. Gaz.* vol. xiv. p. 596.)

[Other instances of this displacement have since been met with. Mr. Liston mentions one which happened in a young man who fell backwards down a staircase, and in the fall his foot became entangled in the railing. The astragalus was found lying betwixt the back of the tibia and the tendo Achillis, its upper articulating surface facing forwards, the lower in contact with the tendon. All attempts to reduce the bone proved fruitless, violent inflammatory action followed, but gave way to active measures, and the limb ultimately became very useful; in fact, though not till after many months, little lameness or shortening was perceptible. (See *El. of Surg.* 2nd ed. 1840, p. 753.) Mr. Lizars speaks of another case in which "the astragalus was driven backwards behind the tibia between it and the os calcis." All attempts at reduction were unavailing, but nevertheless a useful limb was obtained. The astragalus was subsequently much diminished by absorption. (*Pract. Surg.* p. 161, 2nd ed. 1847.)

A case of dislocation backwards, admitted into University College Hospital in 1839, is recorded in the *Lancet*, and is the only one in which reduction could be accomplished. The dislocation was somewhat inwards as well as backwards. The foot was but slightly displaced. A hard tumor was felt between the tendo Achillis and the inner malleolus, which was also fractured, and the irregularity of the broken surface of the lower fragment could be felt under the skin. A hollow, into which the finger could be passed as far as the first joint, existed below and in front of the outer malleolus. The great toe was flexed, and could not be extended by any moderate degree of force. For the reduction, the leg was flexed on the thigh and the foot on the leg. Extension was then made from the heel and instep, and counter-extension from the leg, the foot being at the same time turned inwards, and pressure made to force the hard substance on the tendo Achillis forwards. The pressure being kept up for ten minutes, a snap was heard, and the tumor disappeared. (See *Lancet*, July 6, 1839, p. 559.)

Here probably the astragalus was not completely removed from between the tibia and os calcis, but some portion of it, perhaps the head and neck, was engaged between those bones, and by holding them apart, may have opened a way for the bone to return to its place, and so have rendered the reduction possible.

In all the above cases the dislocation was simple. M. Nélaton mentions a case of compound dislocation backwards, seen by him at the Hôpital St. Louis, where the nature of the accident was ascertainable through the wound in the skin. (*El. de Pathol. Chir.* t. ii. p. 484.) Another was under the care of Mr. Turner, in the Manchester Infirmary. The patient was a railway engineer, and whilst at work, the fly wheel of the engine caught his knee, and, it was supposed, turned the leg violently inwards, whilst the foot was pushed in the opposite direction. The astragalus protruded through a wound in the skin an inch and a half long, situated on the outer side and behind the malleolus externus; the bone was tilted round so as to present its tibial articulating surface to the wound. The dislocation here was not directly backwards, but, as Mr. Turner describes it, "outwards, downwards, and backwards." The tibia and fibula were uninjured. All attempts at reduction proved unavailing, the astragalus was therefore dissected away, and the patient ultimately did well. (See *Trans. of Prov. Med. and Surg. Association*, 1843, p. 440.)]

5. [*Rotatory dislocation of the astragalus. Luxation par rotation sur place.*—In some cases of complete dislocation the astragalus may undergo a movement of rotation on its vertical axis, so as to become placed more or less transversely across the foot; but in the case now under consideration it is rotated without leaving its position between the tibia and os calcis. It may become placed transversely beneath the tibia and fibula, or it may even be turned completely round, so that its head is directed towards the tendo Achillis.

M. Malgaigne relates four instances of this peculiar accident. In one, by M. Laumonier, the head of the astragalus protruded through the skin under the malleolus internus, between the tendons of the tibialis posticus and flexor longus digitorum, and its trochlea was situated transversely in the articulation, holding the tibia and fibula apart. The astragalus was extracted successfully.

In another, M. Denonvilliers found the body of the astragalus separated by a fracture from the head of the bone, and rotated so as to cross the calcaneum at a right angle, with its trochlear surface protruding through the integuments beneath and behind the malleolus internus. The head of the bone remained in its natural situation. The dislocated portion was extracted, but the patient died.

In the two remaining cases there was neither fracture of the bone nor rupture of the integument. In one of these, under M. Thierry, the astragalus was turned completely round, so that its head was directed backwards towards the tendo Achillis; it was also twisted laterally, so that it rested upon its outer side, and its superior articular surface was directed inwards. Beneath the malleolus internus could be felt a smooth rounded prominence, limited below by a convex border, which appeared to be the edge of the trochlear surface of the astragalus; above and behind this prominence could be distinguished another, between the internal malleolus and the tendo Achillis. The external border of the foot was much raised; the heel was carried upwards and backwards. The case was evidently a dislocation of the astragalus, but its precise nature was not recognised, and the attempts at reduction were unsuccessful. The skin soon afterwards sloughed, and the astragalus was exposed, when it was found that the posterior projection was formed by the head of the bone, and that its posterior extremity was carried forwards and outwards, between the os calcis, cuboid, and scaphoid. The tibia rested upon the inner surface of the astragalus, the trochlear surface of which was turned inwards. Extraction of the astragalus was then practised, and it was found that some fibres of the inter-osseous ligament still remained entire. Amputation subsequently became necessary.

The remaining case was a dislocation of old standing, which was dissected by M. Foucher. There was no appearance of cicatrix on the skin. The foot was much flattened, and its internal border was slightly raised. Internally was a considerable projection, which seemed to belong to the malleolus internus. The dissection, however, showed that it was formed by the head of the astragalus, which was situated immediately beneath the malleolus; the trochlea of the astragalus was placed transversely under the tibia. (See *Malgaigne*, *Traité des Fract.* t. ii. p. 1060. The first of these cases is recorded by *Laumonier*, *Journ. de Fourcroy*, 1791. t. ii. p. 40; the other three, by *Foucher*, *Rev. Méd. Chir.* 1845. t. xvii. p. 203.)]

6. [*Dislocation of the astragalus "par renversement."*—In this case the astragalus remains in its natural situation, between the tibia and os calcis, but is twisted upon itself; either half round, so that its lateral surfaces look upwards and downwards, and its superior and inferior surfaces are placed laterally; or completely round, so that its upper surface looks downwards, and its lower surface upwards. This is, in fact, another kind of rotation, the bone rotating on its antero-posterior, instead of on its vertical axis.]

In a case published by Dupuytren, a person dislocated the astragalus by alighting with great violence upon the heel, the bone being driven forward by the pressure which it had sustained between the tibia and os calcis, so as to form a protuberance under the skin of the instep. As the reduction was found impracticable, a cut was made down to the displaced bone with the intention of extracting it, but Dupuytren found that he could not remove it so readily as he expected, nor could he replace it; and it was not till after a tedious operation that he succeeded in taking it away. The difficulty arose from the upper surface of the bone being turned downwards, while the back projection of what was naturally the lower part of it took hold of the tibia in the manner of a hook. (*Annuaire Med. Chir. des Hopitaux de Paris*, 1819, p. 28.)

[Dupuytren met with two other cases of this nature, and Malgaigne mentions in all six instances of it. In three of these the bone was only twisted half round upon itself; in the three others it was turned completely upside down. In those cases in which the bone was twisted half round only, the superior articular surface was directed outwards in two, inwards in the remaining one. Where the bone was completely reversed, it was uncertain in which direction the movement had taken place. In all, the dislocation was simple, there was no fracture of either tibia or fibula, nor had these bones been separated from their connections. The astragalus was incompletely luxated upon the scaphoid, sometimes directly forwards, sometimes obliquely forwards and inwards, or forwards and outwards.

It would be very difficult to distinguish a dislocation of this nature from an ordinary partial dislocation of the astragalus; indeed, the distinction has never yet been made. M. Malgaigne suggests that possibly a very careful examination of the prominences of the astragalus might assist the diagnosis, and if it were established that the bone had undergone the complete reversal of its position, no attempts at reduction should be made, as there is no chance of their being attended with success. If, however, it were only turned half round, it is just possible that it might be replaced, although this has never yet been accomplished. In one of Dupuytren's cases, as has been seen, he cut down upon the bone and removed it at once; in another he removed it six months after the accident, in consequence of the foot having become useless. Mr. Smith, of Leeds, also removed the astragalus five months after the accident, the bone having become exposed by sloughing of the integuments. These cases did well. In two other cases the attempts at reduction caused eschars to form over the head of the bone, but the ulcers healed, and the bone was left undisturbed. In a preparation, of which M. Malgaigne gives a drawing, the astragalus is turned half round, and has become ankylosed to the os calcis.]

[DISLOCATIONS OF THE OS CALCIS.]

[A dislocation of the os calcis from the astragalus and cuboid bone, without any displacement of the other bones of the foot, has been observed, but such an occurrence is very rare. According to Chelius the os calcis may, in consequence of a fall on the heel, or other violence, be dislocated *outwards* from the astragalus and cuboid bone. The great deformity of the heel is the ground of this diagnosis. The bone must be pressed back into its place, and there retained by proper apparatus. As the consequence of an old dislocation of the heel bone which had been produced in early life by violently dragging off a boot, he states that he has observed a degeneration like elephantiasis, which rendered amputation necessary. (See *Syst. of Surg. South's* translation, vol. i. p. 812.) In this case the dissection showed a complete dislocation of the os calcis outwards, so that the astragalus supported the weight of the body. Another instance is mentioned by Rognetta, but, like the last, is somewhat vaguely reported. Here the anterior tuberosity is said to have been displaced upwards and outwards, and the heel, the prominence of which had almost disappeared, was turned downwards and inwards. (See *Malgaigne*, t. ii. p. 1068.) Mr. Hancock has given an account of a dissection formerly in the possession of Mr. Howship, but now in the museum of the College of Surgeons, which affords another example of dislocation of this bone. The os calcis was displaced outwards from the astragalus, and partially also from the cuboid bone, but it is not stated in what direction. The connections of the astragalus with the bones of the leg, and with the scaphoid bone were undisturbed. The lower and posterior portion of the external malleolus rested upon the superior and internal surface of the protuberance of the os calcis, immediately in front of the insertion of the tendo Achillis. (See *Lancet*, *Oct.* 1844, p. 70.)

Mr. Edwin Canton met with an old dislocation of the os calcis outwards from the astragalus, and inwards from the cuboid, in a subject brought to the dissecting-room. The astragalus with the tibia were thrown inwards, but the fibula had been fractured two inches and a half above the malleolus, and that portion of the convex articular surface of the os calcis which was unoccupied by the astragalus was so fashioned as to afford accommodation for the play of the inner side of the fibular malleolus. The anterior part of the os calcis, by continued pressure, had separated the cuboid bone from the scaphoid, and nearly touched the external cuneiform. For further details see *Lancet*, vol. i. 1847, p. 505.

Two cases of dislocation of the os calcis *outwards from the astragalus, and upwards from the cuboid*, observed at the Hôtel Dieu at Marseilles, are referred to by M. Malgaigne. In one the patient, a sailor, had been struck on the inner side of the leg and foot by a piece of timber which had fallen from a height. The external malleolus was deeply depressed. Beneath it was a considerable projection, formed by the superior and external surfaces of the os calcis; in front was recognised the anterior process of the os calcis, separated from the cuboid, upon which it formed a projection. The internal malleolus was clearly defined, beneath it was felt the internal surface of the astragalus, and lower down was a depression, in the centre of which the skin was thrown into folds, and which was bounded behind by the posterior border of the os calcis and tendo Achillis. The articulations of the astragalus with the tibia and with the scaphoid bone were uninjured, and the movements of the foot upon the leg, with the exception of adduction and abduction, were preserved. The reduction was easily effected. An assistant drew the lower part of the leg outwards, while the surgeon, M. Jourdan, pressed the os calcis in the contrary direction. The patient was able to walk in three weeks, and was quite well at the end of a month. In the other case the os calcis was thrown outwards, and its anterior part rested upon the upper surface of the cuboid, but the cuboid was also dislocated outwards, and projected on the outer border of the foot, so that the tuberosity of the fifth metatarsal bone could not be felt. M. Jourdan reduced the os calcis without difficulty, but the cuboid remained dislocated, and it was necessary to use strong pressure separately upon the latter to return it into its place. The cure was complete at the end of a month. (See *Malgaigne*, t. ii. p. 1069.)]

[Dislocations at the Medio-tarsal Articulation.]

[The medio-tarsal articulation is the joint formed by the astragalus and os calcis behind, and the scaphoid and cuboid bones in front. J. L. Petit, in 1723, was the first to speak of dislocation occurring at this part of the foot; he states that two cases had come under his observation. His description, however, is very vague and obscure. (See *Malgaigne*, *Traité des Fract.* t. ii. p. 1072.) The following case has since been recorded by Sir A. Cooper, but this also is not so explicit as might be wished. "A man working at Southwark Bridge had the misfortune to have a stone of great weight glide gradually on his foot. He was brought to Guy's Hospital, and the following were the appearances of the foot. The os calcis and astragalus remained in their natural situation, but the fore part of the foot was turned inwards upon these bones. When examined by the students, the appearance was so precisely like that of a club foot, that they could not at first believe that it was not a natural defect of that kind, but upon the assurance of the man that previously to the accident his foot was not distorted, an extension was made by fixing the leg and the heel, the fore part of the foot was then drawn outwards, and thus the reduction was effected. This person was discharged from the hospital in five weeks, having the complete use of his foot." (*Sir A. Cooper*, *On Dislocations*, *B. Cooper's edition*, p. 336.) Another case of this kind has been mentioned by Mr. Liston. It occurred in a bricklayer's boy, æt. 14, who fell from a height of forty feet and alighted on the extremity of his right foot. The ligaments on the dorsal surface of the foot appeared to have started, the scaphoid and cuboid bones projected a little upwards from their usual situation. The foot was half an inch shorter than the other one. The leg was elevated, fomentations, &c. were applied, but no attempt was made to replace the misplaced bones. In about three weeks he left the hospital: he was able to stand on the foot. The instep appeared higher than the other one, the foot was shorter by half an inch, and had a somewhat clubbed appearance. (*Pract. Surg.* 4th ed. p. 136.)]

[Dislocations of the Scaphoid Bone.]

[A case has been reported by Mr. Burnett of Alton, in which the scaphoid bone was dislocated from the cuneiform bones, and protruded through the skin, together with the head of the astragalus, which bone was also partially dislocated from the os calcis and from the tibia. It occurred in a gentleman, æt. 60, who after taking a leap, while hunting, suddenly found his right foot become displaced. His usual habit was to ride in his stirrup, his foot resting on its outer side. The foot was dislocated inwards, at right angles with the leg, and two bones projected through a wound about three inches in length extending across the outer ancle. The upper of these, the os naviculare, had projected its cuneiform surface outwards and forwards in an oblique direction, and the other bone was the astragalus, which was also driven forwards and outwards, and presented that surface which in its natural condition would be in contact with the os calcis. Mr. Burnett kept up firm and steady pressure for nearly a quarter of an hour upon the prominent os naviculare, in the direction of the joint, to which he was directed by the end of the tibia, which was plainly to be seen beneath the astragalus. At the expiration of this time the bones slipped into their proper places, and the foot resumed its natural character. The patient recovered favourably. (See *Lond. Med. Gaz.* vol. xix. p. 221, Nov. 1836.) This case appears to have been one of double dislocation of the astragalus from the tibia and os calcis, but the astragalus, instead of being as usual dislocated from the scaphoid, had carried that bone with it, separating it from its attachments with the cuneiform bones.

Three cases of dislocation of the scaphoid bone have been observed in which it was separated from its astragaloid as well as from its cuneiform articulations. In one, related by M. Piedagnel, the bone was fractured at the junction of its outer third with its inner two-thirds; the outer portion remained connected with the cuboid, but the inner and larger was dislocated inwards, and was exposed through a lacerated wound at the inner side of the foot. The projecting part of the scaphoid was taken for the head of the astragalus, and attempts were made to reduce it, but without success; gangrene set in the next day, and the leg was amputated, when the real condition of the parts was discovered. The accident occurred from the foot being caught between the pavement and the wheel of a carriage. M. Piedagnel found, on examining the limb after it had been removed, that by pulling upon the metatarsus, and turning it forcibly outwards, reduction was easily effected. (See *Malgaigne*, t. ii. p. 1073.)

Another case in which the bone was dislocated *upwards*, without wound in the skin, has been recorded by Dr. Walker of Peterborough. It occurred in a mason, who in stepping from one wall to another, stepped short, so that his toes only rested upon the wall, and the weight of his body was therefore thrown upon the anterior part of the foot. He felt that his foot was bent upwards, and that something gave way. There was a bold projection on the dorsum of the foot, in the situation of the scaphoid bone, and a corresponding depression beneath. He could bend or extend the ancle-joint without difficulty. The reduction was attempted by making direct pressure upon the dislocated bone, but without success. The foot was then forcibly depressed, and this movement having probably enlarged the space between the astragalus and cuneiform bones, the reduction took place with a distinct snap. A slight tendency to recurrence of the displacement was counteracted by plaster and bandage, and at the end of three weeks the patient was able to return to his work. When examined, three months afterwards, there was no remaining appearance of injury. He had no pain, and the motions of the foot were perfect. (See *Prov. Med. and Surg. Journ.* 1850, p. 563.)

The third case was observed by Mr. R. W. Smith. The accident had happened several years previously. The scaphoid bone had been dislocated *inwards* and had remained unreduced. It was caused by the patient's horse falling with him and lying across his foot, which was entangled in the stirrup. There was a projection at the inner edge of the dorsum of the foot in front of the head of the astragalus, and a remarkable flattening of the plantar region. When seen by Mr. Smith, the man enjoyed the unimpaired use of the limb. (See *Dublin Hospital Gaz.* t. ii. 1855, p. 76.)]

DISLOCATIONS OF THE CUNEIFORM BONES.

Sir A. Cooper states that he has twice seen *the internal cuneiform bone* dislocated, and in both these instances the same appearances presented themselves. There was a great projection of the bone inwards, and some degree of elevation from its being drawn up by the action of the tibialis anticus muscle; and it no longer remained in a direct line with the metatarsal bone of the great toe. In neither case was the bone reduced. One of the patients walked with but little halting, and Sir A. Cooper believed, would in time recover the use of the foot so as not to appear lame. The cause in this case was a fall from a considerable height, by which the ligament was ruptured which connects this bone with the scaphoid and middle cuneiform bones. The other case happened in consequence of the fall of a horse, the patient's foot being caught between the horse and the kerb stone. With regard to the treatment, Sir A. Cooper recommends, first, confining the bone in its place with a roller, kept wet with spirits of wine and water, and when the inflammation is subdued, he directs a leather strap to be buckled round the foot so as to maintain the bone in its place till the ligament be united. (*Sir A. Cooper, On Dislocations*, p. 259. 10th ed.)

[M. Nélaton met with a case of compound dislocation of the internal cuneiform bone, caused by the wheel of a carriage passing over the foot. The wound corresponded to the cuneo-scaphoid articulation, and the posterior and inferior angle of the cuneiform bone protruded through it. The bone was displaced in such a manner as to rest transversely upon the middle cuneiform. The reduction being found impracticable, the dislocated bone was removed, and the patient did well. (See *Elém de Pathol. Chir.* t. ii. p. 488.)

A case of dislocation of all *three cuneiform bones* was treated by Mr. Luke in the London Hospital. The three cuneiform bones appeared to be partially dislocated upwards. The internal cuneiform bone was chiefly displaced from the navicular bone, and projected upwards and inwards. By extension from the toes and by pressure upon the displaced bones, they were returned after some time, with an evident sensation. The inflammation which followed was subdued by leeches and cold lotion. The strength in the foot returned slowly, and the patient was not able to bear on it or to walk till six weeks after the accident. (*Lond. Med. Gaz.* 1831, vol. vii. p. 704.)

A case of compound dislocation of the *middle and external cuneiform bones* has been recorded by Mr. Aston Key. The skin and the tendons on the dorsum of the foot had suffered serious laceration, and the fourth and fifth metatarsal bones were also fractured. The middle and external cuneiform bones were partially dislocated, forming two distinct square swellings on the dorsum of the foot, but inferiorly remaining wedged in their places. By drawing the anterior part of the foot forwards, in a line at right angles with the leg, from which counter-extension was kept up, and at the same time pressing with the thumbs upon the dislocated bones, Mr. Key succeeded in reducing them, and they slipped into their places with a snap. The integuments on the dorsum of the foot sloughed, and a succession of abscesses formed, but the patient ultimately recovered with a scarcely perceptible lameness. (See *Guy's Hospital Reports*, vol. i. 1836, p. 244.)]

[DISLOCATIONS AT THE TARSO-METATARSAL ARTICULATIONS.]

[Dislocations at the tarso-metatarsal articulations have been occasionally seen. The dislocation may implicate the whole range of metatarsal bones, or any lesser number of them.

Dislocation of a single metatarsal bone.—A case of dislocation of the *first* metatarsal bone upwards was met with by Mr. Liston, who succeeded in reducing it. A dislocation of the *fourth* metatarsal bone upwards and backwards on to the cuboid was observed by M. Malgaigne, and was caused by a fall on to the anterior part of the sole of the foot; he endeavoured to reduce it by making extension upon the toe, and by pressing upon the end of the metatarsal bone downwards and forwards. These means failing, he inserted a pointed instrument into the posterior articular surface, and with it pressed the head of the bone in the proper direction. After several attempts it slipped into its place.

Dislocation of two metatarsal bones.—A case of dislocation of the fourth and fifth metatarsal bones upwards and backwards on the cuboid was admitted into St. Thomas's Hospital under Mr. Green. The dislocation was caused by the falling of a heavy cask upon the inside of the foot. The bones were reduced by continued extension with much difficulty, and as they recovered their place a distinct crackling was heard. (*South's* translation of *Chelius*, vol. i. p. 814.) Another instance of dislocation of the same two bones upwards and slightly inwards has been related by Monteggia. (See *Malgaigne*, *Traité des Fract.* t. ii. p. 1078.)

Dislocation of three metatarsal bones.—A *partial* dislocation *upwards* of the three first metatarsal bones was observed by M. Laugier, and was readily reduced. Mr. Tufnell records a case of dislocation of the same three bones *downwards*. It happened in a soldier whose horse fell with him, and crushed his foot against the ground. The foot was found to be much shortened, curved inwards, and bent, the tarsus presented a hard bony projection overhanging the metatarsus, whilst deep under the plantar surface a second bony mass could be felt lying obliquely across the sole of the foot. All attempts at reduction proved unavailing; the patient six months afterwards was able to walk freely with a stick, bearing his weight upon the outer border of the sole of the foot, as in a case of talipes varus. (See *Tufnell*, *Dublin Quart. Journ. of Med. Science*, Feb. 1854, p. 65.)

M. Malgaigne met with two instances of dislocation upwards of the second, third, and fourth metatarsal bones. In one of these the displacement was incomplete; the accident had occurred many years previously, and had remained unreduced; but at the time the patient came under M. Malgaigne's observation he was able to walk perfectly well. In the second case the dislocation was complete, and the metatarsal bones rested on the dorsal surface of the tarsus. Reduction was found impracticable. This patient died, and the state of the parts was verified by dissection. (See *Malgaigne*, *Traité des Fract.* t. ii. p. 1078.)

Dislocation of four metatarsal bones.—M. Malgaigne met with a dislocation of the four first metatarsal bones, caused by the fall of a horse upon the patient's foot. The three first metatarsal bones were dislocated *downwards*, but the fourth was partially displaced *upwards*. The internal border of the foot was shortened nearly half an inch, showing that there was overlapping of the bones to a like extent. The vertical diameter of the foot was increased by about four-fifths of an inch. In this case reduction was impossible, so far as regarded the three first metatarsal bones, but the fourth was pressed downwards into its place. In course of time, however, this patient completely recovered the use of his foot.

Dislocations of all the metatarsal bones. — The entire metatarsus has been seen dislocated from the tarsus in four different directions—upwards, downwards, outwards, and inwards. The upward dislocation is by far the most frequent, for out of twelve examples, to which M. Malgaigne refers, there were eight dislocations upwards, one downwards, two outwards, and one inwards. Only one of the twelve was a compound dislocation.

Dislocation upwards.—In the dislocation upwards it sometimes happens that the first metatarsal bone is not dislocated from the internal cuneiform, but the internal cuneiform is separated from the scaphoid, and is dislocated upwards with the metatarsus. Mr. R. W. Smith first called attention to this form of dislocation, and has given a detailed account of the dissection of two cases of this kind; according to M. Malgaigne, four out of the eight cases of dislocation upwards presented this peculiarity. Mr. Smith thinks the internal cuneiform bone is more likely to remain connected with the first metatarsal bone than with the scaphoid, in consequence of the strong connection maintained between it and the first metatarsal by means of the tendons of the peroneus longus and tibialis anticus; each of which tendons having an attachment to each of the bones in question, must constitute a powerful means of preventing their separation from one another.

In these dislocations the prominence of the tarsus on the dorsum of the foot is easily made out, and the projection of the tarsus downwards is usually also to be distinguished. The anterior part of the foot is shortened more or less, according to the extent to which the bones overlap each other. The form of the prominence on the dorsum of the foot will enable the surgeon to distinguish whether the case is a pure dislocation of the metatarsus, or whether the internal cuneiform is included in the displacement. The two cases dissected by Mr. Smith were instances of old unreduced dislocation; in both the plantar region, instead of presenting its natural concavity, was convex, both in the antero-posterior and transverse diameters; the sole of the foot was directed inwards, and its outer border, in standing and walking, was presented to the ground. A like tendency to inversion of the foot has been observed in other cases. The only case in which the dislocation was compound was observed by M. Mazet. Here the limb was amputated, and its condition was afterwards carefully examined. The three middle metatarsal bones were dislocated upwards on to the tarsus, but the fifth was thrown outwards from the cuboid, and rotated so that its internal surface looked upwards, and the first metatarsal was dislocated inwards from the internal cuneiform. A drawing of this preparation is given by M. Malgaigne. (See pl. xxx. fig. 6.)

Reduction.—In three cases under MM. Dupuytren, Bouchard, and Meynier, the dislocation was easily reduced, by pulling upon the metatarsal bones, and by making pressure also upon their dislocated extremities. All three patients did well; but in Dupuytren's case, at the end of seven or eight weeks there was still some inconvenience in walking. In a fourth case, under M. Delort, reduction was also obtained, but the patient died from internal injuries. In one case, under Dupuytren, all attempts at reduction were fruitless, but the patient was not seen by him till three weeks after the accident. In the two cases recorded by Mr. R. W. Smith it was not known whether any attempt had been made at the time to reduce the dislocation. In the remaining case, that of M. Mazet, the limb was amputated. (See *Malgaigne, Traité des Fract.* t. ii. p. 1077, and *R. W. Smith, On Fractures and Dislocations*, p. 224. Dublin, 1847.)

Dislocation downwards. — The only recorded case of dislocation of the metatarsus downwards is related by Mr. Smyly of Dublin. It happened in a young man, in consequence of the upsetting of a cart which he was driving. He fell so that his right foot got between the shaft and the bank of a ditch, the shaft crushing the heel against the toes, which were fixed by the bank. The foot was at first so swollen that the nature of the accident could not be ascertained, but when the ecchymosis was dispersed, the injury became manifest from the projection of the tarsus, the hollow immediately in front of it, with the corresponding projection in the sole, and the shortening of the foot. On the sixth day the dislocation was reduced by means of pulleys. A piece of wood in the form of a sandal, made to fit the sole of the foot, having a heel-piece of leather, with a strap to cross the instep, retained the bones in their places. Three weeks after the accident the man was sufficiently recovered to use his foot. (See *Dublin Quart. Journ. of Med. Science*, May 1854, p. 317.)

Dislocation outwards.—Two examples of dislocation of the metatarsus outwards have been observed. In one the second metatarsal bone was fractured; in the other, the four outer metatarsal bones were dislocated *upwards* as well as outwards. The manner in which the second metatarsal bone is wedged between the three cuneiform bones would, probably, always prevent this bone being displaced *directly* outwards with the rest without fracture. In the first case, seen by M. Laugier, the accident was caused by the patient falling from a height in such a manner that the weight of the body came upon the anterior part of the external border of the foot. The toes must, therefore, have been carried inwards, and the base of the metatarsus twisted outwards. The internal cuneiform bone was prominent at the internal border of the foot, and a portion of its anterior articular surface could be felt; the fifth metatarsal bone was in like manner unduly prominent externally. A fracture of the second metatarsal bone, towards its middle part, could be distinguished. The reduction was easily obtained by making pressure upon the tarsus outwards and the metatarsus inwards. The patient recovered favourably. In the other case, which is recorded by M. Lacombe, and which occurred in his own person, the accident was caused in a different manner, for the force operated against the anterior part of the *inner border* of the foot, so as to press it outwards. The fore part of the foot was thrown outwards and formed an obtuse angle with the cuboid and os calcis. The fifth metatarsal bone was prominent on the outer side and the internal cuneiform internally, but the four outer metatarsal bones were also dislocated upwards, and overlapped the tarsus in this direction more than half an inch, causing an evident shortening of the foot. The reduction was attempted by traction with the hands only, it being found impossible to apply a bandage round the foot for the purpose of making extension, in consequence of the tendency of the metatarsal bones to overlap each other. Complete reduction was impossible; but the position of the foot was much improved. Ultimately M. Lacombe, by means of an apparatus specially modelled to fit the foot, was able to resume his avocations.

Dislocation inwards.— A case of dislocation of the metatarsus *inwards* is recorded by Mr. Kirk of Glasgow. Here the metatarsus was driven inwards, and formed a projection to the extent of an inch on the inside of the foot, and left a corresponding depression on the outside. The reduction was easily accomplished by grasping the metatarsus in one hand and the tarsus in the other, and pulling or pressing in the direction calculated to bring the articular surfaces into apposition. (See *Lond. Med. Gaz.* 1844, vol. xxxiv. p. 440.)]

[DISLOCATIONS AT THE METATARSO-PHALANGEAL ARTICULATIONS.]

[*Dislocations of the great toe.*—M. Malgaigne refers to nineteen recorded cases of dislocation of the first phalanx of the great toe from its metatarsal bone. Of these nine were simple and ten were compound dislocations. The mode in which the accident was produced is mentioned in seventeen cases: in ten of these the cause was the fall of a horse, the foot of the patient being usually engaged beneath the fallen animal; four times it was produced by the wheel of a carriage; twice by a fall on the toe from an elevated position. It appears probable, also, that at the moment of the accident, the toe is usually forcibly bent backwards upon the metatarsal bone.

In the simple dislocation the toe is, in the great majority of cases, displaced directly *upwards;* occasionally obliquely upwards and inwards. The head of the phalanx is prominent on the dorsal aspect of the foot, and the head of the metatarsal bone forms a projection towards the sole. The dislocation may be complete or incomplete: if complete, the deformity is very considerable, the bones may overlap each other, and shortening of the toe will then be observed; if incomplete, the deformity is of course less, and shortening is impossible. The point of the toe is inclined a little outwards, and usually preserves its natural level; sometimes, however, it is slightly flexed; and, on the other hand, it has sometimes been seen raised to a right angle upon the metatarsal bone.

Reduction.—As in the corresponding joint of the thumb, the reduction is often attended with great difficulty, and has sometimes been found impossible. The difficulty, probably, arises from the same causes as in the thumb, and, as they have been fully explained in speaking of the dislocation of that part, it is not necessary here to repeat them. All the manœuvres recommended for the thumb are also applicable to the great toe. If the sesamoid bones and the anterior ligament are the chief obstacles, as Dr. A. Laurie believed, and which opinion is corroborated by the authority of Sir A. Cooper, the plan which appears most likely to succeed is that of bending the toe backwards on the metatarsal bone, and pushing the dislocated end of the phalanx forwards; then, when its plantar edge has been made to overlap the metatarsal bone, bringing it gradually downwards towards the straight line. (See DISLOCATIONS OF THUMB.) In obstinate cases, section of the extensor tendons has been tried, and section of the extensor tendons and internal lateral ligament also; but equally without effect.

Compound dislocation of the great toe.—When the dislocation is compound, the wound is almost invariably on the inner side of the foot. The head of the metatarsal bone projects through it, and the phalanx is dislocated upwards and outwards. The great toe is inclined outwards, across the others; sometimes forming nearly a right angle with them. In some instances, however, the displacement has appeared to belong rather to the metatarsal bone than to the phalanx, for the toe has preserved its normal position and direction, but the head of the metatarsal bone has been inclined downwards. In one example, the displacement of the head of this bone downwards has been combined with displacement of its tarsal extremity upwards, so that in reality it had been subjected to a double dislocation.

Treatment.—In six of the ten cases to which M. Malgaigne refers the dislocation was reduced, but not always without difficulty. In five of these suppuration took place on the outer side of the metatarsal bone: one of the patients died; three recovered with ankylosis, after exfoliation of the articular cartilages; the fifth also recovered, but whether with ankylosis or not is not stated. The sixth case recovered, and was the only one in which the movements of the joint were preserved: here the wound in the skin was enlarged, and an incision was also made along the outer side of the metatarsal bone, which gave exit to some coagulated blood.

In four examples reduction was impracticable. In two of these the head of the metatarsal bone was excised: one of the patients, a cavalry soldier, was able to resume his duty; the other patient died. In the two others the entire metatarsal bone was excised, but with what object so severe a measure was resorted to it is not easy to understand: in both these cases the usefulness of the foot was very materially impaired.

Sir A. Cooper met with a case of dislocation of the *four outer toes from their metatarsal bones.* Upon examination of the bottom of the foot, a considerable projection was found at the roots of all the smaller toes, the extremity of each of the metatarsal bones being placed under the first phalanx of its corresponding toe. Several months had elapsed from the time of the accident, and at first, from the swelling of the foot, it had not been detected. No extension would have been likely to answer any purpose, and the only mode of relief was to wear a piece of hollow cork at the bottom of the inner part of the shoe, to prevent the pressure of the metatarsal bones upon the nerves and blood vessels. (*On Dislocations*, *B. Cooper's* ed. p. 339.)

An instance of dislocation of *all the toes from the metatarsal bones* has been recorded by M. Josse of Amiens. It happened in a dragoon, in consequence of his horse falling with him and squeezing his foot against the ground. The toes were dislocated outwards, and the head of the first metatarsal bone escaped through a transverse wound on the inner side of the articulation. Reduction was attempted, but the protruding extremity of the metatarsal bone opposed an insurmountable resistance. It was therefore removed, and the bones could then be replaced with great facility, the outer toes resuming their normal position almost spontaneously. The wound in the integuments healed, and at the end of seven weeks he was able to return to his duty, the great toe, strange to say, having preserved all its movements. (*Malgaigne*, t. ii. p. 1095.)

Dislocation of the phalanges of the toes may occasionally occur, but from their diminutive size, and the mobility of the metatarso-phalangeal articulations, such an accident is very unlikely. The treatment required would be the same as in the fingers.] *James R. Lane.*

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DISTICHIA, or Distichiasis (from δὶς, twice, and στίχος, a row). A double row of eyelashes, the innermost ones of which irritate the eye. The pseudo-cilia, which grow in distichiasis, seldom occupy the whole length of the eyelid; but are mostly scattered about between the natural place of the cilia and the Meibomian apertures. (See Trichiasis.)

DURA MATER, FUNGOUS TUMORS OF. The disease arises gradually, in the form of a tumor, which makes its way through the bones of the cranium, and insensibly blends itself with the integuments, which seem, as it were, to make a part of it. Fungous tumors of the dura mater may originate spontaneously at any part of this membrane; but they are particularly apt to grow on the surface, which is adherent to the upper part of the skull, or to its basis. They are firm, indolent, and chronic, seeming as if they were the consequence of slow inflammation, affecting the vessels, which supply the dura mater, and inosculate with those of the diploe. It is very difficult to determine whether the disease begins in the dura mater or the substance of the bone itself. The general belief, however, is that the bone is affected secondarily, and that the disorder originates in the dura mater. The patient, the subject of the first case related by M. Louis, imputed the complaint to a fall, which he had met with four of five months previously, and in which the head itself had not received any violence; but, from this time, he experienced a stunning sensation, which continued till he died. The cranium and dura mater were found both equally diseased. Though this case may tend to prove that fungous tumors of the dura mater may form spontaneously, yet, it is not the less confirmed by a vast number of cases, that this affection more frequently follows blows on the head, than any other cause. Hence, a slow kind of thickening of the dura mater is produced, which ends in a sarcomatous excrescence, the formation of which always precedes the destruction of the bone. In the memoir, published by M. Louis in the fifth volume, 4to. of those of the Royal Academy of Surgery, there is a very interesting case, illustrating the nature of the present disease.

The subject was a young man, aged twenty-one, who had a considerable tumor on the left side of the head, which was taken for a *hernia cerebri*. (See *this Article*.) The swelling had begun in the region of the temple, and had gradually acquired the magnitude of a second head. The external ear was displaced by it, and pushed down as low as the angle of the lower jaw. At the upper part of the circumference of the base of the tumor, the inequalities of the perforated bone, and the pulsations of the brain, could be distinctly felt. Some parts of the mass were elastic and hard; others soft and fluctuating. A plaster, which had been applied, brought on a suppuration at some points, from which an ichorous matter was discharged. Shiverings and febrile symptoms ensued, and the man died in less than four months, in the year 1764. On dissection, a sarcomatous tumor of the dura mater was detected, together with the destruction of the whole portion of the skull, corresponding to the extent of the disease.

When a tumor of this nature has decidedly formed, it makes its way outward through all the parts, soft or hard, which are opposed to it. The swelling, in becoming circumscribed, is partly blended with the dura mater, and its pressure produces an absorption of such parts of the skull as oppose its enlargement. It unexpectedly elevates itself externally, confounding itself with the scalp, and presents itself outwardly in the form of a preternatural, soft, yielding swelling, which even sometimes betrays an appearance of a decided fluctuation, or a pulsation, which may make it be mistaken for an aneurismal tumor. When once the swelling has made its exit from the cavity of the cranium, it expands on every side under the integuments, which readily make way for its growth. The scalp becomes distended, smooth, and œdematous over the extent of the tumor, and lastly, it ulcerates. The matter discharged from the ulcerations is thin and sanious: the outer part of the tumor is confounded with the integuments and edges of the skull, on which it rests, so that, in this state, it is easy to mistake the tumor for one whose base is altogether external. While the swelling thus increases in size externally, it also enlarges internally. The latter change takes place especially while the opening in the cranium is not large enough to admit the whole mass of the tumor, which then depresses the brain, and lodges in an excavation, which it forms for itself. But this cavity quickly diminishes, and becomes reduced almost to nothing, as soon as the tumor projects outwardly. The tables of the skull are absorbed to let the swelling arrive externally; but it is remarked, that the internal, or vitreous table, is always found much more extensively destroyed than the external one. Sometimes new bony matter is found deposited around the opening in the cranium.

It is asserted, that, whatever may be the situation of a fungous tumor of the dura mater, the outer layer of this membrane, upon which the disease forms, is alone altered, the inner layer and the pia mater being always unchanged. (*Lassus, Pathologie Chirurgicale*, tom. i. p. 501. éd. 1809.)

In one of these cases, detailed by Walther, the inner layer of the dura mater was quite natural, though one-half of the tumor, which was large, was within the skull, where it had formed for itself a deep excavation in the posterior lobe of the brain. And, what is remarkable, notwithstanding this latter change, the patient, the day before her death, retained all her intellectual faculties, and the power of voluntary motion. (*Journ. für Chirurgie von C. Graefe und Ph. v. Walther*, b. i. pp. 64, 65, 8vo. Berlin, 1820.)

According to surgical writers, fungous tumors of the dura mater have been caused by contusions on the skull, falls on the buttocks, concussions of the head or whole body, lues venerea, scrofula, inveterate rheumatism, &c. The three last of the alleged causes, however, seem to be little better than mere conjecture.

Even children of the most tender years are liable to the disease. M. Louis has related, that a child, two years of age, died of fungus of the dura mater, which had produced a swelling above the right ear, attended with a destruction of a portion of the parietal and temporal bones. (*Mém. de l'Acad. de Chirurgie*, tom. v. 4to. p. 31.)

Though the common opinion is, that these fungi grow entirely from the dura mater, Sandifort asserts, that the vessels of the diploe have a considerable share in their production. (*Descriptio Musei Anat. Acad. Lugd.* t. i. p. 152.)

A similar belief was entertained by Heister and Kaufmann, and is espoused by Siebold and Walther, the latter imputing the disease to a simultaneous affection of the vessels of the dura mater, and pericranium, attended with an absorption of the earthy part of the bone. (*Journ. für Chir. von. C. Graefe, &c.* p. 91—93.) M. Chelius has written an essay, in which a distinction is established between tumors commencing in the bone, and others beginning in the dura mater itself. (See *Archives de Méd.* Mars, 1832.)

The existence of a fungous tumor of the dura mater cannot be ascertained so long as there is no external change. The effects produced may originate from so many causes, that there would be great risk of a gross mistake in referring them to any particular ones. This is not the case when there is an opening in the skull. Then a hardness, felt from the very first at the circumference of the tumor, denotes that it comes from within. When the swelling is carefully handled, such a crackling sensation is perceived, as would arise from touching dry parchment stretched over the skin. On making much pressure, pain is occasioned, and sometimes a numbness in all the limbs, stupefaction and other more or less afflicting symptoms. The tumor in some measure returns inwards, *especially, when not very large*, and gradually rises up and outward again, when the pressure is discontinued. Sometimes there is pain; at other times there is none; which may be owing to the manner in which the tumor is affected by the edges of the bone through which it passes. The pain is often made to go off by compression, but returns as soon as this is taken off. The tumor has an alternate motion, derived from the pulsation of the brain, or of the large arteries at its base. This throbbing motion has led many practitioners to mistake the disease for an aneurism, as happened in the second case, related in the memoir of M. Louis. When the tumor is pushed sideways, and the finger carried between it and the edge of the bone, through which the disease protrudes, the bony edge may be felt, touching the base of the swelling, and more or less constricting it. This symptom, when distinguishable, added to a certain hardness and elasticity, and sometimes a facility of reduction, forms a pathognomonic mark, whereby fungous tumors of the dura mater may be discriminated from herniæ of the brain, external fleshy tumors, abscesses, exostosis, and other affections, which at first sight resemble them.

Probably, however, some variety prevails in different instances; for, in the cases recorded by Walther, there was no pulsation, strictly so called, but merely an obscure movement, or an alternate distension and flaccidity, arising from the influx of blood into the vessels of the diseased mass; the tumors could not be pushed within the cranium in the slightest degree; nor did the attempt cause any of the effects usually observed to proceed from pressure on the brain. No aperture could be felt in the skull, much less could the irregular edges of the bone around the tumor be distinguished. (*Journ. für Chir.* b. i. p. 57—61, &c. 8vo. Berlin, 1820.)

Whatever movements also were perceptible in the swellings, Walther is convinced could not be communicated to them by the pulsations of the subjacent brain; because they were wedged, as it were, in an aperture in the skull, and adherent to the dura mater beneath them, and to the superincumbent periosteum; so that, even in the dead subject, they did not admit of being pushed in the least outwards without difficulty, and the employment of strong pressure. (Vol. cit. p. 57.)

Indeed, this tight constriction of the tumor not only explains why stupor, paralysis, &c. were not brought on in these particular examples by external pressure, but also why the edges of the hole in the skull could not be felt; and the small size of the same opening, in relation to the magnitude of the swelling, fully accounts, in my opinion, for the circumstance of the swelling not sinking inwards under pressure. But I am far from being convinced with Walther that fungi of the dura mater are in their nature always irreducible (see vol. cit. p. 82); a belief which he grounds upon the connection of the diseased mass with the vessels of the diploe, its constriction by the bone, and its expansion under as well as above the cranium. Here I think Walther is as wrong in saying that none of these fungi can possibly be reduced, as others would be in asserting that it is their invariable character to be reducible. These differences must chiefly depend upon the size of the swelling, in relation to that of the aperture in the skull.

Generally speaking, fungous tumors of the dura mater are very dangerous, as well on account of their nature as of the difficulty of curing them in any certain manner, and of the internal and external disorder which they may occasion. Such as have a pedicle, the base of which is not extensive, which are firm in their texture without much disease in the surrounding bone, are movable, not very painful, and, in persons who are in other respects quite well, are in general reputed to be the least perilous. These are the cases in which a cure may be attempted with a hope of success, though the event is always exceedingly doubtful.

When the contrary of what has been just related occurs—when the disease is of long continuance, and the brain already affected—nothing favourable can be expected.

Compression is the most simple remedial means, and has naturally occurred to such practitioners as have mistaken the disease for an aneurism, or a hernia cerebri. The efficacy of this method has been further misconceived, because the tumor, when not very large, has sometimes been partly or even wholly reduced, without any bad consequences. This had no little share in leading to errors concerning the true character of the disease. But, as might be conceived, this reduction only being attended with temporary success, and having no effect whatever on the original cause of the affection, the symptoms returned, and the tumor rose up again the moment the compression was discontinued. There is a fact in the memoir of M. Louis which seems to evince that good effects may sometimes be produced by compression judiciously employed. A woman, brought to the brink of the grave by the symptoms occasioned by a tumor of the above kind, having rested with her head for some time on the same side as the tumor, found the swelling so suddenly reduced, without any ill effects, that she thought herself cured by some miracle. Compression, artfully kept up by means of a piece of tin fastened to her cap, prevented the protrusion of the tumor again. The pressure, however, not having been always very exact, the symptoms every now and then recurred, while the tumor was in the act of being depressed again, and they afterwards ceased, on the swelling having assumed a suitable position. The symptoms were, doubtless, occasioned by the irritation which the tumor suffered in passing the inequalities around the opening through which it protruded. The patient lived in this state nine years, having every now and then fits of insensibility, in one of which, attended with hiccough and vomiting, she perished.

[These cases of fungous tumors of the dura mater are, for the most part, of a malignant character, and do not admit of operative procedure either by the knife or by escharotics. The surgeon's skill will be best shown in determining, in each individual case, whether the growth be of an innocent nature or not. The following directions, given by Mr. Cooper for their removal, will only apply to the comparatively few cases in which the operator can feel assured of the non-malignancy of the growth he has to deal with; and even in such cases it is more than doubtful whether the dura mater should be so extensively interfered with as Mr. Cooper suggests.]

As compression cannot be depended upon, the following safer method may be tried:—It consists in exposing the tumor with a knife, which is certainly preferable to caustics, the action of which is very tedious and painful, and can never be limited or extended with any degree of precision. A crucial incision may be made through the scalp covering the tumor, and the flaps dissected up, and reflected, so as to bring all the bony circumference into view. Then with trephines repeatedly applied, or with (what would be better) Mr. Hey's saws, all the margin of the bone should be carefully removed. Now, if it be true that the vessels of the diploe are chiefly concerned in the supply of the diseased mass, we see that this source of its growth must be destroyed by the foregoing proceeding.

The tumor, thus disengaged on all sides, may be cut off with a scalpel; and such arteries as bleed much should be tied. Then, instead of applying caustic, as sometimes advised, perhaps it would be better to remove every part of both layers of the dura mater immediately under the situation of the excrescence. By this means, and the removal of the surrounding bone and diploe, all chance of the regeneration of the tumor would be prevented. In attempting the excision of a fungus of the dura mater, it is certainly an interesting point to know whether the tumor has an intimate vascular connection with the diploe and pericranium, as asserted by Siebold, Walther, and some other respectable authorities, though the importance of the information on this subject to the practitioner is somewhat lessened by his being aware that it is necessary always to begin with sawing away the bone in the immediate vicinity of the diseased mass. In the dissection of one case, Walther found the pericranium thickened for a considerable extent around the disease, and closely connected with the tumor by vessels. (Vol. cit. p. 100.)

When the tumor is sarcomatous, and its pedicle small and narrow, as sometimes happens, one should not hesitate to cut it off.

This method is preferable to tying its base with a ligature; a plan which could not be executed without dragging and seriously injuring the dura mater; and the fatal effects of which I saw exemplified in one case that occurred many years ago in St. Bartholomew's Hospital, and was operated upon by the late Mr. Ramsden. Excision is also preferable to caustics, which cause great pain, and very often convulsions. In performing the extirpation, we should remove the whole extent of the tumor, and, if possible, its root, even though it may extend as deeply as the internal layer of the dura mater. This step must not be delayed, for the disease will continue to increase, so as to affect the brain, become incurable, and even mortal. It is to such decision that we must impute the success which attended the treatment of the Spaniard Avalos, of whom Marcus Aurelius Severinus makes mention. The above nobleman was afflicted with intolerable headachs, which no remedy could appease. It was proposed to him to trepan the cranium, an operation to which he consented. This proceeding brought into view, under the bone, a fungous excrescence, the destruction of which proved a permanent cure of the violent pains, which the disease had occasioned. It is not mentioned in this case whether the internal layer of the dura mater was healthy or not; but there is foundation for believing, that if the extirpation of these tumors be undertaken in time, and bold measures be pursued, as in the instance just cited, success would often be obtained. Indeed, reason would support this opinion; for, when the disease is not extensive, it is necessary to expose a much smaller surface of the dura mater.

It appears to me, however, that trepanning can never be warrantable, unless the disease be indicated by some external changes. I saw my late master, Mr. Ramsden, trepan a man for a mere fixed pain in one part of the head, on the supposition, that there was a tumor under the bone; but no tumor was found, and the operation caused inflammation of the dura mater, and proved fatal.

No doubt, in some cases, the hæmorrhage will be considerable, as was exemplified in the instance in which Walther made an incision at the base of one of these fungi, in order to ascertain its nature: two pints of blood being lost from several vessels of large size ere they could be secured; and the further use of the knife discontinued.

M. Louis has described other tumors, which grow from the surface of the dura mater, when this membrane has been denuded, as after the application of the trephine. They only seem to differ from the preceding in not existing before the opening was made in the skull. Tumors of the dura mater should not be confounded with hernia cerebri. (See *this Article.*)

See, on the preceding subject, Mém. sur les Tumeurs, fongueuses de la Dure-Mère par *M. Louis,* in Mém. de l'Acad. de Chir. t. v. 4to. Encyclopédie Méthodique, Partie Chir. art. Dure-Mère. *J. P. Kaufmann,* de Tumore Capitis fungoso post Cariem Cranii exorto. Helmst. 1743. *Lassus,* Pathologie Chir. t. 1. p. 497, ed. 1809. *J.* and *C. Wenzel,* über die Schwammigen Auswuchse auf der aussern Hirnhaut. Fol. Mainz. 1811. Ph. v. *Walther,* in Journ. für Chir. von *C. Graefe,* &c. b. 1. p. 55, c. 8vo. Berlin, 1820. Professor *Chelius,* in Archives de Méd. Mars. 1832.

For inflammation of the dura mater, see HEAD, INJURIES OF.

DYNAMOMETER. An instrument, employed by M. Malgaigne for measuring the degree of extension made with pulleys in the reduction of dislocations. (See *Mém. de l'Acad. R. de Méd.* t. v. p. 143.) It will serve also to measure the force exerted in lithotrity.

E

EAR, DISEASES OF. An organ, so valuable and necessary to the perfection of our existence, as the ear, should have all the resources of surgery exerted for the preservation of its integrity, and the removal of the diseases, with which it may be affected. What, indeed, would have been our lot, if nature had been less liberal, and not endued us with the sense of hearing? As Leschevin has observed, we should then have been ill qualified for the receipt of instruction; a principal inlet of divine and human knowledge would have been closed; and there being no reciprocal communication of ideas, our feeble reason could never have approached perfection. Even our life itself, being as it were dependent upon all such bodies as surround us, would have been incessantly exposed to dangers. The eyesight serves to render us conscious of objects which present themselves before us, and, when we judge them to be hurtful, we endeavour to avoid them. But, to say nothing of our inability to look on all sides at once, our eyes become of no service to us, whenever we happen to be enveloped in darkness. The hearing is then the only sense that watches over our safety. It warns us, not only of every thing which is moving about us, but likewise of noises which are more or less distant. Such are the inestimable advantages, which we derive from this organ. Its importance, when healthy, makes it worthy of the utmost efforts of surgery, when diseased. (See *Méd. sur les Sujets proposés pour le Prix de l'Acad. Royal de Chirurgie,* t. ix. pp. 111, 112, ed. 12mo.)

It is not many years since the diseases of the ear were a subject, on which the greatest ignorance and the most mistaken opinions prevailed; and, indeed, how could any correct pathological information be expected, while anatomists had not given a complete and accurate description of the organ itself? Also, notwithstanding what has now been made out respecting disorders of the ear, and that within the last twelve or sixteen years the knowledge of them has nearly equalled that of the eye, it is generally admitted that they still require much further investigation. Though Duverney, Valsalva, Morgagni, &c. dispelled some of the darkness which covered this branch of surgery, they left a great deal undone. Since their time, science has been enriched with the valuable discoveries of Cotunni, Meckel, Scarpa, and Comparetti; the two first of whom demonstrated that the labyrinth is filled with a limpid fluid, and not (as was pretended) with confined air; while the last two distinguished anatomists favoured the public with the first very accurate description of the parts composing the labyrinth, especially the semicircular canals.

In 1763, the French Academy of Surgery offered a prize for the best essay on diseases of the ear, and two years afterwards, the honour was adjudged to that of Leschevin, senior surgeon of the hospital at Rouen. This memior is still of great value, few modern treatises being more complete. The most useful contributors to our stock of information on the pathology of the ear, subsequently to M. Leschevin, have been Kritter, and Lenten (*Ueber das schwere Gehoer*, Leipz. 1794); Trampel (*Arnemann's Magaz.* b. ii. 1798); Pfingsten (*Vieljahrige Erfahrung ueber die Gehoerfehler*, Kiel, 1802); Alard (*Sur le Catarrhe de l'Oreille*, 8vo. Paris, 1807, edit. 2); Sir A. Cooper (*Phil. Trans.* 1802); Portal (*Anat. Méd.* 1803); J. C. Saunders (*Anat. and Dis. of the Ear*, 1806); Boyer (*Mal. Chir.* t. vi.); Itard (*Traité des Mal. de l'Oreille*, 8vo. 2 tomes); Saissy, in an essay, which received the approbation of the Medical Society of Bordeaux; Rosenthal in a short, but sensible tract on the pathology of the ear (see *Journ. Complém.* t. vi. 1820); and Krämer in a treatise recently published. [The works of Mr. Pilcher, *the Anatomy, Economy, and Diseases of the Ear;* that of Mr. Wilde, *Aural Surgery*; and of Mr. Toynbee, *the Diseases of the Ear, their Nature, Diagnosis, and Treatment,* have added much to our knowledge of aural pathology and surgery.]

Notwithstanding the laudable endeavours of so many men of eminence, the pathology of the internal ear, and the treatment of its diseases, are far, I may say, very far from a high state of improvement. To further advances, indeed, some discouraging obstacles present themselves: the auditory apparatus is extremely complicated; the most important parts of it are entirely out of the reach of ocular inspection: the anatomy of the organ is perhaps not yet completely unravelled; the exact uses and action of several parts of it, anatomically known, are still involved in mystery; the opportunities of dissecting the ear in a state of disease are neither frequent, nor duly watched; and even when they are taken, and when vestiges of disease or imperfection are traced to particular parts of the organ, the utmost difficulty is experienced in drawing any useful practical conclusion, because the natural uses of those parts, and the precise manner in which they contribute to the perfection of the ear, are not known to the most enlightened physiologists. We are here nearly in the same helpless dilemma as a watchmaker would be, were he in examining the interior of a watch, to find parts broken and out of order, the exact uses of which, in the perfection of the instrument, he had not first studied and comprehended. In fact, the physiology of the ear is but imperfectly understood; and, as Rosenthal remarks (*Journ. Complém.* t. vi. p. 17), if, notwithstanding the progress made in optics, and the complete knowledge of the structure of the eye, a perfect explanation has not yet been given of the phenomena of this organ, as an instrument of vision, we cannot wonder, that with far more circumscribed information about acoustics, and the greater difficulty of unravelling the structure of the ear, so little progress should have been made in the physiology of the latter organ. Were it practicable in acoustics to arrive at that precision and certainty, which would enable us to establish laws in the theory of sound, as fixed as those which relate to light, this void in physiological science might perhaps be obviated. But Rosenthal justly argues, that hitherto the approach to perfection has not been made, and this notwithstanding the learned and valuable labours of Culdain. (*Akustik.* 4to. Leipz. 1802.) Some facts, however, are admitted to be well ascertained, and the researches of Autenrieth and Kerner (*Reil's Archiv. für die Physiol.* t. ix. pp. 313—376) are honourably mentioned; for, though they only elucidate the function of the conducting part of the ear, they are of unquestionable importance to the medical practitioner. It is clearly proved, that the difference in the length and breadth of the meatus auditorius, the form of the membrana tympani, and the make of the cavity of the tympanum, modify sound; that is to say, that the differences of structure of the auricle and meatus auditorius externus, which merely receive and concentrate the sonorous undulations, as these emanate from a vibrating body, can only influence the degree of force, or weakness of the sound; while, on the contrary, the differences of structure in the membrane and cavity of the tympanum are not limited to this effect, but the greater or less tension of the one, and the more or less considerable capacity of the other, appear to alter in a greater or lesser degree the particular character of the sound. (*Journal Complém.* t. vi. p. 20.) [We would gladly make honourable mention also of Sir John Herschel and Mr. Wheatstone, whose elucidations of the doctrine of sound are likely to throw light upon the physiology of hearing.]

1. *Wounds and Defects of the external Ear.*

The external ear, which is a sort of instrument calculated for concentrating the undulations or waves of sound, may be totally cut off, without deafness being the consequence. For a few days after the loss, the hearing is rather hard; but the infirmity gradually diminishes, the increased sensibility of the auditory nerve compensating for the imperfection of the organic apparatus. (*Richerand, Nosogr. Chir.* t. ii. p. 122, éd. 2.)

Dr. Hennen says, that he has met with a case where the external ear was completely removed by a cannon-shot, and yet the sense of hearing was as acute as ever. (*Principles of Military Surgery*, p. 348, ed. 2.) Another case, recorded by Wepfer, also proves, that a total loss of the auricle may not cause any material injury of hearing, for the patient of whom he speaks had had the whole of the external ear destroyed by ulceration, and yet could hear as well as before the loss. (*Kritter und Lentin über das schwere Gehoer*, p. 19, Leipz. 1794.) [Mr. Toynbee gives a case in which the watch was heard at a normal distance on both sides after the removal of the ears.] However, if we are to credit the statement of other writers, the recovery is generally far less complete. Thus Leschevin notices, that they who have lost the external ear, or have it naturally too flat, or ill-shaped, have the hearing less fine. The defect can only be remedied by an artificial ear, or an ear-trumpet, which, receiving a large quantity of the sonorous undulations, and directing them towards the meatus auditorius, thus does the office of the external ear. (*Prix de l'Acad. Royale de Chir.* t. ix. p. 120, edit. 12mo.)

Wounds are not the only causes by which the external ear may be lost: its separation is sometimes the consequence of ulceration, and sometimes the effect of the bites of horses and other animals. In cold climates, it is frequently frozen, and afterwards attacked with inflammation and sloughing. When the external ear is not totally separated from the head, the surgeon should not despair of being able to accomplish the reunion of it. This attempt should always be made, however small a connection the part may have with the skin; for, in wounds of this kind, the efforts of surgery have occasionally succeeded beyond all expectation.

Wounds of the external ear, whatever may be their size and shape, do not require different treatment from that of the generality of other wounds. The reunion of the divided part is the only indication, and it may be in most instances easily fulfilled by means of methodical dressings. Such writers as have recommended sutures for wounds of the ear (says Leschevin), have founded this advice upon the difficulty of applying to the part a bandage, that will keep the edges of the wound exactly together. The cranium, however, affords a firm and equal surface, against which the external ear may be conveniently fixed. Certainly, it is not more easy to secure dressings on the nose than on the ear; and yet cases are recorded, in which the cartilaginous part of the nose was wounded, and almost entirely separated, and the union was effected without the aid of sutures. (See *Mém. de M. Pibrac sur l'Abus des Sutures, in Mém. de l'Acad. de Chir.* tom. iii.)

In wounds of the ear, then, we may conclude that sutures are generally useless and unnecessary. As examples may occur, however, in which the wound may be so irregular and considerable as not to admit of being accurately united, except by this means, it should not be absolutely rejected. An enlightened surgeon will not abandon altogether any curative plans; he only points out their proper utility, and keeps them within their right limits. When sticking plaster, simple dressings, and a bandage that makes moderate pressure, appear insufficient for keeping the edges of a wound of the ear in due contact, the judicious practitioner will not hesitate to employ sutures.

When a bandage is applied to the external ear, it should only be put on with moderate tightness, since much pressure gives considerable uneasiness, and may induce sloughing. In order to prevent these disagreeable effects, Leschevin advises us to fill the space behind the ear with soft wool or cotton, against which the part may be compressed without risk. (Op. cit. p. 119.)

Baron Boyer remembers a medical student, who was compelled by an ulcer on the sacrum to lie for a long time on his side, in which posture the pressure on the ear caused a slough of the antihelix, and after the separation of the dead part, an aperture, large enough to receive the end of the little finger, was left in the pinna or auricle.

In the application of sutures to the ear, the ancients caution us to avoid carefully the cartilage, and to sew only the skin. They were fearful, that pricking the cartilage would make it mortify, "*ce qui est souvent fois arrivé*," says Paré. But, notwithstanding so respectable an authority, as Leschevin has remarked, the moderns make no scruple about sewing cartilages. In wounds of the nose, Verduc expressly directs the skin and cartilage to be pierced at once, and the success of the plan is put out of all doubt by a multitude of facts. The same treatment may also be safely extended to the ear.

In this section, a few malformations of the external ear require notice. Sometimes the orifice of the meatus auditorius is diminished by the tragus, antitragus, and antihelix being depressed into it, Here the excision of these wrongly formed eminences has been recommended, as a surer means of perfecting the sense of hearing, than the use of any tube, or dilating instruments. The tragus has been known to project considerably backwards, and to apply itself most closely over the orifice of the meatus, which was also a mere slit, instead of a round opening. In one case of this description, relief was obtained by the introduction of tubes, calculated to maintain the tragus in its proper position. (*Dict. des Sciences Méd.* t. xxxviii. p. 28.)

Sometimes the outer ear is entirely wanting. Thus Fritelli has given an account of a child in this condition, whose physiognomy at the same time strongly resembled that of an ape. (*Orteschi Giorn. di Med.* t. iii. p. 80.) Oberteuffer has also recorded an example of a total deficiency of the auricles in an adult, who yet heard very well. (*Stark's Neues Archiv.* b. ii. p. 638. *J. F. Meckel, Handbuch der Pathol. Anat.* b. i. p. 400. Leipz. 1812.)

I remember a child, which was exhibited many years ago in London, as a curiosity; it was entirely destitute of external ears, and no vestiges of the meatus auditorii could be seen, these openings being completely covered by the common integuments. Yet the child could hear a great deal, though the sense was certainly dull and imperfect. I recollect, that the circumstance of the patient hearing so well as he did, was what excited considerable surprise. I do not recollect, however, at the present time, the degree in which this sense was enjoyed, and several other circumstances, such as the child's age, power of speech, &c. The example is interesting, inasmuch as it proves, that even a deficiency of the auricles, combined with an imperforate condition of both ears, may be unattended with complete deafness, provided the internal and more essential parts of these organs are sound and perfectly formed.

Baron Boyer attended a young man, the lobule of one of whose ears extended in a very inconvement manner over the cheek: the redundant portion was removed with a pair of scissors, and the wound soon healed. [Less important malformations, as of the helix and antihelix, and of the tragus and antitragus, not interfering with the opening into the meatus, are of frequent occurrence, but do not require treatment.]

The auricle, not being a very irritable part, is not often inflamed, and when it is so, the affection is generally of an erysipelatous character. Portal has seen the part nearly an inch thick; and he takes notice of the prodigious thickness which the lobe of the ear sometimes acquires in women who wear heavy ear-rings, which keep up constant irritation. Small encysted and adipose swellings occasionally grow under the skin of the external ear, and demand the same treatment as swellings of the same nature in other situations. (See

Tumors.) Lastly, the external ear is frequently the seat of scrofulous and other ill-conditioned ulcers. These cases generally require cleanliness, alterative medicines, and to be dressed with the ung. zinci, or the ung. hydrarg. nitrat., or a solution of the nitrate of silver; and sometimes, when the sores resist for a long time the effects of medicine and the usual dressings, they will soon heal up, if the treatment be assisted with a blister, or seton, kept open on the nape of the neck. (See *Dict. des Sciences Méd.* t. xxxviii. pp. 28, 29.) [The auricle is expecially prone to attacks of exanthematous disease, both acute and chronic, and more particularly to the eruptions of scarlet fever and small pox, and to herpes and psoriasis; all of which are liable to extend along the auditory canal, and to implicate the membrana tympani.]

2. *Of the Meatus Auditorius, and its Imperfections.*

This is the passage, which leads from the cavity of the external ear, called the concha, down to the membrane of the tympanum. It is partly cartilaginous and partly bony, and has an oblique and curved direction, so that its whole extent cannot be easily seen. There are circumstances, however, in which it is proper to look as far as possible into the passage. Such is the case, when the surgeon is to extract any foreign body, to remove an excrescence, or to detect any other occasion of deafness ; [but above all, to ascertain the condition of the membrane of the tympanum, and of the cavity itself when the membrane is ulcerated.] Fabricius Hildanus gives a piece of advice upon this subject, not to be despised; namely, to expose the ear to the rays of the sun, in order to be enabled to see the very bottom of the passage.

[As sunlight cannot always be obtained it is desirable to use artificial light. For this purpose the portable lamp made by Miller, or the gas lamp made by Weiss, may be used. For the purpose of straightening the external meatus, and of conducting inwards the rays of light, a speculum must be used. The most efficient is the tubular ear speculum, oval at its small extremity.]

The surgical operations practised on the meatus auditorius, are confined to opening it, when preternaturally closed, extracting foreign bodies, washing the passage out with injections, removing excrescences, opening abscesses, &c. &c.

The case which we shall next treat of, is the imperforation of the meatus auditorius externus, a defect with which some children are born.

When the malformation exists in both ears, it generally renders the subject dumb, as well as deaf, for, as he is incapable of imitating sounds, which he does not hear, he cannot of course learn to speak, although the organs of speech may be perfect, and in every respect rightly disposed. In this case, the surgeon has to rectify the error of nature, and (to use the language of Leschevin) he has to give, by a double miracle, hearing and speech to an animated being, who, deprived of these two faculties, can scarcely be regarded in society as one of the human race. How highly must such an operation raise the utility and excellence of surgery in the estimation of the world!

When the meatus auditorius externus is merely closed by an external membrane, the nature of the case is evident, and the mode of relief equally easy. But, when the membrane is more deeply situated in the passage, near the tympanum, the diagnosis is attended with increased difficulty, and the treatment with greater trouble.

If the preternatural membrane be external, or only a little way within the passage, it is to be divided with a bistoury ; the small flaps are to be cut away; a tent, of a suitable size, is to be introduced into the opening; and the wound is to be healed *secundum artem*, care being taken to keep it constantly dilated, until the cicatrisation is completed.

When the obstruction is deeply situated, we must first be sure of its existence, which is never ascertained, or even suspected, till after a long while. It is not till after children are past the age at which they usually begin to talk, that any defect is suspected in the organ of hearing, because, until this period, little notice is taken, whether they hear or not. As soon as it is clear that this sense is deficient, the ears should always be examined with great attention, in order to discover, if possible, the cause of deafness. Sometimes, the infirmity depends upon a malformation of the internal ear, and the cause does not then admit of detection. The most convenient method of making the examination is to expose the ear, which is about to be examined, to the light of the sun. In this situation, the surgeon will be able to see beyond the middle of the bony part of the meatus, if he places his eye opposite the orifice of the passage, and takes care to efface the curvature of the cartilaginous portion of the canal, by drawing upward the external ear. If the passage has been carefully cleansed before the examination, the skin forming the obstruction, may now be seen, unless it be immediately adherent to the membrana tympani.

When the preternatural septum is not closely united to the tympanum, its destruction should be attempted, and hopes of effecting the object, either suddenly or gradually, may reasonably be entertained. According to Leschevin, the particular situation of the obstruction is the circumstance, by which the surgeon ought to be guided in making a choice of the means for this operation. If the membranous partition is so far from the tympanum, that it can be pierced without danger of wounding the latter part, there can be no hesitation in choosing the plan to be adopted. In the contrary state of things, Leschevin is an advocate for the employment of caustic, not only on account of the risk of injuring the tympanum with a cutting instrument, but, also because, if the puncture were ever so well executed, a tent could not be introduced into it, so as to prevent it from closing again.

In the first case, a very narrow sharp-pointed bistoury should be used : after its blade has been wrapped round with a bit of tape to within a line of the point, it is to be passed perpendicularly down to the preternatural membrane, which is to be cut through its whole diameter. The instrument being then directed first towards one side, then the other, the crucial incision is to be completed. As the flaps, which are small and deeply situated, cannot be removed, the surgeon must be content with keeping them separated by means of a blunt tent. The wound will heal just as favourably as that occasioned in removing the imperforation of the concha, or outer part of the meatus auditorius. (*Prix de l'Acad. de Chir.* pp. 124—126,

t. ix.) In the second case, that is to say, when the risk of wounding the membrana tympani leads us to prefer the employment of caustic, the safest and most commodious way of putting the plan into execution would be that of touching the obstruction, as often as circumstance may require, with the extremity of a bougie armed with nitrate of silver. In the intervals of the applications, no dressings need be introduced, except a bit of clean soft cotton, for the purpose of absorbing any discharge which may take place within the passage.

It is manifest, that if the whole, or a considerable part of the meatus auditorius externus were wanting, the foregoing measures would be insufficient. The following observations of Leschevin merit attention: — "I do not here allude to cases, in which a malformation of the bone exists. I know not, whether there are any examples of such an imperforation; but, it is clear, that it would be absolutely incurable. I speak of a temporal bone perfectly formed in all its parts, and the meatus auditorius of which, instead of being merely lined by a membrane, as in the natural state, is blocked up by the cohesion of the parietes of this membrane throughout a certain extent of the canal; just as the urethra, rectum, or vagina, is sometimes observed to be not simply closed by a membrane, but by a true obliteration of its cavity.

"Such a defect in the ear may be congenital, and it may also arise from a wound, or ulceration, of the whole circumference of the meatus auditorius externus, this canal having become closed by the adhesion of its parietes, on cicatrisation taking place.

"Such an imperforation, whether congenital or accidental, must certainly be more difficult to cure than the examples treated of above; but," says Leschevin, "I do not for this reason believe, that the case ought to be entirely abandoned. Yet, I would not have the cure attempted in all sorts of circumstances. For instance, if the defect only existed in one ear, and the other were sound, I would not undertake the operation, because, as the patient could hear tolerably well on one side, the advantages which he might derive from having the enjoyment of the other ear, would not counterbalance the pain and bad symptoms occasioned by such an experiment, the success of which is extremely uncertain. I would not then run the risk of making a perforation, except in a case of complete deafness; and I propose this means only as a dubious one, upon the fundamental maxim, so often laid down, that it is preferable to employ a doubtful remedy, than none at all.

"With respect to the mode of executing this operation," says Leschevin, "the trocar seems the most eligible instrument. I would employ one that is very short, and the point of which is bluntish, and only projects out of a canula as little as possible. This construction would indeed make the instrument less adapted to pierce any thing; but, still, as the parts to be perforated are firm, their division might be accomplished sufficiently well; and the inconvenience of a trivial difficulty in the introduction of the trocar is comparatively much less than that which would attend the danger of wounding with a sharper point the membrane of the tympanum. I would plunge the point of the instrument into the place, where the opening of the meatus auditorius externally ought naturally to be, and which would be denoted, either by a slight depression, or at all events by attending to the different parts of the ear, especially the tragus, which is situated directly over this passage. I would push in the trocar gently, in the direction of the canal formed in the bone, until the point of the instrument felt as if it had reached a vacant space. Then, withdrawing the trocar, and leaving the canula, I would try whether the patient could hear. I would then introduce into the cavity of the canula itself a small, rather firm tent, of the length of the passage, or a small bougie. By means of a probe, I would push it to the end of the canula, which I would now take out, observing to press upon the tent, which is to be left in. The rest of the treatment consists in keeping the canal pervious, making it suppurate, and healing it with common applications. One essential caution, however, would be that of keeping the part dilated long after it had healed: otherwise, it might close again, and a repetition of the operation become necessary. This happened to Heister, as he himself apprises us, and it occurred to Roonhuysen in treating imperforations of the vagina.

"If the cohesion of the parietes of the meatus auditorius externus were to extend to the membrana tympani inclusively, the operation would be fruitless; but, as it is impossible to ascertain this circumstance before the attempt is made, the surgeon would incur no disgrace by relinquishing the operation, and giving up the treatment of an incurable disease. If, then, after the trocar were introduced to about the depth of the tympanum, the situation of which must be judged of by our anatomical knowledge, no cavity were met with, the operation should be abandoned; and if, in these circumstances, any one were to impute the want of success to the inefficacy of surgery, or the unskilfulness of the surgeon, he would act very unfairly.

"It is also plain, that such an operation could cure a congenital deafness, only inasmuch as it might depend upon the imperforation; for, if there should exist, at the same time, in the internal ear, any malformation, destructive of the power of the organ, the remedying of the external defect would be quite useless." (*Leschevin, in Prix de l'Acad. de Chirurgie*, tom. ix. pp. 127—132.)

We find, that this author entertains a great dread of wounding the membrana tympani, and certainly he is right in generally insisting upon the prudence of avoiding such an accident. It will appear, however, in the sequel of this article, that under certain circumstances puncturing the tympanum has been successfully practised as a mode of remedying deafness. The operation, however, demands caution; for, if done so as to injure the connection of the malleus with the membrana tympani, the hearing must ever afterwards be very imperfect. [More extensive acquaintance with ear diseases shows that the above-named malformations are of rare occurrence; and that when they do take place are generally met with at the outer part of the canal, and consequently within reach of easy treatment: this circumstance is to be expected in the fœtal and infantile life, from the superficial position of the membrana tympani, and the shortness of the canal, which, lengthening in the progress of development carries the cuticular lining with it. But a more important malformation, pointed out by Mr. Toynbee, is occasionally met with in the osseous part of the canal, arising from enlargements from the bone; these, however, are growths occurring at any interval after birth; they may be one or several from opposite surfaces of the meatus auditorius, more or less near to, or even in contact with the membrane; but the writer has not yet positively known them to encroach upon the cavity of the tympanum. The skin covering them is bright, polished, vascular, and dry, the result of distention. The interspace between these exostoses usually admits the sonorous waves, and then the sense of hearing is little or not at all impeded; but the small aperture is so likely to be occupied by cerumen and other secretions from the canal, that deafness is a frequent result; further, the bony growths may become so firmly approximated as to totally close the tube. These tumors may be diminished by the use of iodine locally and generally, and no operation for their removal must be attempted.]

3. *Unusual Smallness of the Meatus Auditorius Externus.*

Imperforation is not the only congenital imperfection of the meatus auditorius; this passage is occasionally too narrow for the admission of a due quantity of the sonorous undulations, and the sense is of course weakened. Leschevin mentions that M. de la Metrie found this canal so narrow in a young person, that it could hardly admit a probe. What has been observed concerning the imperforation, is also applicable to this case. If it depends upon malformation of the bone, it is manifestly incurable; but, if it is owing to a thickening of the soft parts within the meatus, hopes may be indulged of doing good by gradually dilating the passage with tents, which should be increased in size from time to time, and, lastly, making the patient wear, for a considerable time, a tube, adapted to the part in shape. (*Leschevin, in Prix de l'Acad. de Chirurgie*, t. ix. p. 132.)

Mr. Earle has published a case, in which the diameter of the meatus auditorius was considerably lessened by a thickening of the surrounding parts, and especially of the cuticle, attended with a discharge from the passage, and great impairment of hearing. A cure was effected by injecting into the passage a very strong solution of the nitrate of silver, which, in a few days, was followed by a detachment of the thickened portions of cuticle. This evacuation was assisted by throwing warm water into the passage. (See *Med. Chir. Trans.* vol. x. p. 411, &c.) Boyer was consulted for a deafness, arising from a malformation, which consisted of a flattening of the meatus, its opposite sides being for some extent in contact. The patient was advised to wear in the ear a gold tube of suitable shape, by which means he was enabled to hear perfectly well. [It must be confessed that such *congenital* defects rarely fall under treatment, but acquired narrowness of the canal, that consequent upon chronic inflammation, of various characters, is not at all infrequent; but the hearing power is not diminished thereby.]

4. *Faulty Shape of the Meatus Auditorius Externus.*

Anatomy informs us, that this passage is naturally oblique, and somewhat winding; and natural philosophy teaches us the necessity of such obliquity, which multiplies the reflections of the sonorous waves, and thereby strengthens the sense. This theory, says Leschevin, is confirmed by experience; for, there are persons, in whom the meatus auditorius is almost straight, and they are found to be hard of hearing. If there is any means of correcting this defect, it must be that of substituting, for the natural curvature of the passage, a curved and conical tube, which must be placed at the outside of the organ, just like a hearing trumpet. The acoustic instrument, invented by Deckers, which is much more convenient, might also prove useful. (Op. cit. p. 133.)

[Experience readily teaches us, however, that such defects occur without producing inconvenience, at least that is to be appreciated; it most probably happens that the deficiency in hearing is supplied by an exaltation in function of the auditory nerve, occurring at an age before the defect is perceived.]

5. *Extraneous Substances, Insects, &c., in the Meatus Auditorius Externus.*

Foreign bodies met with in this situation are inert substances, which have been introduced by some external force; insects, which have insinuated themselves into the passage; or the cerumen itself, hardened in such a degree, as to obstruct the transmission of the sonorous undulations. Worms, which make their appearance in the meatus auditorius, are always produced subsequently to ulcerations in the passage, or in the interior of the tympanum, and very often such insects are quite unsuspected causes of particular symptoms. In the cases of surgery, published in 1778, by Acrel, there is an instance confirming the statement just offered. It is the case of a woman, who, having been long afflicted with a hardness of hearing, was suddenly seized with violent convulsions, without any apparent cause, and soon afterwards complained of an acute pain in the ear. This affection was followed by a recurrence of convulsions, which were still more vehement. A small tent of fine linen, moistened with a mixture of oil and laudanum, was introduced into the meatus auditorius, and, on removing it the next day, several small round worms were observed upon it, and from that period all the symptoms disappeared. To this case, we shall add another from Morgagni:—A young woman consulted Valsalva, and told him, that when she was a girl, a worm had been discharged from her left ear; that another one, about six months ago, had also been discharged, very much like a small silkworm in shape. This event took place after very acute pain in the same ear, the forehead and temples. She added, that since this, she had been tormented with the same pains, at different intervals, and so severely, that she often swooned away for two hours together. On recovering from this state, a small worm was discharged, of the same shape as, but much smaller than, the preceding one, and she was now afflicted with deafness and insensibility on the same side. After hearing this relation, Valsalva no longer entertained any doubt of the membrane of the tympanum being ulcerated. He proposed the employment of an injection, in order to destroy such worms as yet remained. For this purpose, distilled water of St. John's wort, in which mercury had been agitated, was used. In order to prevent an occurrence of the inconvenience, Morgagni recommends the affected ear to be closed up when the patient goes to sleep, in autumn and summer. If this be not done, flies, attracted by the suppuration, enter the meatus auditorius, and, while the patient is unconscious, deposit their eggs in the ear. Acrel, in speaking of worms, generated in the meatus auditorius, observes, that there is no better remedy for them than the decoction of ledum palustre, injected into the ear several times a day. However, as this plant cannot always be procured, an infusion of tobacco in oil of almonds may be used, a few drops of which are to be introduced into the ear, and retained there by means of a little bit of cotton. This application, which is not injurious to the lining of the passage, is fatal to insects, and especially to worms. When caterpillars, ants, earwigs, and other insects, have insinuated themselves into the meatus auditorius, they may be removed with a piece of lint, smeared with honey; and when they cannot be extracted by this simple means, they may sometimes be taken out with a small pair of forceps. In general, however, the most safe and expeditious practice for the removal of small insects, peas, beads, and other extraneous bodies, from the meatus auditorius, is to throw tepid water into the passage with a proper syringe, by which means they are forced out with the fluid. When the bead, or globular substance is small, (according to Mr. Buchanan) the best mode of extraction will be by means of the syringe, and injection of tepid water. For this purpose, the point of the syringe ought to be pressed gently against the edge of the meatus, so that it may occupy as little of the diameter of the tube as possible, and when the injection arrives at the membrana tympani, the regurgitation will force the bead, or other substance, outwards. If this be rather large, it may perhaps remain at the entrance of the meatus, whence it ought to be extracted by means of a pair of forceps. (See *Buchanan's Illustrations of Acoustic Surgery*, p. 40.)

[In this country, at least, the introduction of insects into the meatus is rare, and if the ova be deposited in the pus from a diseased tympanum, they probably die ere they become developed.]

In May, 1829, I was called to a child about two years and a half old, into one of whose ears a pebble, and into the other a French bean, had been pushed by another child, and remained there for ten months, causing complete deafness and extreme suffering. By throwing tepid water forcibly into the ear, I soon dislodged these foreign bodies, which lay close against the tympanum, entirely hidden by the swollen state of the lining of the ear, indurated wax, and dried discharge. With a bent probe their extraction was then readily effected. Several surgeons, previously consulted, had failed in their endeavours to remove the substances by other methods.

The presence of foreign bodies in the ear often occasions the most extraordinary symptoms, as we may see in the fourth observation of Fabricius Hildanus, Cent. 13. After four surgeons, who had been successively consulted, had in vain exerted all their industry to extract a bit of glass from the left ear of a young girl, the patient found herself abandoned to the most excruciating pain, which soon extended to all the side of the head, and which, after a considerable time, was followed by a paralysis of the left side, a dry cough, suppression of the menses, epileptic convulsions, and, at length, an atrophy of the left arm. Hildanus cured her, by extracting the piece of glass, which had remained eight years in her ear, and had been the cause of all this disorder. Although the extraction must have been very difficult, it does not appear that Hildanus found it necessary to practice an incision behind the ear, as some authors have advised, and amongst them Duverney, who has quoted the foregoing case. We must agree with Leschevin, that such an incision does not seem likely to facilitate the object very materially; for, it must be on the outside of the extraneous substance, which is in the bony part of the canal. The incision enables us, in some measure, to avoid the obliquity of the passage, as Duverney has observed; but it is not such obliquity of the cartilaginous portion of the canal, that can be a great impediment; for, as it is flexible, it may easily be made straight, by drawing the external ear upward. Hence, Fabricius ab Aquapendente rejected this operation, first proposed by Paulus Ægineta; and it is justly disapproved of by Leschevin. (*Prix de l'Acad. de Chir.* t. ix. p. 147, édit. 12mo.)

Sabatier relates a case, in which a paper ball, which had been pushed into the meatus auditorius, made its way by ulceration into the cavity of the tympanum, where an abscess formed, which communicated with the interior of the cranium. (*Dict. des Sciences Méd.* t. vii. p. 8.)

[It is impossible too strongly to guard the practitioner against too great interference in attempts to remove these foreign bodies. It has frequently occurred to the writer of this article to witness the entire destruction of the tympanum in such endeavours. No attempt should be made unless the body is distinctly seen, or at all events prominently felt; the latter proof of its existence must, however, be received with very great caution. It has several times occurred to the writer to witness the long duration, in two or three instances for many years, of a foreign body in the meatus, which has unsuspectingly given rise to follicular and other abscesses, and occasional deafness; all which untoward effects subsided upon the removal of the offending material.]

6. *Meatus Auditorius obstructed with thickened or hardened Cerumen.*

The cerumen, secreted in the meatus auditorius by the sebaceous glands, frequently accumulates there in large quantities, and becoming harder and harder, at length acquires so great a degree of solidity as entirely to deprive the patient of the power of hearing. Galen has remarked, *è numero eorum quæ meatum obstruunt, sordes esse quæ in auribus colligi solent.* This species of deafness is one of those kinds which are the most frequent, and, at the same time, the most easy of cure. Formerly injections, either with simple olive oil, or oil of almonds, were recommended. The injection was retained by a piece of cotton, and when there was reason to believe that the matter was sufficiently softened, an attempt was made to extract it by means of a small scoop-like instrument. Various experiments were made by Haygrath, at Chester, in 1769, from which it appears that warm water is preferable to oil. The water dissolves the mucous matter which connects together the truly ceruminous particles, and which is the cause of their tenacity; other applications only succeeding by reason of the water which they contain.

The lodgment of hard pellets of wax, if neglected, may ultimately produce ulceration of the tympanum, and other serious mischief. Thus, in one case, Ribes and Chaussier found the handle of the malleus separated from its head, partly destroyed, and covered with the hardened cerumen that had made its way into the tympanum. (See *Dict. des Sciences Méd.* t. xxxviii. p. 30.)

"The symptoms (says Mr. Saunders) which are attached to the inspissation of the cerumen are pretty well known. The patient, besides his inability to hear, often complains of noises, particularly a clash or confused sound in mastication, and of heavy sounds, like the ponderous strokes of a hammer.

"The practitioner is led by the relation of such symptoms to suspect the existence of wax; but he may reduce it to a certainty by examination.

"Any means capable of removing the inspissated wax may be adopted; but syringing the meatus with warm water is the most speedy and effectual, and the only means necessary. As the organ is sound, the patient is instantaneously restored." (*Anatomy of the Human Ear, with a Treatise on its Diseases, by J. C. Saunders*, 1806, p. 27, 28.)

In order to throw an injection into the ear with effect, a syringe, capable of holding from four to six ounces, should be employed, and the fluid injected with a good deal of force, care being taken to let it enter in the natural direction, and not against one of the sides of the passage. The surgeon must also avoid pressing the pipe too deeply into the ear, so as to hurt the tympanum. As the fluid regurgitates with considerable rapidity, a small basin is to be held close up to the ear at the time of using the syringe, so as to catch the water, and hinder it from wetting the patient's clothes; for the surer prevention of which a napkin is also to be laid over the shoulder. In general it is necessary to throw the water into the ear six or seven times, or more, ere the pellets of wax are loosened, and entirely brought out; and sometimes, the injections will not completely succeed the first day on which they are employed. The evening before the syringe is to be used, a little warm water may be dropped into the ear.

[It not unusually happens that the patient, upon rising in the morning, finds himself deaf, not having been aware of a "hardness of hearing" some time previously; this new symptom is evidently occasioned by lying upon that side of the head, and the collection becoming moulded against the membrane of the tympanum. If any difficulty exist, or is expected, in the removal of the inspissated secretion, the ear had better be filled for a night or two with water, which is a better solvent than oil. In injecting, the water should be thrown along one side of the meatus, between the canal and the hard wax, and with force insufficient to excite pain.]

7. *Imperfect Secretion of Wax.*

When the wax is deficient in quantity, Mr. Buchanan recommends warmth and stimulant applications. He advises two drops of the following mixture to be introduced into the meatus auditorius, every night at bedtime:—℞. Acid. Pyrolign. Spir. Ætheris Sulphur. Ol. Terebinth. āā M. One tablespoonful of the following medicine is also to be taken at the same time:—℞. Tinct. Colchici ʒiij. Aq destillat. ℥ vj. M. If costiveness prevail, the pilulæ rhei. comp. are to be given. (See *Buchanan's Acoustic Surgery*, p. 60.)

When the quality of the secretion requires improvement, the meatus is to be frequently washed out, and a little of the infusion of quassia with rhubarb and magnesia given once or twice a day. The warm bath is to be occasionally used at bedtime, and the following powder exhibited:—℞. Hydrarg. chlor. gr. ij. Pulv. Ipecac. comp. ℈j. ft. Pulv. Horâ decubitûs sumend. In cases where the ear is preternaturally dry, and the cuticle of the meatus peels off, the ensuing injection is to be used every second or third day:—℞. Acid. Pyrolign. ʒij. Aquæ destillatæ ℥ vi. ft. lotio; or the vapour of a mixture of equal parts of distilled water and pyroligneous acid introduced three times a week into the meatus with the aid of a glass retort. A little cotton should afterwards be put into the ear. (See *Buchanan's Acoustic Surgery*, p. 62.)

[This is a most rare cause of deafness, if it ever occurs as a primary disease; this deficient secretion is not at all infrequently a part of a general loss of power of the whole organ, usually sympathising with an anesthenic auditory nerve. It also follows the various kinds of inflammation of the canal, particularly of the ceruminous follicles, and these especially may give rise to exfoliations of the cuticle. The remedy best suited to the latter condition is the ung. hydrar. nitr. melted and placed on the diseased part of the tube, and allowed to remain, or, being diluted, it may be frequently renewed; the various ointments of zinc, and of lead, are valuable applications.]

8. *Discharges from the Meatus Auditorius.*

Purulent discharges from the ear either come from the meatus auditorius externus itself, or they originate from suppuration in the tympanum, in consequence of blows on the head, abscesses after malignant fevers, the small-pox, or the venereal disease. [By far the most frequent cause of such discharges is scarlet fever, which occasions disease of the tympanum, as frequently as, perhaps more so than all the other exciting causes together; a circumstance to be expected from the tympanum being situated in the interval between the outer ear and the Eustachian tube, the exanthematous disease spreading along both canals.] In such cases the little bones of the ear are sometimes detached, and escape externally, and complete deafness is most frequently the consequence. However, in a few instances, total deafness does not follow even this kind of mischief, as I myself have witnessed on one or two occasions. [Deafness is not usually complete upon the loss of the ossicula, though the hearing is generally much affected; but even sometimes its diminution is hardly perceptible, particularly in the young, in whom the auditory nerve, and the general capability of appreciating lessened sounds, may be so much increased in power as to supply in a great measure the deficiency occasioned by the loss of the mechanical portion of the organ. It does not generally happen that the stapes comes away, and when such is the case, complete deafness usually results; it has, however, occurred to the editor of this article to be certainly assured of the escape of the stapes, with good hearing still remaining.] There is greater hope when the disorder is confined to the meatus; as judicious treatment may now avert the most serious consequences.

In Acrel's surgical cases, there is a case relative to the circumstance of which we are speaking. Suppuration took place in the meatus auditorius externus, in consequence of acute rheumatism, which was followed by vertigo, restlessness, and a violent headach. The matter discharged was yellowish, of an aqueous consistence, and acid smell. The meatus auditorius was filled with a spongy flesh. On introducing a probe, Acrel felt a piece of rough bone, which he immediately took hold of with a pair of forceps, and extracted. From the time when this was accomplished, the discharge diminished; and, with the aid of proper treatment, the patient became perfectly well.

The meatus auditorius, like all other parts of the body, is subject to inflammation. This is frequently produced by exposure to cold. It is hardly necessary to say, that generally topical bleeding and antiphlogistic means are indicated. The meatus auditorius should also be protected from the cold air, particularly in the winter season, by means of a piece of cotton.

Mr. Saunders observes, "When the means employed to reduce the inflammation have not succeeded, and matter has formed, it is generally evacuated, as far as I have observed, between the auricle and mastoid process, or into the meatus. If it has been evacuated into the meatus, the opening is most commonly small, and the spongy granulations, squeezed through a small aperture, assume the appearance of a polypus. Sometimes the small aperture, by which the matter is evacuated, is in this manner even closed, and the patient suffers the inconvenience of frequent returns of pain from the retention of the discharge. When the parts have fallen into this state, it will be expedient to hasten the cure by making an incision into the sinus, between the auricle and mastoid process.

"It occasionally happens, that the bone itself dies in consequence of the sinus being neglected, or the original extent of the suppuration. The exfoliating parts are the meatus externus of the os temporis, or the external lamina of the mastoid process." (P. 24, 25.)

[A follicular abscess, or an abscess occurring in one or more of the ceruminous follicles, is a very fruitful source of such a discharge; it is often attended with extreme suffering from the non-yielding character of the surrounding parietes; and from the distension occupying the canal, complete deafness results, to be relieved only upon the subsidence of the tumefaction. These abscesses frequently require to be opened, and are to be treated with warmth and moisture in the ordinary manner.]

In some examples of purulent discharge from the ear, and particularly in scrofulous patients, Mr. Buchanan employs alterative medicines, as calomel, the tincture of iodine, and the compound rhubarb pills of the *Edin. Pharmacopœia.* He also sometimes has recourse to the pyroligneous injection. (See *Illustrations of Acoustic Surgery*, p. 93, &c.) Some additional cases in favour of the efficacy of iodine, in certain forms of deafness, may be found in Dr. Manson's work. (See *Medical Researches on the Effects of Iodine*, 8vo. London, 1825.)

9. *Excrescences in the Meatus Auditorius.*

Though the membrane lining the meatus auditorius is very delicate, it is not the less liable to become thickened, and to form polypous excrescences. As such tumors are ordinarily firmer in their texture than polypi of the nose, they are sometimes not so easily extracted with forceps. When they are situated near the external orifice, and admit of being taken hold of with a small pair of forceps, or a hook, and drawn outwards, they may easily be cut away. Sometimes the excrescences, instead of being adherent by a narrow neck, have a broad base, which occupies a considerable extent of the passage. In such cases, the use of escharotics has been proposed; but, they cannot be used without risk of injuring the tympanum. Mr. Buchanan prefers the practice of removing polypi of the meatus with forceps, and afterwards touching the part from which they grew with the ung. hydrarg. nitrat. or tinct. ferri muriatis. (*Acoustic Surg.* p. 74.) He also recommends washing out the passage every day with the injection, ℞. Acid. Pyrolign. ʒij. Aq. destillatæ ℥ vj. ft. lotio. I lately attended a lady, who had a round smooth tumor growing from the membrana tympani, to which it was attached by means of a long pedicle. It nearly filled the meatus, and was attended with a discharge. With the assistance of Mr. Morton, of University College, I cut through its pedicle, removed it, and then applied the nitrate of silver. But, in a few weeks, it grew again, and it was once more removed with the same result. I next intended to twist it off; but it was attacked with inflammation, and sloughed away. I do not at present know whether it is growing again.

10. *Herpes of the Meatus Auditorius.*

An herpetic ulcerous eruption sometimes affects the meatus auditorius and auricle, producing considerable thickening of the skin, and so great an obstruction of the passage, that a good deal of deafness is the consequence. Mr. Saunders remarks, that, in this case, "the ichor, which exudes from the pores of the ulcerated surface, inspissates in the meatus, and not only obstructs the entrance of sound, but is accompanied with a great degree of fetor. This disease is not infrequent. I have never seen it resist the effect of alterative medicines," the use of injections containing the bichloride of mercury, and the application of the unguentum hydrargyri nitratis. Mr. Saunders exhibited calomel as the alterative, and in one instance, employed a solution of the nitrate of silver as an injection. (P. 25, 26.) When the disease is obstinate, a seton should be made on the nape of the neck, or a blister be applied behind the ear. The tincture of iodine should also be tried.

[Extreme cleanliness is of the utmost importance in these and similar affections; in addition to which astringent lotions appear to be the most available, as the solutions of lead, of alum, of zinc, &c. A very useful form is liq. plumb. diacet. ʒss., acidi acetici diluti ʒss., aquæ ʒvij., to be dropped into the ear two or three times a day, or syringed in night and morning, as the urgency of the case may require.]

11. *Affections of the Tympanum.*

The ear is sometimes affected with a puriform ichorous discharge, attended with a loss of hearing, proportionate to the degree of disorganisation which the tympanum has sustained. Frequently, on blowing the nose, air is expelled at the meatus auditorius externus ; and, when this is the case, it is evident that the discharge is connected with an injury, or destruction of the membrana tympani. However, when the Eustachian tube is obstructed with mucus, or matter, or when it is rendered impervious, and permanently closed by inflammation, the membrana tympani may not be perfect, and yet, it is clear, no air can in this state be forced out of the external ear in the above manner. An examination with a blunt probe, or with the eye, while the rays of the sun fall into the passage, should therefore not be omitted. If the membrane have any aperture in it, the probe will pass into the cavity of the tympanum, and the surgeon feel that his instrument is in contact with the ossicula, or internal wall of the tympanum.

In this manner, the affection may be discriminated from an herpetic ulceration of the meatus auditorius externus. The causes are various : In scarlatina maligna, the membrana tympani occasionally inflames and sloughs ; the ossicula are all or in part discharged, and, if the patient live, he often continues quite deaf. An earach, in other words, acute inflammation of the tympanum, is the most common occasion of suppuration in this cavity, in which, and the cells of the mastoid process, a good deal of pus collects. At length the membrana tympani ulcerates, and a large quantity of matter is discharged ; but, as the secretion of pus still goes on, the discharge continues to ooze out of the external ear.

[In cases where the membrana tympani is absent, the use of the artificial membrana tympani has been suggested by Mr. Toynbee—cotton wool by Mr. Yearsley.]

Instead of stimulating applications, inflammation of the tympanum demands the rigorous employment of antiphlogistic means. Unfortunately, it is a too common practice, in this case, to have recourse to acrid spirituous remedies. Above all things, the repeated application of leeches to the skin behind the external ear, and over the mastoid process, should never be neglected. As soon as the inflammation ceases, the degree of deafness, occasioned by it, will also disappear. This, however, does not always happen.

When an abscess is situated in the cavity of the tympanum, Mr. Saunders thinks that the membrana tympani should not be allowed to burst by ulceration, but be opened by a small puncture. (P. 31.) However, unless there were the strongest ground for believing, that the Eustachian tube were impervious, this advice, I think, ought not to be followed, more especially as the symptoms are generally too vague to afford any degree of certainty in the diagnosis.

Sometimes the disease, of which we are treating, is more insidious in its attack : slight paroxysms of pain occur, and are relieved by slight discharges. The case goes on in this way, until, at last, a continual discharge of matter from the ear takes place. The disorder in its tendency is destructive to the faculty of hearing, and it rarely stops until it has so much disorganised the tympanum and its contents, as to occasion total deafness. Hence, Mr. Saunders insists upon the propriety of making attempts to arrest its progress,—attempts which are free from danger ; and he censures the foolish fear of interfering with the complaint, founded on the apprehension, that bad constitutional effects may originate from stopping the discharge.

If the case be neglected, the tympanum is very likely to become carious ; before which change, the disease was considered by Mr. Saunders, to be mostly curable.

Mr. Saunders divides the complaint into three stages : — 1. A simple puriform discharge. 2. A puriform discharge complicated with fungi and polypi. 3. A puriform discharge with caries of the tympanum. As the disease is local, direct applications to the parts affected are chiefly entitled to confidence. Blisters and setons may also be advantageously employed. Mr. Saunder's practice consisted in administering laxative medicines and fomenting the ear, while inflammatory symptoms lasted, and afterwards injecting a solution of the sulphate of zinc, or acetate of lead.

In the second stage, when there were fungi, he removed or destroyed them with forceps, afterwards touched their roots with the nitrate of silver, or injected a solution of alum, sulphate of zinc, or nitrate of silver.

Writers describe a relaxed state of the membrana tympani, as a cause of deafness. If, says a late author, after a discharge from the meatus auditorius externus, or cavity of the tympanum, or a dropsy of the latter cavity, the hearing remains hard, there is reason to suspect, that the infirmity may depend upon relaxation of the membrane of the tympanum, or paralysis of the internal muscle of the malleus. This suspicion will be strengthened, if the deafness should increase in damp, and lessen in dry, weather ; and particularly, if it be found, that the hearing is benefited by introducing into the ear dry warm tonic applications, such as the smoke of burning juniper-berries, or other astringent vegetable substances. The decoction of bark, used as an injection, is also said to have done good.

The relaxation of the tympanum, alleged to proceed from a rupture of the muscle of the malleus, is deemed incurable ; but it is not so with the case, which depends upon paralysis of this muscle. Here tonic injections into the tympanum, through the Eustachian tube, are recommended. (*Dict. des Sciences Méd.* t. xxxviii. p. 50.) Electricity, stimulating liniments, gargles, a blister, or the external use of strychnia, might also be tried.

Imperfect hearing is supposed sometimes to arise from preternatural tension of the membrane of the tympanum, indicated by the patient hearing better in wet than dry weather, and by his hearing what is spoken in a low tone, near his ear, better than anything said in a loud manner. The opinions delivered by writers on the causes of this affection are only uncertain conjectures. The local treatment recommended consists in injecting into the meatus auditorius emollient decoctions, or warm milk, or introducing into the passage a dossil of soft cotton, dipped in oil of sweet almonds. Nothing certain is known respecting the proper constitutional treatment, as must be clear from our ignorance of the causes of this form of disease of the ear.

Hardness of hearing appears sometimes to be caused by a chronic thickening of the membrane of the tympanum ; and it is alleged, that there are cases of this description, which proceed from syphilis, and require mercury. An issue in the arm nearest the affected ear, the tincture of iodine, and emollient and slightly stimulant injections, are likewise commended. When the tympanum was so considerably thickened, that there was no chance of restoring it to a healthy state, Portal questioned whether it might not be advisable to make a small opening in it? (*Précis de Chir. Pratique*, t. ii. p. 430.) This operation, which is said to have been first suggested by Cheselden, will be considered in the ensuing section.

Morgagni found the cavity of the tympanum intersected by numerous membranes, which impeded the movements of the ossicula. (*Epist.* an. vi. § 4.)

Meckel does not mention any example of a deficiency of all the ossicula. (*Handb. des Pathol. Anat.* b. i. p. 402.) Mersanni, however, found the incus wanting. (*Bonet Sepulch.* t. i. sect. 19, obs. 4, § 1.) Caldani, the malleus and incus. (*Epist. ad Haller*, t. vi. p. 142.) The latter case was unattended with any bad effect on the hearing; the first with deafness. In a deaf child, three years of age, Bailly found the ossicula of only ⅓ their proper size. (*Bonet Sepulch.* t. i. sect. 19, obs. 4, § 3.) In an example, where the fenestra rotunda was obstructed, Cotunnius found the ossicula twice as large as natural. (*De Labyrinthi Auris contentis*, § 72, and *Meckel's Handb. des. Pathol. Anat.* b. i. p. 402.) A case, in which all the ossicula were wanting, is on record. (See *Dict. des Sciences Méd.* t. xxxviii. p. 114.)

[Of the causes of deafness alluded to in this section—"affections of the tympanum"—the most common are: 1st. *Myringitis*, or inflammation of the membrana tympani, which most frequently commences in a subacute form, affording but little other indication of the disease beyond the resulting deafness, until it be examined in a good light. It may commence in the acute or chronic condition, then exhibiting the appropriate symptoms of severity or slowness; in the former case the cardinal signs of inflammation are very marked and prominent, yet unaccompanied by deafness until a change in the organisation of the membrane is effected beyond the mere increased vascularity. In the latter state effusion of fibrine takes place between the layers of the membrane, thickening its structure, and giving rise to a very marked deafness. Acute myringitis, when uncomplicated, most frequently subsides upon appropriate treatment; but it may terminate in ulceration, either through the membrane, or confined to the surface, or an aphthous appearance of the cuticular coverings may result: granulations from these ulcerated surfaces may occur, producing the vegetations to which allusions have already been made.

2nd. *Tympanitis*, or inflammation of the mucous membrane lining the cavity of the tympanum. This affection may be simply of the catarrhal character, producing an accumulation of mucus, and of course corresponding deafness, resulting from the impossibility of the vibrations of the membrane or the oscillations of the bones being maintained; a condition which generally subsides as the cause passes away, the mucus either escaping through the Eustachian tube or becoming absorbed. The tympanitis often extends to the submucous tissue, to the proper textures of the membrana tympani, occasioning myringo tympanitis, and terminating in thickening of the whole structures, or in the formation of bands of fibrine ankylosing the ossicles together and to the fenestra ovalis, and thus not infrequently producing permanent deafness. These circumstances ought to direct the surgeon's careful attention to the treatment of such cases in their early and incipient form. Acute tympanitis also terminates in suppuration of the cavity of the tympanum, which happily usually extends through the membrane, and thus the pus finds its customary discharge; it sometimes, more happily still, finds an escape through the Eustachian tube; which, however, in these severe cases is generally nearly closed towards the tympanic cavity: suppuration also extends backwards into the mastoid process, diseasing those cells. Disease of these cells not at all infrequently extends outwards through the bony parietes, forming external abscess, which is most constantly seated between the periosteum and the bone. Severe cases of tympanitis will ulcerate the parietes of the tympanum, and thus extend the disease through the walls to the dura mater and to the brain; it most frequently finds its way through the superior surface, but the inflammation of the bone is often traceable through the posterior as well as the anterior wall. This most severe form of tympanitis is constantly the result of malignant scarlet fever, as has been already observed. Further, it not infrequently happens that suppurations of the tympanum extend to the aqueduct of Fallopius, paralysing the portio dura, either by directly implicating that nerve in the disease, or by simple pressure of the pus upon its structure. The treatment in these various forms of inflammation must be for the most part strictly antiphlogistic, and conducted upon the ordinary principles of surgery. Catheterism of the Eustachian tube is often a most valuable adjunct in accumulations of mucus in the cavity of the tympanum.]

12. *Obstruction of the Eustachian Tube.*

This is often the cause of a considerable degree of deafness, because it is necessary for perfect hearing, that air should be conveyed from the mouth through this passage into the cavity of the tympanum, which now can no longer happen.

A degree of deafness generally attends a severe cold, which is accounted for by the Eustachian tube being obstructed with thickened mucus. Mr. Saunders tells us, that the obstruction most frequently arises from syphilitic ulcers in the throat, or sloughing in the cynanche maligna. The deafness comes on when such sores are healed, that is, when the obstruction is complete. The descent of a nasal polypus into the pharynx, and enlarged tonsils, have also been known to close the tube. (P. 42.)

When the Eustachian tube is obstructed, the patient cannot feel the membrana tympani crackle, as it were, in his ear, on blowing forcibly with his nose and mouth stopped. A history of previous ulceration, or disease, of the throat will sometimes facilitate the diagnosis.

When the Eustachian tube is obstructed with mucus, it has been proposed to employ injections, which are to be thrown, by means of a syringe and catheter, into the guttural orifice of that canal. This operation will be presently described. [True stricture of the Eustachian tube is of rare occurrence, though it has been frequently described.]

Sir A. Cooper had noticed, that hearing was only impaired, not lost, when suppuration in the tympanum had injured, and even destroyed the membrana tympani, and that the degree of deafness by no means equalled what resulted from an obstruction of the Eustachian tube. Hence, when the tube was permanently obliterated, he conceived, that a small puncture of the membrana tympani might be the means of enabling the patient to hear. This gentleman reports four cases, in which the experiment was made with success.

The operation consists in introducing an instrument, resembling a hydrocele trocar, but curved, into the meatus auditorius externus, and pushing it through the anterior and inferior part of the membrana tympani; a place rendered most eligible, on account of the situation of the chorda tympani and manubrium of the malleus, parts which should be left uninjured. The instrument must not be introduced far, lest it wound the vascular lining of the tympanum, and cause a temporary continuance of the deafness, by an effusion of blood. When the puncture is made, in proper cases, and in a judicious manner, hearing is immediately restored. A small hole in the membrana tympani now conveys the air into the cavity of the tympanum, answering the same purpose as the Eustachian tube.

The surgeon will be able to operate with more ease, if he take care to lessen the curvature of the meatus auditorius by drawing upward the external ear.

There is some chance of a relapse in consequence of the opening closing up. This consideration led Richerand to propose making the aperture with caustic, so as to destroy a part of the membrane. (*Nosogr. Chir.* t. ii. p. 132, éd. 2.) This suggestion is not likely to be adopted on account of the inconveniences of applying caustic within the ear. Mr. Saunders is an advocate for making the opening large. However, perhaps the best method of doing the operation both effectually and safely is that lately described by Mr. Buchanan of Hull, the chief peculiarity of whose mode consists in *drilling* the perforation. The quadrangular point of his perforator cuts the fibres of the membrana tympani across; they retract; the wound assumes an oval shape; and there is less danger of its closure again, than after the common plan of making a single puncture. "A room (says Mr. Buchanan) with a window fronting the south, should be chosen for the place of the operation; and the patient placed on a low seat, so that the rays of the sun may fall into the meatus. The manubrium, or handle of the malleus will then be distinctly seen, pointing downwards and inwards; occupying the superior half of the membrana tympani. The surgeon being seated on a high chair, should lay his left hand on the head of the patient, and, with the right, take hold of the instrument in the same manner as he would a pen when writing: he should then cautiously and steadily enter the point of the perforator into the membrana tympani, about half-way between the centre and its lower edge, and, with the thumb and index finger, give the instrument half a turn one way, and then half a turn the other, and in this manner gently push the point about a line through the membrane." (See *Engraved Representation of the Anatomy of the Ear*, p. 33.) Mr. Saunders, by puncturing the tympanum, instantaneously restored the hearing of one patient, who had been deaf thirty years in consequence of the destruction of a part of his palate by syphilis. (P. 45.) In an instance where a young man had been deaf for eight years, apparently from obstruction of the Eustachian tube by swellings and disease about the throat, Paroisse also restored the hearing directly, by perforating the anterior and inferior part of the tympanum. (*Opuscules de Chir.* p. 309, 8vo. Paris, 1806.) The practice has also been successfully adopted by Michaelis in one case, and Hunold has tried it in a vast number of examples, two-thirds of which succeeded. (*Dict. des Sciences Méd.* t. 38, p. 63.) Sir A. Cooper's cases are in the *Phil. Trans. for* 1802.

Puncturing the membrana tympani has been attended with some degree of success in France, where it has been tried by Itard, Celliez, and Maunoir, &c. It is not to be dissembled, however, that it is liable to failure. Dubois performed the operation in four instances without success. (*Richerand*, *Nosogr. Chir.* t. ii. p. 132.)

In most cases the patients benefited are said to have experienced pain just after the trocar was withdrawn. The organ, not being accustomed to sound, had become so extremely sensible, that it could not bear the gentlest impression of the sonorous vibrations; and the patient's first request, after the perforations had been made, was, that persons near him, might speak softly. This excessive tenderness of the sense gradually subsides.

The two principal objections made to the foregoing practice, are the risk of injuring that part of the tympanum which is connected with the malleus, and the tendency of the puncture to heal up again. (See *Dict. des Sciences Méd.* t. xxxviii. p. 57; *Maunoir in Journ. de Méd.* t. xiii.; *Sabatier*, *Traité d'Anatomie*, t. ii. p. 186.) The author of the article Oreille in the latter dictionary, who cannot, however, be deemed at all partial to the operation, delivers the following judgment concerning it: — 1. It is the only operation, which is likely to answer, where the tympanum is cartilaginous or ossified, and the rest of the organ is sound. 2. It will be attended with some success, where the Eustachian tube is closed, and this defect cannot be otherwise removed. 3. It will be useless where the cavity of the tympanum is filled with matter, which is too thick to escape through the puncture. 4. When deafness depends on paralysis of the auditory nerve. 5. When the infirmity arises from inflammation of the ear or nervous irritation. 6. Or from fevers, the Eustachian tube being pervious.

[The operation of puncturing the membrana tympani is not now often performed; and most probably in consequence of the facility with which the Eustachian tube can be catheterised, and the obstructions, where they exist, removed. But more particularly in consequence of the general failure of the operation.]

Wathen, Boyer, Itard, Buchanan, and the latest surgeons, who have considered the operation of injecting fluids into the Eustachian tube, agree, that it is more easily performed by passing the tube through one of the nostrils, than the mouth. The patient being seated on rather a low chair, with his head supported upon the breast of an assistant, standing behind him, the surgeon takes a probe, which is bent towards its end to an angle of about 135°, and he introduces it, with the end turned downwards, along the floor of the nostril, and, when it has reached the pharynx, a circumstance denoted by its descent behind the soft palate, a rotatory movement outwards to the extent of a quarter of a circle is given to it, and the handle is inclined downwards and inwards. The instrument's becoming fixed denotes its entrance into the

Eustachian tube. (See *Ph. F. Blandin* in *Dict. de Méd. et de Chir. Pratiques,* t. xii. p. 280.) Wathen's instruments are described in the *Phil. Trans.* 1794 ; those of Boyer in *Traité des Mal. Chir.* t. vi. p. 391 ; those of M. Itard, which deserve particular notice, in his *Traité des Mal. de l'Oreille ;* and those of another modern advocate for this operation, in *Dict. des Sciences Méd.* t. xxxviii. p. 108. The latter author, after stating how his tubes, which are four French inches in length, and shaped somewhat like an italic *S*, are introduced, enumerates the following as the advantages derived from their employment. 1. Fluid applications may be conveyed into the Eustachian tube, the cavity of the tympanum, and the mastoid cells, and deeply seated obstinate ulcerations within these parts cured. 2. The same parts can be cleared from any mucus by which they are obstructed. 3. Blood extravasated within the tympanum, from blows on the head, can be washed out. 4. Chalky substances, which sometimes form in the tympanum, may be brought out in the same manner. 5. Through the tube a stilet can be passed into the Eustachian tube, so as to perforate a congenital septum, or any cicatrix, obstructing the entrance of that passage. 6. When the sensibility of the auditory nerve is dull, the effect of fluids, thrown into the tympanum, can be tried. (See also *T. Buchanan's Engraved Representation of the Anatomy of the Human Ear*, p. 28, fol. Hull, 1823.)

[Mr. Toynbee, in his recent treatise on the Diseases of the Ear, has shown that the Eustachian tube is shut except during the momentary act of swallowing, during which act the air can be heard to enter the tympanic cavity by means of the otoscope, if the mouth and nose are closed. The Eustachian catheter as a means of diagnosis is consequently not needed.]

13. *Of perforating the Mastoid Process.*

Of all the cases of deafness for which Arnemann and others have recommended this operation, that attended with an abscess and caries of this process is the only one, in which the practice is now at all sanctioned. An instance is related by Jasser, in which the carious surface of the right mastoid process was exposed by an incision, and an opening detected with a probe. An injection was thrown into the aperture with a syringe, when, to the astonishment of Jasser and his patient, the fluid gushed out of the right nostril. The plan was repeated for a few days, and at the end of three weeks, the part was healed, and the hearing greatly improved. This success induced Jasser to make a perforation in the left mastoid process, the ear on that side being deaf, and to employ the injection, which was also discharged from the left nostril. The hearing, however, was not so completely restored in this as it had been in the right ear ; but the wound healed up without any exfoliations. (*Journ. de Méd. Fev.* 1793.) The idea of perforating the mastoid process was suggested long before the time of Jasser. Riolan, in various parts of his works, mentions the propriety of making a small perforation in several cases of deafness, and tinnitus aurium, attended with obstruction of the Eustachian tube. Rolfincius also advised a similar opening to be made in the mastoid process with a trocar, in cases of dropsy of the cavity of the tympanum and of the mastoid cells. Jasser, however, was the first who actually made the experiment, and his example was followed by Hagstroem, whose attempt did not succeed, the completion of the operation having been interrupted by profuse hæmorrhage, and no benefit done to the hearing. The injections also appear to have caused, in this instance, alarming symptoms, violent pains in the head, loss of vision, sense of suffocation, and syncope. The fluid entered the mastoid cells, without any of it issuing, either by the nostrils or mouth. (Op. cit.)

The operation was successfully tried by Loffler. The injection did not pass into the mouth, yet the hearing was restored, though it was lost again when the wound closed. Hence a new opening was made, and kept from healing by means of a piece of catgut. The patient was afterwards able to hear when his mouth was open.

The perforation of the mastoid process was not approved of by Morgagni ; indeed, it must often fail, as both Morgagni and Hagstroem have observed, on account of complete bony partitions preventing all communications between the mastoid cells ; and sometimes the mastoid process, instead of being cellular, is perfectly solid, an instance of which is recorded by A. Murray. In children, the mastoid cells are but imperfectly developed, and the operation may bring on caries, necrosis, erysipelas, &c. (See *Blandin in Dict. des Méd. et de Chir. Pratiques,* t. xii. p. 281.)

[The performance of this operation is now wisely never had recourse to except in well-recognised disease of the mastoid cells, and generally to afford an escape for the matter contained in the cells, or for the removal of diseased bone.]

14. *Diseases of the Labyrinth.*

These are much more diversified than might, at first, be supposed, and, if we admit the two doubtful cases, said to depend upon the state of the lymph of Cotunnius, there are not less than seven different species of disease affecting the labyrinth: —1. Disease of the fenestra ovalis, and fenestra rotunda, as ulceration, thickening, &c. 2. Malformation of these apertures. 3. Malformation of the labyrinth. 4. Inflammation of the nervous membrane, which lines its cavities. 5. Alteration of the liquor of Cotunnius. 6. Deficiency of the same fluid. 7. Affections of the nerve of hearing.

No doubt deafness (and that kind of it which so frequently foils the most skilful men) often arises from an insensible state of the portio mollis of the auditory nerve, or of the surfaces on which its filaments are spread. This affection is analogous to amaurosis, in which, though every part of the eye may seem to possess its natural structure, sight is lost, because the rays of light only strike against a paralytic, or insensible retina. Mr. Saunders dissected the ears of two deaf patients with the greatest care, but could not discover the least deviation from the natural structure. In the commencement of deafness from a paralytic affection of the auditory nerve, Sir A. Cooper remarked, that the secretion of cerumen was diminished, and, when the deafness became worse, was totally suppressed. And another particular symptom of paralysis of the auditory nerve, pointed out by the same author, is the patient's inability to hear the sound of a watch placed between the incisor teeth.

With respect to the causes of a paralytic affection of the auditory nerve, they are mostly buried in great obscurity, and some of them probably depend upon congenital imperfection of the nerve, or brain itself. It seems, however, that a part of the causes to which we allude, act mechanically, as an extravasation of blood, a steatoma, or an exostosis; while others operate on the ear by sympathy, as is the case when deafness is produced by the presence of worms in the bowels.

Mr. Saunders remarks, that all the diseases of the internal ear may be denominated nervous deafness; the term, in this sense, embracing every disease, the seat of which is in the nerve, or parts containing the nerve. Nervous deafness is attended with various complaints in different cases, noises in the head of sundry kinds, the murmuring of water, the hissing of a boiling kettle, rustling of leaves, blowing of wind, &c. Other patients speak of a beating noise corresponding with the pulse, and increased by bodily exertion, in the same degree as the action of the heart. (*Saunders*, p. 47.) [This is a circumstance of very common occurrence, and is evidently produced by the pulsations of the internal carotid artery being heard by the excited or erethistic auditory nerve.]

According to this author, there is a syphilitic species of nervous deafness, attended with a sensation of some of the above peculiar noises; and one case is related, in which the hearing was completely restored, in five weeks, by a mercurial course.

Mr. Saunders relieved several cases of nervous deafness by confining patients to low diet, giving them calomel freely, repeated doses of sulphate of soda, or magnesia, sometimes twice, sometimes thrice, a week, or according to circumstances, and applying blisters behind the ears at intervals of a week. The plan requires perseverance.

[Many cases of ankylosis of the stapes described by Mr. Toynbee have doubtless been confounded with those of nervous deafness.]

Electricity has been highly recommended for the cure of nervous deafness, though the prospect of benefit from it must entirely depend upon the nature of the cause of the infirmity. It is allowed to be sometimes useful in cases of incomplete paralysis of the auditory nerve; but it cannot be of any service where the Eustachian tube, the cavity of the tympanum, or the mastoid cells, are obstructed. It is set down as hurtful, when the patients are very irritable, and subject to vertigo, bleeding from the nose, great determination of blood to the head, &c. (*Dict. des Sciences Méd.* t. xxxviii. p. 124.) The evidence in favour of the efficacy of galvanism, is still more scanty and questionable. [Electricity, in the modified forms of electro-galvanism, magnetico-galvanism has been administered, and invariably without success when applied in the usual manner upon the surface of the neighbourhood of the ear. The writer has been in the habit of administering it through the Eustachian tube, using the catheter as one conductor, and applying the other in the external auditory canal, thus allowing but little more than the tympanum to intervene between the two conductors: and in a small minority of cases the practice appears to have been attended with advantage. Kramer has introduced the vapour of acetic ether in such cases, and he states with wonderful success, though in the later editions of his work he appears to have urged the practice less forcibly; many of his supposed instances of erethistic or excited auditory nerve were most probably cases of myringo-tympanitis, or chronic affections of the nervous membrane itself. The writer not infrequently injects a minute quantity of acetic ether, very largely diluted, into the cavity of the tympanum, with, however, doubtful benefit.]

Whether, in certain cases of deafness from torpor of the auditory nerve, the introduction of tonic injections into the cavity of the tympanum, through the Eustachian tube, will answer in the manner stated by a late writer, future experience must determine. (*Dict. des Sciences Méd.* t. xxxviii. p. 120, 121.) The tincture of iodine, blisters, mercury, and the external use of strychnia, are means often deserving a fair trial.

This article, I think, may be usefully concluded with a few general, but sensible, observations on the various kinds of deafness, made by a modern writer. According to Professor Rosenthal, all the disorders of the sense of hearing may be comprised under three principal forms.

1. Deafness (*Surditas*, *Cophosis*), in which the faculty of hearing articulated sounds is completely annihilated.

2. Hardness of hearing (*Dysœcia*), in which this faculty is so diminished, that articulated sounds cannot be heard, without the assistance of a particular apparatus.

3. Alteration, or diminution of hearing (*Paracusis*), in which the faculty of hearing articulated sounds, in the natural way, is imperfect for want of precision.

1. *Deafness*, Rosenthal distinguishes into two degrees; the first of which is marked by an absolute impossibility of hearing at all; the second, by a power of still distinguishing certain sounds, as whistling, the vowels, &c. The first is usually congenital, and a cause of dumbness.

The discrimination of these two degrees, Rosenthal considers of great importance in practice, and especially in institutions for the deaf and dumb; because the exceedingly fine sense of touch, with which dumb persons are sometimes gifted, is apt to be mistaken for the faculty of hearing. This fact is illustrated by some interesting experiments made by Pfingsten on deaf and dumb persons. (*Vieljährige Erfahrung über die Gehoerfehler der Taubstummen*, Kiel, 1802, p. 32.) A deaf and dumb girl, who was at needlework in a room near the house door, regularly gave notice whenever it was opened or shut. As the door was furnished with a little bell, which rang loud enough whenever the door moved to be plainly heard in the neighbouring room, and with the exception of this noise, no other impulse nor shock could be distinguished, Pfingsten was surprised at the circumstance. Desirous of ascertaining how the girl really knew about the movements of the door, he caused the bell to be rung with great force without the door being opened: the child was perfectly unconscious of the noise. The bell was afterwards kept still, while a person opened and shut the door so softly, that Pfingsten himself could not hear it; yet, the child instantly gave warning that somebody had entered. The inference was, that the chair, on which she sat, communicated to her legs and back a certain impulse, which made her conscious of the motion of the door.

The dissection of the ears of deaf and dumb persons has brought to light some facts, explanatory of the cause of the loss of hearing. Amongst other things, it appears, that complete deafness, whether congenital or acquired, more frequently depends upon morbid alterations of the soft parts, than upon any irregularity in the formation of the bones. Thus, in the body of a person, who had been deaf and dumb while living, Hoffmann found the auditory nerve diminished in size, while every other part of the organ was perfectly natural. Arnemann found the nerve harder than common. Dr. Haighton met with an instance, in which the vestibule was filled with a caseous substance. (*A Case of original Deafness, in Mem. of the Med. Society*, vol. iii. p. 1—15.) Duverney and Sandifort found the auditory nerve strongly compressed by a steatoma. In one case, Itard found every part of the ear apparently so natural, that the deafness could not be ascribed to paralysis of the nerve. In another, the infirmity depended upon obstruction of the passages. In a third, the cavity of the tympanum, and the vestibule, contained small portions of calcareous matter. He has also seen the tympanum filled with a thick yellow lymph, or a thin fluid enclosed in membranous cells. In the dissection of the body of a deaf and dumb person, Rosenthal noticed amongst other remarkable circumstances, a greater hardness of the auditory, than of the facial nerve, and preternatural firmness of the medulla oblongata; thickening of the membrane of the tympanum; the bony roof of the cavity of the tympanum not thicker than paper; and just over the junction of the malleus with the incus, the bony substance was so absorbed, that an appearance like that of membrane alone remained. The mastoid cells, cavity of the tympanum, and the Eustachian tubes, contained a limpid yellow fluid. In the tympanum, the periosteum was thickened, forming small cells around the ossicula, which were of their natural structure. Nothing particular was remarked in the labyrinth.

In a small proportion of instances, the above degree of deafness has been traced to anomaly in the structure of the solid parts. Thus, Mundini found the cochlea composed of only one circle and a half. (*Opusc. Acad. Bonon.* 1791, t. vii. p. 422.) Valsalva found the stapes adherent to the fenestra ovalis (*De Aure Humanâ*, cap. 11); and Reimarus relates a case in which the ossicula were entirely wanting. (*Kunstribe der Thiere*, p. 57.)

Mr. Edward Cock has examined the temporal bones of five children, who died of strumous diseases of the thoracic and abdominal viscera, in the Asylum for the Deaf and Dumb. In three instances, one or both ears were the seat of scrofulous ulceration, affecting the tympanum and meatus externus, with partial destruction of the membrana tympani. In one case, the cavity of the tympanum, together with the mastoid cells, was completely filled with the thick cheesy deposit of scrofula, whilst a similar affection pervaded the whole cancellated structure of the petrous bone. The connexions of the ossicula were destroyed, but the bones themselves remained entire. In all the cases examined by Mr. Cock, the petrous portions of the temporal bones exhibited more than the usual varieties of size and shape. In some, the bone was so deficient in particular spots, as barely to cover the internal cavities, whilst, in others, there was a preternatural osseous development. In one instance, the petrous bone of a child, twelve years old, exceeded in size, hardness, and compactness of structure, that of an adult. One malformation, discovered in two cases, consisted in a partial deficiency of two of the semi-circular canals. Their extremities opening into the vestibule, were perfect, but the central portions were impervious, or rather did not exist at all. In one case the scala tympani was terminated at its larger extremity by a bony septum, which separated it from the tympanum, and occupied the situation of the membrane of the fenestra rotunda. With the exception of these malformations, and the scrofulous affections of the tympanum, already mentioned, which were probably of recent occurrence, no deviation from the healthy state could be discovered in either of the five subjects examined. The Eustachian tubes were pervious; the bones, muscles, and membranes entire and natural; the labyrinths were filled with their transparent fluid; and the auditory nerve presented no peculiarity. The chorda tympani existed in each of the cases; but the integrity of all its little filaments, passing into the tympanum, and requiring a microscope for their dissection, could not be vouched for. (*E. Cock* in *Med. Chir. Trans.* vol. xix. p. 152.) In a case, dissected by Mr. Dalrymple, the aqueduct of the vestibule was large enough to admit a small probe; and, in a later examination of the ear of a child, who died in the Asylum for the Deaf and Dumb, Mr. Cock could find no vestige of the fenestra rotunda on either side, the usual situation of the membrane being occupied by solid bone. The temporal bones were exceedingly large, though soft and spongy. The cavities were extraordinarily capacious, and the Eustachian tubes three or four times larger than common. On one side, the aqueduct of the vestibule readily allowed the passage of a large bristle; but, on the other side, the canal could not be traced through the bone, although its two extremities were more than usually expanded. In one tympanum, suppuration had taken place. (*E. Cock, ib.*) See a table in Mr. Toynbee's work on the Diseases of the Ear, and of the morbid condition of the ears of the Deaf and Dumb, as shown by dissection.

In the first degree of deafness above described, which, when congenital, must excite suspicion of serious malformation of the organ, and abolition of the nervous influence, and when acquired, indicates a complete injury of the functions of the nerve, the prognosis, as Rosenthal observes, must be unfavourable. Nor can it be otherwise in the second *congenital* degree of the disease, though only a partial imperfection of the organ and nerve can here be supposed. On the other hand, when the latter degree is *acquired*, there is more prospect of relief, because merely a partial alteration in the soft parts is to be suspected.

2. *Hardness of hearing.* Rosenthal also distinguishes several degrees of, what is termed, hardness of hearing. In the first, the patient cannot hear a distant noise, and especially high tones; but he can perceive, though, it is true, not in a very distinct manner, articulated sounds, when the voice is a good deal raised. In the second degree, he hears and distinguishes both high and low tones very well, and also words, but only when the voice is somewhat raised.

These two cases are better understood, inasmuch as it is tolerably well ascertained, that the immediate cause of the infirmity is some alteration in that part of the organ which serves as a conductor for the vibrations of sound, or else an increased sensibility of the nerve, all the internal ear being in other respects right.

Amongst alterations of the conducting parts of the organ, Rosenthal comprehends:

1. A total obliteration of the meatus auditorius externus, its imperforation, or complete absence. These cases may almost always be detected by a superficial examination, the patient only hearing when some solid bodies are placed between his teeth, while his dull perception of sounds does not appear to be much lessened when the ear is covered.

2. Diseases of the cavity of the tympanum, as inflammation of its membranous lining, caries of its parietes, or collections of blood, pus, or other fluid, in its cavity. Rosenthal thinks there can be no doubt, that inflammation and .suppuration in the tympanum are much more frequent than is generally supposed, the former affection being often mistaken for a slight attack of rheumatism. In dissecting aged subjects, he has frequently found the membrane of the tympanum thickened and opaque, and he could only impute this appearance to previous inflammation.

After detailing a case illustrative of the symptoms of inflammation within the tympanum, and a few observations on caries and collections of fluid in the cavity, Rosenthal notices the *hardness of hearing, connected with nervous irritability*, in the treatment of which case, he insists upon the advantage that would result from a knowledge of the particular species of morbid excitement prevailing in the patient. But, as nothing very certain can be made out on this point, and only conjectures can arise from dissections of bodies, that the affection consists either in a determination of blood to the part, or in a partial paralysis of the auditory nerve, the exact nature and form of which are quite incomprehensible, it is absolutely necessary to attend solely to the diagnosis of the nervous affection in general. This diagnosis will be facilitated, 1st, If the patient has been previously very sensible to the impression of certain tones, or sound in general; 2ndly, If the power of hearing has been lost all on a sudden, without any mark of inflammation; 3rdly, If the affection coincides with other nervous disorders.

3. *Alteration or Diminution of Hearing.*—Between the most perfect hearing, congenital or acquired, and this point of diminution of the faculty of hearing, Rosenthal observes, there are a great many degrees, the cause of which is the most difficult to comprehend, as the circumstances of structure, which enable every part to perform its functions with freedom and perfection, are not yet made out. If, says he, it were in our power to determine what is truly the regular structure of each part, we should then be furnished with a means of judging correctly of the anomalies of function, the changes in which would be indicated quite as clearly, as in the eye, by shades of organisation, absolutely in the same way as we judge of the modifications, which the image of objects must undergo at the bottom of the ocular mirror, by the greater or less convexity of the cornea, or lens, or the consistence of the other humours.

In the present state of physiological and pathological knowledge of the ear, therefore, Rosenthal conceives, that little can be attempted with respect to a scientific classification of these cases of altered, or diminished hearing. As the cavity of the tympanum and its contents are the parts which have principal influence over the intensity of sound, and a great share in the propagation of articulated sounds, their faulty condition must here be chiefly the subject for consideration. And, amongst their numerous defects, traced by dissection, and already specified in the foregoing columns, Rosenthal particularly calls the attention of the reader,

1. To alterations of the membrane of the tympanum, whether proceeding from congenital malformation, or situation, or from thickening, ossification, perforation, or laceration of the same part.

2. The lodgment of fluid in the cavity of the tympanum, more frequently produced, than is commonly supposed, by obstruction of the Eustachian tube. In most new-born infants, Rosenthal has also found the cavity of the tympanum filled with a thick, almost gelatinous fluid, which for some days is not absorbed, and is probably the cause of the indifference, evinced by new-born children, to sounds, which are even so intense as to be offensive to the ears of an adult.

3. Alterations of the membrane of the fenestra rotunda, such as its imperfect formation, or erroneous situation, its thickened state, &c.

Mr. Toynbee has given ample details of the pathological conditions of the ear. But, it is remarked by Rosenthal, that as the difference in the intensity of sound may occasion a modification in the sensations of the ear, the merely conducting parts of the auditory apparatus must not be forgotten, as the external ear and the meatus auditorius externus, which regulate the quantity of sonorous waves striking the auditory nerve. However, the malformations of the meatus and the state of the ceruminous secretion within it, are observed by Kritter and Lentin (*Ueber das schwere Gehör*, l. xix. Leipz. 1794) to have more effect on the hearing, than defects of the auricle itself, the whole of which, as we have stated, may be lost without any material deafness being produced. Lastly, Rosenthal calls our attention to the nervous action, or influence, which, whether too much raised, or depressed, may equally render the hearing dull; and some useful information may for the most part be derived from attending to the patient's general sensibility. *Geo. Pilcher.*

See Journ. Complém. t. vi. p. 21, &c. *Duverney*, De l'Organe de l'Ouie, 12mo. 1683. *P. Kennedy*, A Treatise on the Eye, and on some of the Diseases of the Ear, 8vo. Lond. 1713. *A. D. Dienert*, Quæstio, &c. an absque Membranæ Tympani Apertura topica injici in Concham possint, Paris, 1748. *Leschevin*, Mém. sur la Théorie des Maladies de l'Oreille, et sur les Moyens que la Chirurgie peut employer pour leur Curation, in Prix de l'Acad. de Chir. t. ix. p. 111, &c. éd. 12mo. *I. D. Arnemann*, Bemerkungen über die Durchborung des Processus Mastoideus in gewissen Fallen der Taubheit, 8vo. Gött. 1792. *G. R. Trampel*, Von den Krankheiten des Ohres, in *Arnemann's* Magazin für die Wundarzneiwissenschaft, b. ii. p. 17, &c. 8vo. Gött. 1798. *Richerand*, Nosogr. Chir. t. ii. p. 135, &c. édit. 4. *A. Cooper*, in the Phil. Trans. for 1802. *Saunders*, On the Anatomy and Diseases of the Ear, 1806. *Desmonceaux*, Traité des Maladies des Yeux et des Oreilles, 2 tom. 8vo. Paris, 1806. *Lassus*, Pathologie Chirurgicale, t. i. p. 84, édit. 1809. *W. Wright*, An Essay on the Human Ear, its Anatomical Structure, and incidental Complaints, 8vo. Lond. 1817. Dict. des Sciences Méd. art. Oreille, t. xxxviii. 8vo. Paris, 1819. *Rosenthal*, Essai d'une Pathologie de l'Organe de l'Ouie, in Journ. Complémentaire du Dict. des Sciences Méd. t. vi. p. 17, 8vo. Paris, 1820.

J. M. G. Itard, Traité des Maladies de l'Oreille, et de l'Audition, 2 tom. 8vo. Paris, 1821. *T. Buchanan,* An Engraved Representation of the Anatomy of the Human Ear, fol. Hull, 1823. Also Illustrations of Acoustic Surgery, 8vo. 1825. *Manson's* Med. Researches on Iodine, 8vo. Lond. 1825. For an account of malformations of the organ, see *Meckel's* Handbuch der Pathol. Anat. b. i. p. 400. &c. 8vo. Leipz. 1812. *Ph. F. Blandin,* in Dict. de Méd. et de Chir. Pratiques, t. xii. art. Oreille. *L. Ch. Roche,* Op. vol. cit. art. Otitis. Deleau, Mém. sur la Perforation du Tympan, 8vo. Paris, 1822. Id. l'Art. de Sonder la Trompe d'Eustasche, 8vo. Paris, 1826. *Edward Cock,* in Med. Chir. Trans. vol. xix. p. 152. *J. Thurnam,* Examination of the Organs of Hearing in a Case of congenital Deafness, vol. cit. p. 162. *Todd,* in Anat. of Organs of Hearing. *Wilhelm Kramer,* Die Erkenntniss und Heilung der Ohrenkrankheiten, 8vo. Berlin, 1836. *A. W. Webster,* On the Structure of the Ear and Deafness, 12mo. Lond. 1836. [See also an enlarged edition of *Kramer's* Work, 1849. *Dr. C. G. Lincke,* of Leipzig, 2 vols. *Dr. E. Schmalz,* of Dresden. *Dr. Martell Fremk,* of Würtzburg. *Mr. Pilcher's* Prize Essay on the Structure, Economy, and Diseases of the Ear, upon some points in the Physiology of the Tympanum, and on the consequences of Scarlet Fever on the Ear. Dr. *J. Williams'* Prize Essay, a Treatise on the Ear, including its Anatomy, Physiology, and Pathology. *Mr. Wharton Jones,* Ear and Hearing, Diseases of, in the Cyclopædia of Practical Surgery. *Mr. Toynbee's* work on the Diseases of the Ear, and his valuable papers in the Medico-Chirurgical Transactions, the Medical Times and Gazette, and other periodicals.]

ECCHYMOSIS (from ἐκχύω, to pour out). A swelling, attended with a livid or blue colour of the skin, and produced by blood extravasated in the cellular tissue.

The causes of ecchymosis are falls, blows, sprains, &c. which occasion a rupture of the small vessels on the surface of the body, and a consequent effusion of blood, even without any external breach of continuity. Ecchymosis is one of the symptoms of a contusion. (See CONTUSION.) A considerable ecchymosis may originate from a very slight bruise, when the ruptured vessels are capable of pouring out a large quantity of blood, and particularly when the parts contain an abundance of loose cellular substance. In general, ecchymosis does not make its appearance immediately after the blow or sprain, and sometimes not till several hours after the application of the violence; at least, it is not till this time that the black, blue, and livid colour of the skin is most conspicuous. A black eye, which is only an ecchymosis, is always more disfigured six or eight hours after the receipt of the blow, than at an earlier period.

A common ecchymosis will generally yield to discutient lotions, and purgatives. The best topical applications are vinegar, the lotio ammoniæ hydro-chloratis; spirit. vin. camph. and the liquor ammon. acet.

The object is to prevent inflammation, and to promote the absorption of the extravasated fluid.

I have seen such success attend the practice of dispersing collections of extravasated blood by means of absorption, that I consider the plan of evacuating it by an incision seldom necessary. When an opening is made, and air is admitted, the portion of blood, which cannot be pressed out, soon putrefies, and extensive inflammation and suppuration are the frequent consequences. A man, in going down one of the staircases at the King's Bench, fell, and suffered a contusion over the sacrum, where a tumour, from effused blood, soon formed, almost as large as his head. The blood was completely absorbed in a few weeks, without any suppuration having taken place. Mild antiphlogistic treatment, cold evaporating lotions and purgatives, were the only means employed. A man was brought into the University College Hospital, Oct. 1, 1836, with a lacerated wound of the scrotum, protrusion of both testes, a fracture of the right femur in its upper third, and a copious extravasation of blood from external violence applied to the left hip. The quantity of blood, effused after a time, was calculated to be not less than three or four quarts. I scarcely expected to succeed in dispersing the whole of it; yet, in about two months, every particle of it was absorbed.

The quick and powerful action of the absorbent vessels in removing extravasations of blood, can now be no longer called in question, when we daily see it proved in modern practice, that the largest aneurismal swellings are thus speedily diminished and removed, after the operation of tying the arteries, from which such tumours arise.

I wish, however, the preceding observations merely to convey a general condemnation of the practice of opening swellings containing extravasated blood; for no surgeon is more assured than I am, that there are particular exceptions, in which the plan is highly proper and necessary. Thus, whenever a case of extensive ecchymosis, or a large tumour of extravasated blood, either excites suppuration, or creates excessive pain from distension, it is better to practise a free opening. So it sometimes happens, in aneurism, that the skin gives way over the tumour after the artery has been tied, and some of the blood escapes; but the remainder putrefies, and soon becomes blended with purulent matter in the sac. Here the making of a free incision into the swelling for the discharge of its irritating contents, with due attention to every caution delivered in the article ANEURISM, will often be followed by beneficial effects.

[ECRASEUR. This instrument consists of a handle and steel canula, in the interior of which are two grooves opposite each other, for the passage of a jointed chain somewhat resembling a chain-saw, but without teeth, the edge being blunted but not serrated. From the extremity of the canula a loop of the chain as long as may be required projects, which is passed around the tumour or other body to be removed, and is gradually tightened by the drawing in of the links by means of a rack and pinion. A modification of the instrument has been constructed, having a handle and steel cylinder, along the side of which there is an opening, and at the extremity a flattened ring through which a loop of the chain before described passes, one end of it being attached to the top of the cylinder, the other to a piece of metal projecting through the opening at the side of the instrument. At the handle, there is a wheel attached to a long screw which passes into the interior of the cylinder, and by its revolutions acts upon the piece of steel to which the chain is attached. The advantage of the latter instrument is that the pressure upon the tumour is gradual, instead of being in jerks as with the rack and pinion movement; and also the chain being external to the cylinder, the instrument is not so liable to become clogged by matter getting into the interior. Charrière has combined the advantage of a straight and curved instrument by making several extremities screw on to one handle. Chains too of various calibres are fitted to the instrument, enabling us to employ that size best suited to the operation to be performed. The chain attached to the curved extremity has been made with a degree of curves in its links, so that besides being more easily applied to a tumour in a deep passage, as the vagina or rectum, it adapts itself to the channel of the instrument more easily than a straight chain, and is consequently less apt to be broken when drawn home. The mode of attaching the ends of the chain is also rendered more simple and satisfactory, and as traction can if necessary be made on both ends at once, the power is much increased. Strong wire or a soft cord of hemp have been occasionally used instead of the jointed chain.

The ecraseur has been used by Chassaignac of Paris, since the year 1850; and it is intended for the removal of morbid growths on those parts of the body from which, on account of their vascularity, considerable hæmorrhage may be expected, and in such cases it has been thought that it would supersede the use of the knife and the ligature. Its action, although much slower than that of the knife, is considerably more rapid than that of the ligature, which divides the tissues by the process of gangrene it induces, and consequently there is for some time a putrid mass at the part constricted, subjecting the patient to the danger of purulent absorption. On the other hand, the ecraseur acts directly by first condensing the tissues, and subsequently dividing them with extreme regularity. When it acts upon an artery, it first divides the two internal coats which are folded up in such a manner as to plug the vessel; the closure is assisted by the agglutinisation of the outer coats before they are divided, and after separation has been effected the closure is so perfect that the channel cannot be opened, even by blowing forcibly through it.

In some experiments which have been made at the Veterinary School near Paris, the carotids of sheep have been divided without loss of blood—this will be readily understood on considering the small amount of hæmorrhage usually following contused and lacerated wounds. The operations for which the ecraseur is suitable are, as before observed, those in which, from the vascularity of the part, much hæmorrhage may be expected, such as cancer of the tongue, hæmorrhoids, prolapse of the rectum, uterine polypi, cancer of the neck of the uterus, varicocele, sarcocele, &c. &c. It is also necessary that the part to be removed should be pedunculated; where this is not the case the tumour should be raised up well, and several needles passed under it at different angles; a ligature should be tied behind these, and thus form a peduncle for the chain to pass round, or the base of the tumour may be transfixed by a needle and double thread, thus pedunculating each lateral half.

In removing the tongue two ecraseurs will be required; the chain of one is introduced into the mouth by means of a needle passed through an incision below the chin, in the same way as Cloquet applies ligatures for accomplishing the same end. The root of the tongue is thus encircled and cut from above downwards. The second chain introduced by the mouth is laid in the incision made by the first across the base, and is made to divide all the attachments of the organ from behind forwards. Half an hour is sufficient to accomplish this operation. Half the tongue may be removed by passing two chains through the tongue at the angle of union of the diseased and healthy structures, and making one chain sever the parts from behind forwards while the second cuts its way out at right angles to the first.

For the removal of piles, the tumour is seized with a vulsellum and drawn out, when if small a ligature is simply thrown round its base, and the chain applied, or if larger a double thread is carried through its base and tied so as to constrict it in two halves, or a needle may be left transfixing its base, and a ligature applied behind it. When the anus is entirely surrounded by vascular piles, Chassaignac removes the whole at one grasp by introducing a pair of his diverging forceps within the orifice, drawing it well out, and applying a ligature, so as to pedunculate the part, and then using the chain. A bougie must, in this case, be introduced within twenty-four hours, and that with great gentleness, to prevent tearing, so as to ensure the patency of the gut, which is apt to be obliterated by the strong compression of the chain. It is necessary, also, that the bowels should be kept quiet by opium for twenty-four hours. In the operation for the cure of varicocele it is necessary to pass three needles beneath and at right angles to the veins, taking care that the lowest one does not pierce the tunica vaginalis. A ligature must be applied behind the needles, and thus a peduncle formed for the chain to encircle. For removing the testicle, either one or two instruments may be used; if one, the scrotum most be drawn up around the organ to be removed, and the chain applied above the testicle; but if two are used it will be necessary to introduce a trocar and canula through the scrotum above the testis and behind the cord. The trocar being withdrawn, two chains are passed through the canula, which is then removed, and each chain attached to its apparatus; one will divide the scrotum longitudinally, the other will divide the cord and tissues above the testicle.

The ecraseur has been very much lauded by its inventor, Chassaignac; but although it has been tried in England for four years, its success is not so certain. There is no doubt that it may be useful in the removal of piles, polypi, and such erectile or malignant growths as could not be removed by the knife without probability of dangerous hæmorrhage; and in such cases its superiority over the ligature is the time gained and the non-liability to putrid or purulent absorption. (*T. Wakley.*)

Chassaignac, Traité de l'Ecrasement Linéaire, 8vo. 1856. Lancet, 1856, vol. ii. fol. 488; 1857, vol. i. fol. 152; vol. ii. fol. 23 and 548. Med. Times and Gazette, 1856, vol. xxxiv. fol. 364, *Spencer Wells;* fol. 390, 540, *Macleod;* 1857, vol. xxxvi. fol. 89; 1858, vol. xxxvii. fol. 115, 414, 576, 631; vol. xxxviii. fol. 97; 1859, vol. xxxix. fol. 634.

ECTHYMA (*ἐχθυμιάω*, *exhalo*, or from *ἐχθύειν*, to break with fury). A term, employed by the ancients, and revived by Willan, to denote an inflammation of the skin, principally characterised by large or phlyzaceous pustules of the skin, in one or several regions of the body. The term *phlyzaceous* was applied by Willan to pustules which are large, elevated on a hard circular base, of a bright red colour, and succeeded by a thick indurated scab, of a dark colour.

ECTROPION (from *ἐκτρέπω*, to turn). An eversion of the eyelids.

One case is produced by an unnatural swelling of the lining of the eyelids, which not only pushes their edges from the eyeball, but also presses them so forcibly, that they become everted: another, arises from a contraction of the skin of the eyelid, or its vicinity, by which means the edge of the eyelid is first removed to some distance from the eye, and afterwards turned completely out, together with the whole of the affected eyelid.

The morbid swelling of the lining of the eyelids, which causes the first species of ectropion (putting out of present consideration a similar affection incidental to old age), arises mostly from a congenital laxity of this membrane, afterwards increased by obstinate chronic ophthalmia in relaxed, unhealthy subjects; or else the disease originates from purulent ophthalmia affecting the eyes.

While the disease is confined to the lower eyelid, as it most commonly is, its lining may be observed rising in the form of a semilunar fold, of a pale red colour, like the fungous granulations of wounds, and intervening between the eye and eyelid, which latter it in some measure everts. When the swelling is occasioned by the lining of both the eyelids, the disease assumes an annular shape, in the centre of which the eyeball seems sunk, while the circumference of the ring presses, and everts the edges of the two eyelids so as to cause both great uneasiness and deformity. In each of the above cases, on pressing the skin of the eyelids with the point of the finger, it becomes manifest that they are very capable of being elongated, and would readily yield, so as entirely to cover the eyeball, were they not prevented by the intervening swelling of their membranous lining.

Besides the considerable deformity, which the disease produces, it occasions a continual discharge of tears over the cheek, and, what is worse, a dryness of the eyeball, frequent exasperated attacks of ophthalmia, incapacity to bear the light, and, lastly, opacity and ulceration of the cornea.

The second species of ectropion, or that arising from a contraction of the integuments of the eyelids, or neighbouring parts, is not unfrequently a consequence of puckered scars, produced by the confluent small-pox, deep burns, or the excision of cancerous or encysted tumours, without saving a sufficient quantity of skin; or, lastly, the disorder is the effect of malignant carbuncles, or any kind of wound attended with much loss of substance. Each of these causes is quite enough to bring on such a contraction of the skin of the eyelids, as to draw these parts towards the arches of the orbits, so as to remove them from the eyeball, and turn their edges outward. No sooner has this circumstance happened, than it is often followed by another one equally unpleasant, namely, a swelling of the internal membrane of the affected eyelids, which afterwards has a great share in completing the eversion. The lining of the eyelids, though trivially everted, being continually exposed to the air, and to irritation from extraneous substances, soon swells, and rises up, like a fungus. One side of this fungus-like tumour covers a part of the eyeball; the other pushes the eyelid so considerably outward, that its edge is not unfrequently in contact with the margin of the orbit. The complaints, induced by this second species of ectropion, are the same as those brought on by the first; and, in both cases, when the disease is inveterate, the fungous swelling becomes hard and callous.

In the first species of the disease, the skin of the eyelids and adjoining parts is not deformed with scars; and by pressing the everted eyelid with the point of the finger, the part would with ease cover the eye, were it not for the intervening fungous swelling. But, in the second, besides the obvious cicatrix and contraction of the skin of the eyelids or adjacent parts, when an effort is made to cover the eye with the eyelid, by pressing upon the latter part with the point of the finger, it does not give way, so as completely to cover the globe, or it does not move in the least from its unnatural position, by reason of the integuments of the eyelids having been so extensively destroyed, that their margin is adherent to the arch of the orbit.

Mr. Guthrie instances a case, depending on chronic inflammation, accompanied with contraction of the integuments of the eyelid, but *without any manifest cicatrix.* It is described as usually taking place after a long continuance of *lippitudo*, and proceeding from the excoriation, contraction, and hardening of the skin, "the result of the passage of the vitiated secretions over it, and which, by dropping on it, increase the irritation." (*Operative Surgery of the Eye*, p. 50—55.) This form of the disease is rarely attended with such a thickening of the inner membrane of the eyelid, as to need removal with the knife or scissors; for it subsides with the removal of the complaint. (P. 60.)

According to Scarpa, the cure of ectropion cannot be accomplished with equal perfection in both its forms, the second species being, in some cases, absolutely incurable. For, as in the first species of ectropion, the disease only depends upon a morbid thickening of the internal membrane of the eyelids, and the treatment merely consists in removing the redundant portion, art possesses many efficacious means of accomplishing what is desired. But, in the second species, the chief cause of which arises from the loss of a portion of the skin of the eyelids or adjacent parts, which loss no known artifice can restore, surgery is not capable of effecting a perfect cure The treatment is confined to remedying, as much as possible, such complaints as result from this kind of eversion, and this can be done in a more or less satisfactory manner, according as the loss of skin is little or great. Cases in which so much skin is deficient that the edge of the eyelid is adherent to the margin of the orbit, Scarpa abandons as incurable. How far the case can be rectified, he thinks, may always be estimated by remarking to what point the eyelid admits of being replaced, on being gently pushed with the end of the finger, towards the globe of the eye, both before and after the employment of such means as are calculated to effect an elongation of the skin of the eyelid; for it is to this point, and no further, that art can reduce the everted part, and permanently keep it so replaced.

When the first species of ectropion is recent, the fungous swelling of the lining of the eyelid not considerable, and, consequently, the edge of the eyelid not much turned out, and in young subjects (for in old ones the eyelids are so flaccid, that the disease is irremediable), Scarpa prefers destroying the fungous surface of the internal membrane of the eyelid by the repeated application of the nitrate of silver. Mr. Guthrie touches the fungous portion of the conjunctiva every four days, with a probe dipped in sulphuric acid, and gently applies every day, or every second day, the sulphate of copper, at the same time not omitting some minor remedies, which he also employs in cases proceeding from contraction of the skin independent of any cicatrix, and which I shall presently notice. (*Operative Surgery of the Eye*, p. 70.) In recent cases, where the patient is weak and irritable (or a child), Beer commences the treatment with simply applying every day the tincture of opium, which, after a time, is strengthened by the addition of naphtha. To the relaxed conjunctiva he afterwards applies escharotic eye-salves, and lastly, the nitrate of silver, and muriate of antimony. When the part is hard and callous, the caustic is preceded by scarifications. (*Lehre, &c.*, b. ii. p. 136.)

For remedying the inveterate form of the first species of the disease, Beer and Scarpa are advocates for cutting away the whole of the fungous swelling closely from the inside of the eyelid. The following is Scarpa's description of the operation: —

The patient being seated, with his head a little inclined backward, the surgeon, with the index and middle finger of his left hand, is to keep the eyelid steadily everted; and holding a small pair of curved scissors with convex edges, in his right, he is completely to cut off the whole fungosity of the internal membrane of the eyelid, as near as possible to its base. The same operation is then to be repeated on the other eyelid, should that be affected with the same disorder. If the excrescence should be of such a shape, that it cannot be exactly included within the scissors, it must be raised with a forceps, or a double hook, and dissected off at its base, by means of a small bistoury with a convex edge. The bleeding stops of itself, or as soon as the eye has been bathed with cold water. The surgeon is then to apply two small compresses, one put on the upper, the other on the lower arch of the orbit, and over these the uniting bandage, in the form of the monoculus, or so as to compress and replace the edges of the everted eyelids, in order to make them cover the eye. On the first removal of the dressings, which should take place in twenty-four or thirty hours after the operation, the surgeon will find the whole, or almost the whole of the eyelid, in its natural position. The wound on the inside of the eyelid should then be washed twice a day with simple water or barley-water. If, towards the end of the cure, it should assume a fungous appearance, or the edge of the eyelid seem to be too distant from the eyeball, the wound on the inside of the eyelid must be rubbed several times with the nitrate of silver, for the purpose of destroying a little more of the membranous lining, so that, when the cicatrisation follows, a greater contraction of it may take place, and the edge of the eyelid be drawn still nearer the eye.

In England, the excision of the fungous thickened portion of the conjunctiva, has mostly been relinquished for the employment of caustic. The difficulty of dissecting off every particle of the fungus renders the practice of excision less certain than the treatment with caustic. Scarpa confesses its occasional failure, and the necessity of then having recourse to the latter plan. Demours also lets the employment of caustic follow the use of the knife. (*Mal. des Yeux*, p. 98.) In ectropion from a relaxed fungous state of the conjunctiva, the consequence of purulent ophthalmia, Dr. Vetch begins with a light careful application of the nitrate of silver to the whole granulated villous surface. The everted part is then to be returned, and secured in its place with a compress, and straps of plaster and a bandage. Every time the eye is cleaned, the same things are to be repeated, and, in the course of a few days, the tendency to protrude will disappear. (*On Diseases of the Eye*, p. 228.)

In the species of ectropion produced by an accidental contraction of the skin of the eyelids, or neighbouring parts, Scarpa observes, that, if a contraction of the integuments has proved capable of everting the eyelid, the excision of a piece of the internal membrane of the part, and the cicatrix which will follow, must also be capable, for the same reason, of bringing back the eyelid into its natural position. But, since nothing can restore the lost skin, the shortened state of the whole eyelid, in whatever degree it exists, must always continue, even after any operation the most skilfully executed. Hence the treatment of the second species of ectropion will never succeed so perfectly as that of the first, and the replaced eyelid will always remain shorter than natural, in proportion to the quantity of integuments lost. It is true that, in many cases, the eversion seems greater than it actually is, in regard to the small quantity of skin lost or destroyed; for, when the disease has once begun, though the contraction of the skin may be trivial, in consequence of the little quantity of it deficient, still the swelling of the lining of the eyelid, which never fails to increase, at last brings on a complete eversion of the part. In these cases, the cure may be accomplished with such success as is surprising to the inexperienced; for, after the fungous swelling of the internal membrane of the eyelid has been cut off, and the edge of the part approximated to the eyeball, the shortening of the eyelid remaining after the operation is so trivial, that it may be considered as nothing in comparison with the deformity and inconvenience occasioned by the ectropion. Whenever, therefore, the retraction of the skin of the everted eyelid, and the consequent shortness of it, are such as not to prevent its rising again and covering the eye, if not entirely, at least moderately, Scarpa directs the surgeon to cut away the internal membrane of the everted eyelid, so as to produce a loss of substance on the inside of it. In inveterate cases of ectropion, in which the lining of the eyelids has become hard and callous, Scarpa applies to the everted eyelid, for a few days before the operation, a soft bread and milk poultice.

The division of the cicatrices, which have given rise to the shortening and eversion of the eyelid, as Scarpa observes, does not procure any permanent elongation of this part, and consequently it is of no avail in the cure of the present disease. Fabricius ab Aquapendente, who well knew the inutility of making a semilunar cut in the skin of the eyelids, for the purpose of remedying their shortness and eversion, proposes, as the best expedient, to stretch them with adhesive plasters applied to them and the eyebrow, and tied closely together. Whatever advantage may result from this practice, the same degree of benefit may be derived from using, for a few days, a bread and milk poultice, afterwards oily embrocations, and, lastly, the uniting bandage, so put on as to stretch the shortened eyelid in an opposite direction to that produced by the cicatrix;

a practice which Scarpa thinks should always be carefully tried before the operation is determined upon.

The surgeon, with a small convex-edged bistoury, is to make an incision of sufficient depth into the internal membrane of the eyelid, along the tarsus, carefully avoiding the situation of the puncta lachrymalia. Then, with a pair of forceps, he should raise the flap of the divided fungous membrane, and continue to detach it with the bistoury from the subjacent parts, all over the inner surface of the eyelid, as far as where the membrane quits this part, to be reflected over the front of the eye, under the name of *conjunctiva.* The separation being thus far accomplished, the membrane is to be raised still more with the forceps, and cut off with one or two strokes of the scissors, at the lowest part of the eyelid. The compresses and bandage to keep the eyelid replaced, are to be applied as above directed. On changing the dressings, a day or two after the operation, the eyelid will be found, in a great measure, replaced, and the disfigurement which the disease caused greatly amended. The operation is occasionally, though rarely, followed by bad symptoms, such as vomiting, violent pain, and inflammation. However, should they occur, the vomiting may be relieved by means of an opiate clyster, and as for the pain and inflammation, attended with great tumefaction of the eyelid operated upon, these complaints may be cured by applying a poultice, or bags filled with emollient herbs, at the same time employing internal antiphlogistics, until the inflammation and swelling have subsided, and suppuration has commenced on the inside of the eyelid, on which the operation has been done. After this, the treatment is to consist in washing the part twice a day, with water, or barley-water, and lastly, in touching the wound a few times with the nitrate of silver, in order to keep the granulations within certain limits, and to form a permanent cicatrix, proper for maintaining the eyelid replaced.

Juengken describes a plan, which has been adopted by Jaeger, and was practised a hundred years ago by Platner (*Instit. Chir.* § 582), and even recommended a century before this author, by our countryman, Bannister. Heister and Dionis notice it still more circumstantially. (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 787.) It consists in detaching the everted eyelid from the cheek, or superciliary ridge, at every point, excepting the angles, by introducing a sharp-pointed double-edged knife, through the conjunctival surface, near the inner angle, bringing it out through the skin, and conveying it across to the outer angle. A portion of the thickened conjunctiva, or a triangular piece of the lid, may be first removed, if necessary. The detached lid is then to be accurately fixed, in contact with the globe, and the skin of the cheek drawn towards the eye, and kept in that position with adhesive plaster, compresses, and bandage. (*Handbuch, &c* p. 696.) Dieffenbach makes an incision through the skin and orbicularis, nearly parallel to the edge of the lower lid, beginning two or three lines from one angle, and terminating at the same distance from the other. It is one line from the edge of the lid at its two ends, and two or three lines in the middle. He turns up the small flap of skin, and dissects through the lid to the conjunctiva, which he divides to the extent of the external wound. With a hook he draws the external margin of the divided conjunctiva into the wound of the skin, and keeps it and the integuments together with sutures. (See *Chir, Erfuhrungen über die Wiederherstellung Zerstorter Theile, &c. von J. F. Dieffenbuch*, p. 127. Berlin, 1830.)

In cases in which the eversion is considerable, Sir W. Adams never found the simple excision of the fungus sufficient to effect a radical cure, and he therefore tried a new mode of operating. In his first attempts he employed a small curved bistoury, the point of which he carried along the inside of the eyelid, at its outer angle, downwards and outwards, as far as the point of reflection of the conjunctiva would admit. He then pushed it through the whole substance of the everted eyelid and its integuments, and cut upwards through the tarsus, making an incision nearly half an inch in length. With a curved pair of scissors he next snipped off a piece of the edge of the tarsus, about one-third of an inch in width, and he afterwards removed with the same instrument the whole of the diseased conjunctiva. When the bleeding had ceased, Sir W. Adams passed a needle and ligature through the whole substance of the two divided portions, and brought them as accurately into contact as possible. Finding, however, that too much integument had been left at the lower part of the incision, he employed, in future operations, instead of the scalpel, a pair of straight scissors, with which he cut out an angular piece of the lid, resembling the letter V, with its broad interval towards the ciliary edge of the lid. Latterly, Sir W. Adams found it advantageous to leave about a quarter of an inch of the lid adjoining its external angle; and after shortening the part as much as necessary, he brought the edges of the incision together with a suture. (See *Practical Obs. on Ectropion, &c.* p. 4 and 5. Lond. 1812.)

That this operation will cure the ectropion, caused by the contraction of cicatrices, or produce great improvement, the experience of Mr. Travers confirms. (*Synopsis of the Diseases of the Eye,* p. 235.) Mr. Guthrie also acknowledges that it may be highly useful in the ectropion from the contraction of a cicatrix. (*On the Operative Surgery of the Eye*, p. 71.) The contracted scar must be divided, in addition to the other proceedings.

In the form of ectropion, arising from a hardened and contracted state of the integuments of the eye, but without any cicatrix, the indications seem to Mr. Guthrie to be: 1st, To relieve the contraction of the skin externally; 2ndly, To restore and retain the eyelid in its proper situation, until the unnatural curvature of the cartilage has been overcome, and the chronic inflammation removed. For fulfilling the first indication he recommends washing the external parts with warm water, so as to leave the skin as clean as possible. It is then to be carefully dried, and repeatedly anointed with the ung. zinci, for three or four days. Being thus protected from the irritation, it becomes softer, and in a favourable state to yield to mild extension. For accomplishing the second indication, Mr. Guthrie applies the sulphuric acid; the eyelid having been cleansed so as to prevent its slipping, the conjunctiva is to be gently wiped dry, and everted as much as possible, so that the part where it begins to be reflected over the eyeball may be seen. An assistant is to raise the upper eyelid a little, and the patient to look upwards. The blunt end of a common silver probe is then to be dipped in the sulphuric acid, and rubbed over the conjunctiva, so that every part of it may be touched with the acid. The round point of the probe is to be carried as far as where the membrane begins to be reflected over the eyeball, but no further. The punctum lachrymale, caruncle, and semilunar fold are to be avoided; but the external angle, as well as every other part, except what is reflected over the eye, is to be carefully rubbed. The acid will turn the touched portion of the conjunctiva white; and in order to prevent the acid from affecting the eyeball, a stream of water is now to be directed over the eyelid with an elastic gum syringe. If the conjunctiva should not be turned sufficiently white, the application may be repeated. The use of the acid is to be repeated every fourth day; "and, when applied in the manner directed, it does not cause a slough, but a general contraction of the part, which is, however, only perceptible after two or three applications, by its effect in inverting the lid, which gradually begins to take place. After six or eight applications, the cure will be more than half accomplished, and, in most cases of this species of eversion, the thickening of the conjunctiva will have subsided." The ung. zinci is to be constantly applied to the skin, and the ung. hydrarg. nitr. in the proportion of one part to four or six of the ung. cetacei, to the edge of the eyelid. After the eyelid has returned two-thirds of the way towards its natural position, the intervals between the applications of the acid must be longer, lest the contraction within the eyelid be carried too far, and an inversion of it produced. After the eversion has been cured, the lippitudo may yet partly remain, and demand the use of the ung. hyrdrarg. nitr., or other gentle stimulants.— (*C. Bader.*)

See *Scarpa*, Osservazioni sulle Malattie degli Occhi; ed. 5. cap. vi. *Richter's* Anfangsgr. der Wundarzneykunst, b. ii. p. 473, &c. *Pellier*, Recueil d'Obs. sur les Maladies des Yeux. Sir *W. Adams*, Pract. Observ. on Ectropion, or Eversion of the Eyelids, with a Description of a new Operation for the Cure of that Disease; on the Modes of forming an artificial Pupil; and on Cataract, 8vo. Lond. 1812. *M. Bordenave*, Mémoire dans lequel on propose un nouveau Procédé pour traiter le Renversement des Paupières, in Mém. de l'Acad. Royale de Chirurgie, t. xiii. p. 156. et seq. édit. 12mo. It was in this memoir, that the proposal of removing a portion of the inside of the eyelid for the cure of ectropion was first made. *P. J. Roux*, Parallèle de la Chirurgie Anglaise avec la Chirurgie Française, p. 289—292. Paris, 1815. *G. J. Beer*, Lehre von den Augenkrankheiten, b. ii. p. 133. &c. 8vo. Wien, 1817. *Benj. Travers*, Synopsis of the Dis. of the Eye, p. 234. 356, &c. 8vo. Lond. 1820. *Demours*, Traité des Mal. des Yeux, p. 98. *G.J. Guthrie*, Lectures on the Operative Surgery of the Eye, 8vo. Lond. 1823. *Wm. Lawrence*, On Diseases of the Eye, p. 349, 8vo. Lond. 1833. *Wm. Mackenzie*, On Dis. of the Eye, p. 207. ed. 2. 8vo. Lond. 1833. *R. Middlemore*, On Dis. of the Eye, vol. i. p. 120; vol. ii. p. 782, 8vo. Lond. 1835. [*Mackenzie*, On the Diseases of the Eye, edit. 4, 1854. *Desmarres*, Traité Théorique, &c., edit. 2. Paris, 1855.]

ECZEMA, or ECZESMA (from *ἐκζέω*, to boil out), is characterised by an eruption of small vesicles on various parts of the skin, usually close, or crowded together, with little or no inflammation round their bases, and unattended by fever. It is not contagious. (*Bateman's Synopsis*, p. 250. ed. 3.) There are several varieties of this disease, the most remarkable of which is the *eczema rubrum* from the irritation of mercury. This form is attended with quickened pulse and a white tongue; but the stomach and sensorium are not materially disturbed. (See MERCURY.)

EFFUSION, in surgery, means the passage of any fluid out of the vessel, or viscus, naturally containing it, and its lodgment in another cavity, the cellular tissue, or the substance of parts. Thus, when the chest is wounded, blood is sometimes effused from the vessels into the cavity of the pleura; in false aneurism, the blood passes out of the artery into the cellular tissue; in retention of urine, this fluid, after a time, flows from the bladder and urethra into the cellular tissue of the perinæum and scrotum; and, when great violence has been applied to the skull, blood is often effused upon, or in the substance of, the brain. Effusion also sometimes signifies the separation of fibrine, or a serous fluid from the vessels by the process of secretion, or some action of the vessels analogous to it. (See EXTRAVASATION.)

ELECTRICITY. Among the aids of surgery, electricity once held a conspicuous and important situation. It has, however, met with a fate, not unusual with remedies too much cried up and too indiscriminately employed; that of having fallen into an undeserved degree of neglect. Whatever its effects may be on the system, it certainly possesses this advantage over other topical remedies, that it may be made to act on parts very remote from the surface. Electricity, as a topical remedy for surgical diseases, is chiefly tried in amaurosis, deafness, some chronic tumours, and abscesses, weakness from sprains, or contusions, paralysis, &c. In suspended animation, electricity is sometimes an important auxiliary for the restoration of the vital functions. (See *J. Curry's Obs. on Apparent Death, &c.* ed. 2, 1815.)

ELEVATOR. An instrument for raising depressed portions of the skull. Besides the common elevator, now generally preferred by all the best operators, several others have been invented; as, for instance, the tripod elevator, and another, which was first devised by J. L. Petit, and afterwards improved by M. Louis.

EMBROCATION. (See LINIMENTUM.)

EMBRYOTOMIA (from *ἔμϐρυον*, the fœtus, and *τέμνω*, to cut). The operation of cutting into the womb, in order to extract the fœtus. (See CÆSAREAN OPERATION.)

EMPHYSEMA (*ἐν*, into, *φυσάω*, I inflate). A swelling produced by the presence of atmospheric air, or of any other gaseous fluid, which has insinuated itself into, or been formed in, the cellular tissue. Emphysematous swellings are divided into two classes; one, the *traumatic*, in which they originate from a wound of some part of the organs of respiration; and another, the *idiopathic* or *spontaneous*, where they proceed either from chemical decomposition, or from secretion or internal pathological causes, the nature of which is obscure. In the latter class have been arranged *emphysema of the lungs*, a subject on which the researches of Laennec throw important light; and certain cases, where, in consequence of decomposition, gas is found under the mucous membrane of the digestive canal. (See *L. J. Bégin in Dict. de Méd et de Chir. Pratiques*, t. vii. art. *Emphysème*.)

With regard to *traumatic emphysema*, or that originating from a breach in the air-passages, sometimes it arises from a manifest, or concealed wound of the lungs, bronchi, trachea, or larynx; sometimes it follows a rupture of the air-cells, or passages, by the air itself. One common cause is a fractured rib, by which the air vesicles of the lungs are wounded, so that the air escapes from them into the cavity of the thorax. But, as the rib, at the moment of its being fractured, is pushed inwards, and wounds the pleura, which lines the ribs and intercostal muscles, part of the air most commonly passes through the pleura, into the cellular tissue, on the outside of the chest, and thence is diffused through the same over the whole body, so as to inflate it sometimes in an extraordinary degree.

Emphysema is frequent after a fractured rib, in cases where there is a wide laceration of the lungs, and no exit for the air; it is less frequent in large wounds with a knife, or broad sword, because the air has an open and unimpeded issue ; it is again more frequent in deep stabs with bayonets, or small swords ; and it often follows gunshot wounds of the chest, particularly those in which the ribs are splintered. (See *J. Bell*, *On Wounds of the Breast*, p. 265.)

Emphysema has also been known to arise from a rupture of the larynx and trachea, produced by a blow, or kick, as is exemplified in the case reported by Dr. L. O'Brien. (See *Edin. Med. and Surg. Journ.* No. lxxii.)

The emphysematous swelling, wheresoever situated, is easily distinguished from œdema, or anasarca, by the crepitation which occurs on handling it, or by the noise, resembling that which is heard on compressing a dry bladder half filled with air. The tumour is colourless and free from pain. It does not form especially in depending parts, though by pressure it may be made to change its situation. It is elastic, that is to say, it may be pressed down, but it rises up again as soon as the pressure is discontinued. The swelling never retains the impression of the end of the finger, or, in the language of surgery, never *pits*. The part is not heavy. The tumour first makes its appearance in one particular place ; but soon extends, and causes an extraordinary distension of the skin. (*Richter's Anfangsgr. der Wundarzn.* b. i. p. 451.)

In bad cases, the patient complains of a considerable tightness of the chest, with pain, chiefly in the situation of the injury, and great difficulty of breathing. This obstruction of respiration gradually increases, and becomes more and more insupportable. The patient soon finds himself unable to lie down in bed, and cannot breathe, unless when his body is in the upright posture, or he is sitting a little inclined forward. In vain he endeavours to articulate a few words ; at each inspiration a fresh column of air escapes from the breach in the lung, and renders his condition worse. Together with these symptoms, there is sometimes bloody expectoration, announcing a deep wound of the lungs. (See *Case by Dupuytren, in Clin. Chir.* t. i. p. 117.) The countenance becomes dusky and puffed. The pulse, at first weak and contracted, becomes afterwards irregular. The extremities grow cold ; and, if the patient continue unrelieved, he soon dies suffocated.

The diagnosis is not always free from obscurity, especially when emphysema is deeply seated, without any external tumour. An accumulation of air in one of the cavities of the pleura, however, is attended with an elevation and expansion of the ribs on the injured side, a clear sound on percussion, and excessive difficulty of breathing. In one example, where the fifth and sixth ribs were broken, there was, in addition to other symptoms already enumerated, an internal hissing sound at each expiration. (*Bégin*, *Dict. de Méd. et de Chir. Pratiques*, t. vii. p. 117.) For other symptoms and signs of the presence of air in the cavities of the pleura, see PNEUMO-THORAX.

The wound of the parietal pleura and intercostal muscles may sometimes be too small to suffer the air to get readily into the cellular tissue, and inflate it ; in such case a portion of the air may be confined in the cavity of the thorax, so as to compress the lungs, prevent their expansion, and cause the same symptoms of tightness of the chest, quick breathing, and sense of suffocation, which the serous fluid does in hydrops pectoris or the pus in empyema. (*Hewson, in Med. Obs. and Inq.* vol. iii.)

To understand why the air passes at all out of the wound of the lungs, we must advert to the manner in which inspiration and expiration are naturally carried on. In the perfect state, the surface of the lungs always lies in close contact with the membrane lining the chest, both in inspiration and expiration. The lungs themselves are chiefly passive organs, having only a slight contractile power, depending upon their elasticity. They are incapable, by any action of their own, of expanding and contracting, so as to maintain their external surface always in contact with the inside of the thorax, which is continually undergoing an alternate change of dimensions. Every muscle, that has any share in enlarging and diminishing the capacity of the chest, must contribute to the effect of adapting the volume of the lungs to the cavity in which they are contained, so long as there is no communication between the cavity of the pleura and the external air. In inspiration, the thorax is enlarged in every direction ; the lungs are expanded in the same way ; and the air, entering through the windpipe into the air-cells of these organs, prevents the occurrence of a vacuum.

But, when a free communication exists between the atmosphere and the pleural cavity, in consequence of a wound, no sooner is this cavity expanded, than the air naturally enters it at the same time, and for the same reasons, that the air enters the lungs through the trachea ; in consequence of this the lung itself remains proportionally collapsed. When the thorax is again contracted, in expiration, the air is compressed out of the lung, and also out of the sac of the pleura, through the external wound, if there be a direct one ; in which circumstance, the emphysematous swelling is never extensive.

But, in the case of a fractured rib, attended with a breach in the pleura costalis, pleura pulmonalis, and air-cells of the lung, there is no direct communication between the cavity of the chest and the external air ; in other words, there is no outward wound in the parietes of the thorax. There is, however, a preternatural opening formed between the air-cells of the lung and the cavity of the chest, and also another one between the latter space and the general cellular tissue of the body, through the breach in the pleura costalis. The consequence is, that when the chest is expanded in inspiration, air rushes from the wound in the surface of the lung, and insinuates itself between it and the pleura costalis. The lung collapses in proportion, and the place which it naturally occupied, when distended, is now occupied by the air. When, in expiration, the dimensions of the chest are everywhere diminished, the air, now lodged in the sac of the pleura, cannot get back into the aperture in the collapsed lung, because this is already full of air, and is equally compressed on every side, by that which is confined in the thorax. Were there no breach in the pleura costalis, this air could not now become diffused; the muscles of inspiration would next enlarge the chest, remove the pressure from the surface of the wounded lung, more air would be sucked out of it, as it were, into the space between the pleura costalis and pleura pulmonalis, and this process would go on, till the lungs of the wounded side were completely collapsed. But, in the case of a fractured rib, or narrow stab, in which there is also a breach in the pleura costalis, without any free vent outward for the air which gets out of the lung into the cavity of the pleura, as soon as the expiratory powers lessen the capacity of the chest, this air, not being able to pass back through the breach in the collapsed lung, is forced through the laceration, or wound, in the pleura costalis, into the cellular tissue.

It is through the communicating cells of this structure that the air becomes most extensively diffused over the whole body, in proportion as the expiratory muscles continue in their turn to lessen the capacity of the chest, and pump the air, as it were, through the breach in the pleura costalis, immediately after it has been drawn out of the wound of the lung in inspiration. (See *John Bell, On Wounds of the Breast, and Halliday, On Emphysema*, 1807.)

When organised adhesions exist between the pleura costalis and pleura pulmonalis, so as to establish a continuity of textures between the surface of the lung and the parietes of the chest, the comprehension of the mechanism of emphysema is, as Dupuytren remarks, assuredly perfectly simple. The air then passes directly from the interior of the lung into new-organised cellular texture, and thus gets through the parietes of the injured side into the subcutaneous cellular tissue. When there are no adhesions, a part of the air escapes, during inspiration, from the opening in the surface of the lung, and then becomes diffused in the surrounding textures and the cavity of the pleura. Thence it is forced in all directions, as Dupuytren conceives, both by the alternate movements of expansion and contraction of the chest in respiration, and by the effect of its own elasticity; and it is made to enter progressively the cellular tissue of all the internal and external organs. Thus, if the quantity of air drawn out of the lung is considerable, it passes not only into the parietes of the chest and belly, the upper and lower extremities, the interior of the scrotum, the neck and head, but also into the cavity of the pleura, the two mediastina, the pericardium itself, and even into the interlobular cellular tissue of the lungs themselves. (See *Dupuytren, in Clin. Chir.* t. i. p. 113. 119.) In some cases, emphysema is the principal disorder; in others, it is only one of secondary importance, and, sometimes not readily ascertained. An example, illustrating this fact, is given by Dupuytren, where the upper fragment of a broken sternum had penetrated the pericardium, and torn the right ventricle of the heart; and where a considerable quantity of bloody serum and of black blood itself was effused in the right cavity of the pleura; the fourth, fifth, and sixth ribs broken; and their cartilages separated from the sternum. (*Ib.* p. 120.) A case, published by M. Littre, well illustrates the enormous distension of the cellular tissue occasionally produced: on the chest, the swelling was eleven inches thick; on the belly, nine; on the neck, six; and four on other parts. (See *Mém de l'Acad. des Sciences*, 1713.)

To prove that the confinement of air in the chest is the cause of the dangerous symptoms attending emphysema, Hewson adverts to the histories of some remarkable cases, published by Littre, Mery, W. Hunter, and Cheston. (See *Mém. de l'Acad. Royale des Sciences for* 1713; *Med. Obs. and Inquiries*, vol. ii.; and *Pathological Inquiries*.) The same eminent man made several experiments on animals, tending to prove that air in their chests produced great difficulty in breathing, such as occurs in emphysema; and, in one case, which he examined after death, air was actually discharged on puncturing the thorax.

While none of the symptoms denote the extension of emphysema to internal organs, and the quantity of air does not exceed a few cubic inches, the patient is not in danger, so far as this disorder is concerned. But the case is very different when the air has passed not only into all the subcutaneous cellular tissue, but also into that of the internal organs of the chest, and even those of the abdomen; and when, besides such distension of the cellular tissue generally, there is likewise an accumulation of air in the pleural cavity. (See *Dupuytren, Clin. Chir.* t. i. p. 112.)

The passage of air as a complication of fractures, or penetrating wounds of the chest, occurs not only in the subcutaneous or intermuscular cellular tissue, but in any region adjacent to the air passages or cavities. M. Carré has published an instance of air ascending the nasal duct, and rupturing one of the lachrymal canals, when the patient blew his nose. (See *Mém. de Méd. Milit.*) One case of emphysema of the eyelids from a presumed fracture of the horizontal plate of the ethmoid bone, or os unguis, and another from a supposed laceration of the pituitary membrane, used to be related by Dupuytren in his lectures. He also gives the particulars of an emphysema of the temporal region from a fracture of the frontal sinus. In all these examples of emphysema from injury of the upper parts of the respiratory apparatus, the surgeon will notice, in addition to the crepitation, &c. a sudden increase of the swelling whenever the patient coughs or blows his nose. (Vol. cit. p. 123—130.) Here the treatment consists in the application of cold astringent lotions, and the avoidance of everything calculated to make the air escape through the breach into the cellular tissue.

The object of Mr. Hewson's paper is to recommend making an opening in the chest, for the purpose of giving vent to the air confined in that cavity, just as is done for the discharge of pus, in empyema, or of a serous fluid, in hydrops pectoris.

In wounds of the lungs, says this author, whether occasioned by fractured ribs, or other causes, when symptoms of tightness and suffocation come on, so far should we be from dreading the emphysematous swelling of the cellular tissue, that we should rather consider it as a favourable symptom, showing that the air is not likely to be confined in the thorax; and so far should we be from compressing the wound to prevent the inflation, or emphysema, that we should rather dilate it (if not large enough already) or perform paracentesis thoracis. We may judge of the necessity of this operation from the violence of the symptoms, such as the oppressed breathing, &c. For when these are not considerable, and the air passes out of the chest with sufficient freedom, the operation is then unnecessary.

If the disease is on the right side, the best place for performing the operation, says Mr. Hewson, will be on the fore part of the chest, between the fifth and sixth ribs; for there the integuments are thin, and, in the case of air, no depending drain is required. But, if the disease is on the left side, it will be more advisable to make the opening between the seventh and eighth, or eighth and ninth ribs, in order that we may be sure of avoiding the pericardium. As large penetrating wounds are inconvenient on account of the air entering by the aperture in such a quantity *as to prevent the expansion of the lungs*, a small wound will be eligible, especially as air does not require a large one for its escape. Mr. Hewson recommends dissecting cautiously with a knife, in preference to the coarse and hazardous method of thrusting in a trocar.

There is one error in Hewson's paper, for which he has been justly criticised by John Bell; viz., the idea that it is possible and proper to make the collapsed lung expand by making an opening in the chest. Bromfield and B. Bell imbibed the same erroneous opinion, and proposed plans for exhausting the air and expanding the lung. It is certain that it is impracticable to make the collapsed viscus expand, until the breach of it is closed, and this closure is greatly promoted by the quiet state in which the collapsed lung remains; a state, also, the most favourable for the stoppage of any bleeding from the pulmonary vessels.

The true object then of making an opening in the thorax, when the symptoms of suffocation are violent, is not to obtain an expansion of the lung on the affected side, nor to take the pressure of the air from it, but to remove the pressure caused on the opposite lung by the distension of the mediastinum, and, at the same time, to diminish the pressure of the air on the diaphragm. The lung on the affected side must continue collapsed, and it is most advantageous that it should do so. The opposite lung is that, which for a time must of itself carry on respiration, and it is known to be fully adequate to the function, provided the quantity of air, on the other side of the chest, does not produce too much pressure on the mediastinum and diaphragm.

Mr. John Bell concludes his remarks on this subject, with advising the following practice:—

1st. When the crackling tumour begins to form over a fractured rib, small punctures should be made with the point of a lancet, as in bleeding; and if the point be struck deep enough, the air will rush out audibly. But, as (supposing the lung is not adherent to the inside of the chest) this air was in the thorax, before it came into the cellular tissue, it is plain, that the thorax is still full, and that the lung of that side is already collapsed and useless, and must continue so. The purpose, therefore, of making these scarifications, and, especially, of making them so near the fractured part, is not to relieve the lungs, but merely to prevent the air spreading more widely beneath the skin.

2ndly. If the air should have spread to very remote parts of the body, as to the scrotum, and down the thighs, it will be easier to make small punctures in those parts, to let out the air directly, than to press it along the whole body, till it is brought up to the punctures made on the chest, over the wounded part.

3rdly. If, notwithstanding free punctures and pressing out the air in this way, it is found by the oppression, that either air, or blood, is accumulating within the cavity of the thorax, so as to oppress, not the wounded lung only, which was of course collapsed and useless from the first, but the diaphragm, and through the diaphragm to affect also the sound lung, then a freer incision must be made, through the skin and muscles, and a small puncture should be cautiously made through the pleura, in order to let out the air, or blood, confined in the thorax. (*John Bell*, op. cit. p. 278.)

I believe, with Dupuytren, that making cuts, or punctures in the skin, will be of little service where emphysema is attended with urgent symptoms depending upon the accumulation and confinement of air in internal cavities and organs, though the practice may answer the purpose of preventing the further diffusion of air in the subcutaneous cellular tissue by affording an outlet for it. Hence, if the case be not too far advanced, or joined with complications beyond the reach of surgery, Dupuytren was not adverse to the plan of puncturing the pleura. (See *Clin. Chir.* t. i. p. 117.)

Sometimes the necessity for puncturing the pleura is rendered obvious by the oppressed state of the breathing, and other urgent symptoms of pneumo-thorax; but, from the extreme distension of the integuments it may be, in some rare cases, difficult to ascertain on which side the operation should be performed. In one instance upon record, an incision was made between the sixth and seventh ribs on the left side; every symptom became immediately worse, and death followed in a quarter of an hour. The post mortem examination showed, that the operation had been performed on the wrong side. (See *Halliday, On Emphysema.*) In traumatic cases, or those from fractured rib, I think that such difficulty is not likely to happen; the wound, or fracture, being a guide.

In all these cases, copious and frequently repeated venesection is generally proper; and for the obvious reason, of bringing the quantity of blood in the body into a due relation to the diminished aerating surface.

After a few days, the wound in the collapsed lung is closed by the adhesive inflammation, so that air no longer passes out of it into the cavity of the chest, and the outer wound may therefore be healed. What air is already there is ultimately absorbed, and the lung, expanding in proportion, resumes its original functions.

The application of a bandage round the chest is sometimes practised for the relief of emphysema; and its utility, when the ribs are broken, has been highly spoken of by Mr. Abernethy. "Pressure by bandage (says he) not only hinders the air from diffusing itself through the cellular substance, but serves to prevent it from escaping out of the wounded lung; and, of course, facilitates the healing of the wound, which would be prevented by the constant transmission of air. Its early application, therefore, will often prevent a very troublesome symptom, whilst, at the same time, by keeping the fractured bones from motion, it greatly lessens the sufferings of the patient." (*Abernethy's Surgical Works*, vol. ii. p. 179.) When emphysema is complicated with a fractured rib, the latter injury is unquestionably a reason in favour of a bandage. But, whether the pressure of the roller will be useful, or hurtful, with respect to the emphysema itself, or the state of the lungs and respiration, may be questionable. As for its tendency to resist the diffusion of air in the cellular tissue, this circumstance does not appear to me important; because the air, thus diffused, much as it disfigures the patient, is nearly harmless, at least so long as the pleural cavities, and the interlobular texture of the lungs, remain uninflated; a danger, also, which no bandaging has any tendency to prevent. Neither will a bandage have so much effect in hindering the diffusion of air, as scarifications, with this important additional consideration, that punctures, or small incisions, made over the broken rib, prevent the spreading of the air, by letting it escape, while a bandage can only do so by more or less resisting its escape from the cavity of the pleura; which mode of operation in some cases would dangerously interfere with the continuation of respiration by the lung of the opposite side. At the same time, I believe, that when the air extravasated within the injured side of the chest is not in such quantity as to oppress the sound lung, and a rib is broken, a bandage will generally afford great relief. Indeed, it is but justice to Mr. Abernethy to state, that he does not recommend the employment of a bandage in all cases of emphysema. "Patients (says he) will not always be able to wear a bandage, when one lung is collapsed, particularly if any previous disease has existed in the other, as it equally confines the motions of the ribs on both sides, and as every possible enlargement of the chest becomes necessary for the due admission of the air into the lung, which still executes its functions. Under these circumstances, if the emphysema continues (and its continuance must always denote that the wound in the lung is not closed), I should esteem it the best practice to make a small opening into the chest, so that the external air might have a free communication with that cavity; and then the injured lung must remain motionless till its wound is healed, and the mediastinum will, in every state of the thorax, preserve its natural situation." (*Abernethy*, vol. cit. p. 183.) In the case recorded by Cheston, the patient on having a compress and bandage applied, exclaimed that he could not endure it.

When emphysema was combined with a fractured rib, and not any urgent compression of the lungs by air in the cavity of the pleura, Dupuytren used to bleed, apply to the injured side compresses wetted with a resolvent lotion, and then surround the chest with a bandage, so as to suspend the action of the external muscles of respiration, and oblige the patient to breathe entirely by the diaphragm, the principle insisted upon by Abernethy. In this manner the union of the fracture was promoted, and, as was believed, the causes of emphysema opposed. The possibility of a person breathing wholly by the diaphragm seemed proved to Dupuytren by what happens in injuries of the upper part of the spinal chord, when all the external muscles are struck with paralysis. (*Clin. Chir.* t. i. p. 115.) When, however, the respiration was dangerously interrupted by the accumulation of air in the pleura, Dupuytren abstained from applying a bandage, which he conceived to be only likely to augment the patient's sufferings. (See *Clin. Chir.* t. i. p. 117.)

The utility of a free incision, and scarifications, is well illustrated in a case recorded by Larrey. The emphysema arose from a wound of the lungs by a lance. The whole body was prodigiously swelled; the integuments so distended that the limbs were inflexible, the eyes buried; and the lips so enlarged that nothing could be introduced into the mouth. The pulse and respiration were scarcely perceptible, and the voice feeble and interrupted. The lance had entered obliquely under the lower angle of the scapula; and though the external and internal orifices of the wound were not parallel, the surgeon had applied adhesive straps, and closed the external one. Hence the air, as it escaped from the lungs, distended the cellular tissue. Larrey immediately removed the dressings; and, with a bistoury, made the openings in the pleura and skin parallel. Cupping glasses were then applied over the wound, and quickly filled with air and blood. The lips of the wound were now brought together, and kept so with a suitable bandage. Cupping glasses and scarificators were applied to various parts of the body, and, in others, incisions were made with a scalpel. The patient recovered. (See *Mém. de Chir. Militaire*, t. iv.)

In emphysema, dependent upon over distension and rupture of the air cells, and the escape of air into the interlobular tissue of the lungs, and thence through the mediastinum, into the common cellular tissue, the best practice is that of diminishing the violence of the respiratory efforts, by which the air is forced at each respiration into the mediastinum. With this view, copious venesection should be employed, for the double purpose of relieving the pulmonary congestion, and of diminishing the mass of circulating fluid; for, by lessening the quantity of blood for oxygenation, we also lessen the necessity for taking in so large a supply of air for the purpose, and, in the same proportion, diminish the efforts made by the muscles of respiration to dilate and contract the thorax. Opiates should be employed with the same intent; and the antiphlogistic regimen enforced. (See *Townsend in Cyclop. of Prac. Medicine*, art. Emphysema; and *Laennec, On Dis. of the Chest*, ed. by Forbes.)

Emphysema has been known to arise from the bursting of a vomica, and ulceration of the surface of the lungs; but the air which escapes cannot pass into the cavity of the thorax, because the inflammation which precedes the abscess and ulceration of the air-cells closes those which are adjacent, and produces an adhesion of the edges of the vomica, or ulcer, to the inner surface of the chest, so as entirely to separate the two cavities. Palfyn and Dr. Hunter met with cases, in which emphysema originated from abscesses of the lungs, attended with adhesion to the pleura and ulcerations in the situation of such adhesion. In these instances, the pus having made its way through the pleura and intercostal muscles, the air escaped through the same track, and passed into the cellular tissue on the outside of the chest.

A violent effort of respiration has sometimes produced a certain degree of emphysema, which first makes its appearance about the clavicles, and afterwards spreads over the neck and adjacent parts. The efforts of labour have been known to occasion it. (*Medical Communications*, vol. i. p. 176; *Blackden, in Med. Facts and Experiments*, vol. ii.; *Wilmer's Obs. in Surgery*, p. 143; and *Halliday on Emphysema.*)

Dr. Johnson, of Dublin, met with six examples of this in his practice, In general, the emphysematous swelling is confined to the neighbourhood of the throat, where it first makes its appearance; but it may spread to a vast extent, and even to the very tips of the fingers. In hooping cough emphysema may be produced, as proved by the observations of Drs. Johnson, Mackintosh, and Beattie. (See *Cyclop. of Pract. Med.* art. *Emphysema.*) I agree with the writer of this article in thinking it highly probable that many cases of emphysema supposed to be spontaneous, really proceed from a rupture of the air-cells of the lungs. Thus, besides the emphysema, which sometimes appears on the sides of the thorax, when much force is employed to reduce a dislocation of the humerus, which was believed by Desault to depend upon a rupture of the air-cells, caused by the violent efforts which the patient makes to hold his breath during the reduction of the dislocation, the emphysematous swellings, which are noticed occasionally in hysteria, may admit of similar explanation, the air being forced through the cellular tissue of the lung and mediastinum by the violent efforts at expiration made during the paroxysm, while the glottis is spasmodically constricted. (*Townsend*, ib.)

Louis described an emphysema, which, on account of its cause, and the indication furnished by it to the practitioner, is highly important. It took place in a young girl, who died suffocated from a bean falling into her windpipe; and he considers it, though not correctly, as a pathognomonic symptom of such an accident, concerning the existence of which it is so essential not to commit any mistake. (See Tracheotomy.) It made its appearance on both sides of the neck, above the clavicles, and came on suddenly, on the third day after the accident. The inspection of the body proved, that the lungs and mediastinum were also in an emphysematous state. The retention of the air, confined by the foreign body, produced, says Louis, at each attempt to expire, and, especially, when the violent fits of coughing occurred, a strong propulsion of this fluid towards the surface of the lung, into the spongy surface of this viscus. Thence, the air passed into the cellular texture, which unites the surface of the lung to the pleura pulmonalis; and, by communications from cells to cells, it caused a prodigious swelling of the cellular tissue, between the two layers of the mediastinum. The emphysema, increasing, at length made its appearance above the clavicles. This tumefaction of the lung, and surrounding parts, in consequence of the air getting into their spongy and cellular texture, is an evident cause of suffocation, and the swelling seems so natural an effect of the presence of a foreign body in the trachea, that one can hardly fail to think it an essential symptom, though no author has made mention of it. (*Mém. de l'Acad. de Chir.* t. iv. in 4to.) The emphysematous swelling, sometimes formed in the axilla, in the reduction of a dislocated shoulder was accounted for by Desault and Bichat, on the same principle as the foregoing case, viz. a rupture of one of the air-cells, by the patient's efforts to hold his breath during the reduction of the bone.

The example, lately recorded by Dr. Ireland, as one of idiopathic emphysema following pneumonia, bears so strong a resemblance to the case above cited from M. Louis, that I cannot refrain from suspecting, that it may have been one of the same nature. (See *Trans. of the King's and Queen's College of Physicians*, vol. iii. art. 4.)

An emphysematous swelling of the head, neck, and chest, has also been noticed in typhoid fevers. Dr. Huxham relates an instance of this sort, in a sailor of a scorbutic habit. (*Medical Obs. and Inquiries*, vol. iii. art. 4.) Another example in a case of bilious fever is on record. (See *London Med. Repository*, No. 73.) A case of spontaneous emphysema is likewise described by Dr. Baillie. (See *Trans. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 202.)

A curious example of what has been called a spontaneous emphysema, is reported by Mr. Allan Burns:—"The patient was a strong athletic man, who, about six years previous to his application at the Royal Infirmary, had received a smart blow on the neck from the keel of a boat. This injury was soon followed by the formation of a firm tense tumour, on the place which had been hurt. The swelling increased very slowly, during the five years immediately succeeding its commencement; but, during the sixth, it received a very rapid addition to its bulk. At this time, it measured nearly six inches in diameter, seemed to be confined by a firm and dense covering, and the morbid parts had an obscure fluctuation. From the first to the last, the tumour had been productive of very little pain.

"Judging from the apparent fluctuation that the tumour was encysted, it was resolved, at a consultation, to puncture the swelling, draw off its contents, and then pass a seton through it. By plunging a lancet into it, only a very small quantity of blood, partly coagulated, and partly fluid, was discharged; a quantity so trifling, that, after its evacuation, the size of the tumour was not perceptibly reduced. A seton was passed through the swelling. At this time the man was in perfect health.

"About ten hours after the operation, the patient was seized with extremely violent rigors, followed by heat, thirst, pain in the back, excessive pain in the tumour, and oppressive sickness.

"An emetic was prescribed; but instead of producing vomiting, it operated as a cathartic. To remove the irritation, the seton was withdrawn. The pain in the tumour, however, and the general uneasiness continued to increase, and thirty hours subsequent to making the puncture, air began to issue from the track of the seton; and afterwards the cellular membrane of the neck, and of the other parts of the body in succession, became distended with a gaseous fluid. In the course of a few hours, after the commencement of the general emphysema, the man died.

"Twelve hours after death, when the body was free from putrifaction, it was inspected. The emphysema was neither increased nor diminished since death ; and some idea may be formed of its extent, when the scrotum was distended to the size of the head of an adult. Even the cavities of the heart, and the canals of the blood-vessels, contained a considerable quantity of air. We could discover no direct communication between the tumour and the trachea or lungs, although such was carefully sought for." (*A. Burns on the Surgical Anatomy of the Head and Neck*, pp. 51—53.)

From such cases, we may infer, that from the mere rupture of a few of the bronchial cells, occasioned by irregular action of the lungs, or by some other internal cause, a spontaneous diffusion of air may take place in the cellular tissue. Such examples are dependent on the same cause as emphysema from injury of the lungs ; only the rupture of the bronchial cells in the former cases is less obvious.

Emphysema frequently attends gangrene, especially the humid. Here, however, the air is the product of putrefaction, and the disorder has not the smallest connection with any injury, or disease, of the lungs. In one instance of gangrene from an external cause, Dr. Hunter found, that he could as easily mark the progress of the mortification from day to day by the emphysema, as by the change of colour in the integuments. (See *Med. Obs. and Inq.* vol. ii.) Gangrene, when accompanied by emphysema, is observed to have a great disposition to spread. (See *James on Inflammation*, p. 96.)

A remarkable case is recorded by Dr. Duncan, in which several emphysematous tumours were formed in succession over the chest and neck, in consequence of communications formed by ulceration between the lung and common cellular tissue. (See *Edinb. Med. Chir. Trans.* vol. i.) Or the air may first get into the cavity of the pleura, so as to occasion pneumo-thorax, and afterwards pass into the cellular tissue through an ulceration of the pleura costalis. (See *Halliday*, Op. cit.) Emphysema has been known to arise from the passage of air from the alimentary canal, through a rupture of its parietes. (*Haller*, *Opuscula Pathol. Obs.* 31, t. iii.) A violent contusion of the abdomen has produced in this way an extensive emphysema. (See *Archives Gén. de Méd.*) In ruminating animals, in consequence of the fermentation of their food, the accident is not uncommon. (See *Obs. sur les Animaux Domestiques, par MM. Chabert et Huzard.*)

C. C. Puysch, De Emphysemate. Haller, Disp. Chir. ii. 567. Halæ, 1733. *H. A. Nies*, De Miro Emphysemate, 4to. Duisb. ad Rhen. 1751. *Hewson's* Paper in Medical Obs. and Inquiries, vol. iii. Mém. de l'Acad. Royale des Sciences for 1713. Dr. *W. Hunter*, in Med. Obs. and Inquiries, vol. ii. *Cheston*, in Pathological Inquiries. *Abernethy's* Surgical Works, vol. ii. *Richter*, von der Windgeschwulst, in Anfangsgr. der Wundarzneykunst, b. I. p. 451, &c. *John Bell*, On Wounds, edit. 3. Edin. 1812. *Halliday* of Emphysema, 1807. *Allan Burns*, on the Surgical Anatomy of the Head and Neck, p. 52, &c. Trans. of a Society for the Improvement of Medical and Chir. Knowledge, vol. i. p. 262. *Wilmer's* Observations in Surgery, p. 143. *F. C. Waitz*, De Emphysemate, 4to. Lips. 1803. *Lassus*, Pathologie Chir. t. ii. p. 321, &c. edit. 1809. Dict. des Sciences Méd. t. xii. p. 1, &c. Dict. de Méd. et de Chir. Pratiques, art. Emphysema. *Townsend*, in Cyclopædia of Pract. Med. art. Emphysème. *J. Hennen*, Principles of Military Surgery, p. 376, edit. 2, 8vo. Edin. 1820. *C. Bell*, Surgical Obs. vol. i. p. 161, &c. *Laennec*, On Dis. of the Chest, ed. by Forbes, ed. 3. *Dupuytren*, Clinique Chir. t. i. p. 110, 8vo. Paris, 1832.

EMPLASTRUM. [Plasters are adhesive applications intended to cover for a considerable period the part to which they are applied. They are usually spread on linen or leather. Some plasters, as the emplastrum plumbi, the emplastrum saponis, the emplastrum resinæ, can hardly be said to possess any medicinal properties; they are principally used for their adhesive and protective qualities, either to bring the edges of recent wounds together, and retain them in position, or simply to cover tender surfaces. They are also used to maintain uniform pressure, especially in the treatment of varicose ulcers, for which latter purpose they are applied in strips from the ankle to the knee. (See ULCERS.) Mr. Liston introduced a simple unirritating adhesive plaster for adjusting recent wounds, composed of isinglass and gin, which, when spread on white silk, is sufficiently transparent to admit of the edges of the wound being seen from day to day without disturbing the plaster.

Other plasters possess stimulating anodyne or specific properties. Of these, the emplastrum ammoniaci, the emplastrum picis, the emplastrum galbani, are of the first kind; the emplastrum opii, the emplastrum belladonnæ, of the second; and the emplastrum hydrargyri, and the emplastrum potassii iodidi, of the third. The ordinary blistering plaster, or emp. lyttæ, may be considered as simply irritating without possessing any other medicinal quality; while the emplastrum ammoniaci c. hydrargyro possesses stimulating and specific properties combined. For the exact composition of the several plasters used in practice the reader is referred to the *London Pharmacopœia*. In the treatment of chronic affections of the larger joints great advantages have been derived from the methodical application of plasters, as practised and recommended by the late Mr. Scott of Bromley, by the means of which, warmth, a moderate degree of pressure, counter-irritant, and specific agents, were all brought to render at one and the same time unremittingly their combined remedial effects in counteracting the tedious joint disease.]

EMPYEMA (from ἐν, within, and πύον, pus, or matter). A collection of purulent matter in the cavity of the chest.

The ancients made use of the word "empyema" to express every kind of internal suppuration. It was Ætius who first restricted the term to collections of pus in the cavity of the pleura, or membrane lining the chest ; and all the best modern surgeons invariably attach this meaning alone to the expression.

The operation for empyema—thoracentesis—properly means the making of an opening into the thorax, for the purpose of discharging pus collected in the cavity of the pleura, though the phrase with several writers denotes making an incision into the chest, in order to let out any effused or confined fluid, whether matter, blood, or a serous fluid. It is not always easy, however, to determine, *à priori*, the precise nature of the fluid collected in the chest. Thus, in a case of empyema of two months' standing, occasioned by the bursting of a tubercular abscess of the lung into the pleura, the fluid was observed by Dr. Townsend to present all the characters of genuine pus ; while, in another case, where the effusion was produced by a similar cause, and assumed the same chronic form, thoracentesis gave issue to a fluid as transparent and colourless as water. (See *Cyclop. of Pract. Med.* art. *Empyema.*)

Acute and chronic abscesses not unfrequently form in the cellular tissue, between the pleura and the ribs, and intercostal muscles. A swelling occurs between two of those bones; the skin does not undergo any change of colour; a fluctuation is distinguishable, and sometimes extensive œdema.

With respect to abscesses formed in the cellular tissue, connecting the pleura costalis to the intercostal muscles, they rarely burst into the chest, because the pleura is in such case considerably thickened. However, in order to keep them from spreading extensively, as well as to obviate any possibility of their breaking inwards, the best rule is to make an early, and, if possible, a depending opening into them. The motions of respiration then both promote the exit of the matter, as well as the contraction of the cavity in which it was lodged; and the disease, if unattended with caries, generally terminates favourably.

It often happens, however, that the abscess is caused by a carious rib, and then the cure is more tedious and difficult. A modern writer, indeed, informs us that, when the inside of the rib is extensively carious, or when the caries is near the junction of the bone to the spine, the fistula is incurable. (*Lassus, Pathologie Chir.* t. i. p. 128, edit. 1809.) On the other hand, another surgeon of vast experience recommends us to endeavour to separate the diseased bone, either by cutting it away or employing the trepan. (*Pelletan, Clinique Chir.* t. iii. p. 253.) Were a part of a diseased rib to admit of being sawn away, Mr. Hey's convex saw would be a more proper instrument for the purpose than a trepan.

An abscess of the preceding kind may be so situated, and attended with such a pulsation, as greatly to resemble an aneurism of the origin of the aorta. An interesting case of this description is detailed by Pelletan (*Clinique Chir.* t. iii. p. 254), and another was seen by Boyer. (*Mal. Chir.* t. vii. p. 333.)

When the surface of the lungs, and that of the pleura costalis have become adherent to each other, around the abscess, so as to constitute what is termed *encysted empyema*, the pus, disposed by a law of nature to make its way to the surface of the body, generally occasions ulceration of the intercostal muscles, and collects on the outside of them. An abscess of this kind comes on with a deep-seated pain in the part affected; an œdematous swelling, which retains the impression of the finger; and a fluctuation, which is at first not very distinct, but, from day to day, becomes more and more palpable, and, at length, leads the surgeon to make an opening.

If this be not done when the fluctuation becomes perceptible, the abscess may possibly insinuate itself into the cavity of the pleura, in consequence of the adhesion being in part destroyed by ulceration. Sabatier affirms that the case may take this course, even when the abscess has been punctured, and while a free external opening exists; and this experienced surgeon has adduced a fact in confirmation of such an occurrence. (See *Méd. Opératoire*, tom. ii. p. 249.)

In a few instances, the surface of the lung ulcerates, and the matter is voided from the trachea. If inflammation occurs in the anterior mediastinum, and ends in suppuration, the abscess may possibly burst into neither of the cavities of the chest, but make its way outwards, after rendering the sternum carious, as happened in the example recorded by Van Swieten. (*Comment on Boerhaave's 895th Aphorism.*)

But though collections of matter in the anterior mediastinum are influenced by the general law, in accordance with which abscesses tend to the surface of the body, and though it be true that they rarely burst into the cavity of the pleura, the contrary may happen, as is proved by the 9th case in La Martinière's memoir, on the operation of trepanning the sternum. Here the event was the more unexpected, as there was already an external opening in the abscess.

External injuries, such as the perforation of the sternum with a sword (*Vanderwiel, Obs.* 29, *Cent.* 1), a contusion, a fracture, or a caries of this bone, may give rise to an abscess in the anterior mediastinum. Galen has recorded a memorable example, where the abscess was the consequence of a wound of the fore part of the chest. After the injury, which was in the region of the sternum, seemed quite well, an abscess formed in the same situation, and being opened, healed up. The part, however, soon inflamed, and suppurated again. The abscess could not now be cured. A consultation was held, at which Galen attended. As the sternum was obviously carious, and the pulsation of the heart was visible, every one was afraid of undertaking the treatment of the case, since it was conceived that it would be necessary to open the thorax itself. Galen, however, engaged to manage the treatment without making any such opening, and he expressed his opinion that he should be able to effect a cure. After the removal of a portion of the bone, the heart was quite exposed (as is alleged), by reason of the pericardium having been destroyed by the previous disease. The patient experienced a speedy recovery.

J. L. Petit met with an abscess in the anterior mediastinum, in consequence of a gun-shot wound in the situation of the sternum. The injury had been merely dressed with some digestive application; no dilatation, nor any particular examination of the wound had been made. The patient, being to all appearance quite well, joined his regiment again, but was soon taken ill with irregular shiverings, and other febrile symptoms. Petit probed the wound, and found the bone affected. As there was a difficulty of breathing, he suspected an abscess either in the diploe or behind the sternum, and, consequently, he proposed laying the bone bare, and applying a trepan. The operation afforded an outlet for some sanious matter, and, as soon as the inner part of the sternum had been perforated, a quantity of pus was discharged. The patient was relieved, and afterwards recovered. (*Petit, Mal. Chir.* t. i. p. 80.)

Another instance, in which an abscess behind the sternum was cured by making a perforation in that bone, opposite the lower part of the cavity, in which the matter had collected, is recorded by De la Martinière. (*Mém. de l'Acad. de Chir.* t. xii. edit. 12mo.)

When, in consequence of inflammation, an abscess forms deeply in the substance of the lungs, the pus more easily makes its way into the air-cells, and tends towards the bronchi than towards the surface of the lungs. In this case the patient spits up purulent matter. When the opening, by which the abscess has burst internally, is large, and the pus escapes from it in considerable quantity at a time, the patient is in some danger of being suffocated. However, if the opening be not immoderately large, and the pus, which is effused, be not too copious, a recovery may ensue. Collections of matter in the liver may also be discharged by the pus being coughed up through the trachea, when the parts affected become connected with the lungs by adhesions, and the abscesses of the liver are situated on its convex surface. When the collection of matter in the liver takes place on its concave surface, the pus sometimes makes its way into the colon, and is discharged with the stools. Several cases of this kind are related by authors: Sabatier has recorded two (*Méd. Opératoire*); Le Dran makes mention of others; and Pemberton (*Diseases of the Abdominal Viscera*, p. 36) relates additional instances of a similar nature.

I shall now proceed to the consideration of empyema, strictly so called. Sometimes it is a consequence of a penetrating wound of the chest; occasionally it proceeds from the bursting of one or more vomicæ; in a few examples, it arises from the particular way in which abscesses of the liver burst (*Journ. de Méd.* t. iii. p. 47. *Morgagni*, epist. xxx. art. 4); but, in the greater number of instances, originates from pleuritic inflammation, either acute or chronic. (*Boyer*, *Mal. Chir.* t. vii. p. 352.) Empyema more rarely takes place in both than in one cavity of the pleura.

Sometimes firm adhesions intersect the purulent effusion, and divide the sac of the pleura into distinct compartments. Dr. Townsend examined the body of a patient, who died of empyema in the Whitworth Hospital, and in whom the effusion was contained in three compartments, so perfectly distinct from each other, that, if paracentesis had been performed, only one of the three separate collections would have been discharged. (See *Cyclop. of Pract. Medicine*, art. *Empyema.*) In all cases the purulent, or thinner fluid of empyema may be said to be principally, if not entirely, a morbid secretion from the pleura; and even where pus or other matter is introduced from another source, as from the rupture of a pulmonary or hepatic abscess, the collection of fluid, which constitutes the empyema consequent thereon, does not consist so much of the matter of the abscess, as of the morbid secretion from the pleura, which the irritation caused by the presence of that matter produces. (*Townsend*, ib.)

In cases of empyema, the pleura is almost constantly lined with a coating of adventitious matter, which gives the interior of the chest much more the appearance of the walls of a large abscess, than of a cavity lined with a serous membrane. The membrane is susceptible of inflammation, ulceration, and gangrene, and when the latter change occurs, the detachment of the slough may form an outlet for the empyema. The adventitious membrane of serous tissues is also capable of undergoing fibrous, cartilaginous, and calcareous transformations, and is liable to the development of tubercles in it. These are generally small and numerous, and mostly follow chronic pleuritis. Sometimes, however, they form numerously and rapidly. (See *Andrat, Clinique Méd.* t. ii.)

When empyema arises from thoracic inflammation, pleuritis, or pneumonia, the symptoms characterising it are usually preceded by those of the disease, of which the effusion of pus into the pleura is the effect. Inquiry must, therefore, be made whether the patient has had pleurisy, or peripneumony, the symptoms of which have lasted longer than a fortnight: and whether, after a transient amendment, there have been frequent shiverings, followed by a low continued fever, with nightly exacerbations. Now these first circumstances justify the belief, that the inflammatory disorder has terminated in suppuration, and that the symptoms afterwards experienced depend upon effusion of matter into the chest. Some of these symptoms arise from the mechanical action of the pus upon the lungs, heart, and parietes of the chest, and belong also to other effusions in the thorax; the rest may be said to be the effects of ulceration and suppuration of the parts on the animal economy, and, therefore, particularly belong to empyema.

First, of the common symptoms, the respiration is difficult, short, and frequent; the patient suffers great oppression, and experiences a sense of suffocation, and of weight upon the diaphragm. He cannot move about, even for a short time, without being quite out of breath, and threatened with syncope. He has an almost incessant, and very fatiguing cough, which is sometimes dry, sometimes attended with expectoration. (*Boyer*, *Mal. Chir.* t. vii. p. 356.)

Few writers of the last century have described the symptoms of empyema with more discrimination and accuracy than Mr. Samuel Sharp. He remarks, that it has been almost universally taught, that, when a fluid is extravasated in the thorax, the patient can only lie on the diseased side, the weight of the incumbent fluid on the mediastinum becoming troublesome, if he places himself on the sound side. For the same reason, when there is fluid in both cavities of the thorax, the patient finds it most easy to lie on his back, or to lean forwards, in order that the fluid may neither press upon the mediastinum, nor the diaphragm. But it is noticed by Mr. Sharp, that, however true this doctrine may prove in most instances, there are a few, in which, notwithstanding the extravasation, the patient does not complain of more inconvenience in one posture than another, nor even of any great difficulty of breathing. (See *Le Dran's Obs.* 217; and *Marchetti*, 65.)

On this account, observes Mr. Sharp, it is sometimes less easy to determine when the operation is requisite, than if we had so exact a criterion as we are generally supposed to have. But, says he, though this may be wanting, there are some other circumstances, which will generally guide us with a reasonable certainty. He states, that the most infallible symptom of a large quantity of fluid in one of the cavities of the thorax, is a preternatural expansion of that side of the chest where it lies; for, in proportion as the fluid accumulates, it will necessarily elevate the ribs on that side, and prevent them from contracting so much in expiration as the ribs on the other side. This change is said to be most evident when the surgeon views the back of the chest. (*Boyer*, vol. cit. p. 357.) Mr. Sharp also refers to *Le Dran's Obs.* 211, vol. i., in order to prove, that the pressure of the fluid on the lungs may sometimes be so great, as to make them collapse, and almost totally obstruct their function. When, therefore, says Mr. Sharp, the thorax becomes thus expanded, after a previous pulmonary disorder, and the case is attended with the symptoms of suppuration, it is probably owing to a collection of matter. The patient, he observes, will also labour under a continual low fever, and a particular anxiety from the load of fluid.

Besides this dilatation of the cavity by an accumulation of the fluid, the patient will be sensible of an undulation, which is sometimes so evident that a bystander can plainly hear it in certain motions of the body. Mr. Sharp adds, that this was the case with a patient of his own, on whom he performed the operation: but the fluid, in this instance, he says, was very thin, being a serous liquid, rather than pus. Sometimes, when the practitioner applies his ear close to the patient's chest, while this is agitated, a noise can be heard, like that produced by shaking a small cask not quite full of water. (See *Dr. Archer's Case, in Trans. of the Fellows, &c. of the King's and Queen's College of Physicians in Ireland*, vol. ii. p. 2.) In this instance, the fluid resembled whey. [Such undulations of the fluid, however, are only to be thus recognised, when air, as well as fluid, is present in the pleural cavity.]

According to the same author, it will also frequently happen, that though the skin and intercostal muscles are not inflamed, they will become œdematous in certain parts of the thorax; or, if they are not œdematous, they will be a little thickened; or, as Boyer states, the intercostal spaces are widened, and, when the empyema is considerable, instead of being depressed, as they are in thin persons, they project beyond the level of the ribs. (*Mal. Chir.* t. vii. p. 357.) These symptoms, joined with the enlargement of the thorax, and the preceding affection of the pleura or lungs, seem unquestionably to indicate the propriety of the operation. But, observes Mr. Sharp, amongst other motives to recommend it upon such an emergency, this is one, that if the operator should mistake the case, an incision of the intercostal muscles would neither be very painful, nor dangerous. (See *Critical Inquiry into the present State of Surgery*, sect. on Empyema.)

"The difficulty of lying on the side, opposite to the collection of pus," says Le Dran, "is always accounted a sign of an empyema. This sign, indeed, is in the affirmative; but, the want of it does not prove the negative; because, when there is adhesion of the lungs to the mediastinum, the patient may lie equally on both sides." (*Le Dran's Obs.* p. 108, edit. 2.) The explanation of this circumstance, offered by Le Dran, is, that when the cyst, in which the matter is contained, is between the mediastinum and the lungs, the mediastinum gradually yields to the volume of the pus, in proportion as it is formed, and the cyst in which it is contained becomes dilated; "whence habitude becomes a second nature." Whereas, in an empyemal person, in whom the lung is not adherent to the mediastinum, and who lies on the side opposite to that on which the collection of pus is situated, the mediastinum is on a sudden loaded with an unusual weight of fluid. (P. 111.)

Richerand contends, that the difficulty of breathing, which patients with extravasated fluid in the chest experience in lying upon the side opposite to that on which the disease is situated, never originates, as has been commonly taught and believed, from the fluid pressing upon the mediastinum and opposite lung. "I have (says he) produced artificial cases of hydrothorax, by injecting water into the thorax of several dead subjects, through a wound made in the side. This experiment can only be made on subjects in which the lungs are not adherent to the parietes of the chest. In this way from three to four pints of water were introduced. I then cautiously opened the opposite side of the chest: the ribs and lungs being removed, the mediastinum could be distinctly seen, reaching from the vertebræ to the sternum, and supporting, without yielding, the weight of the liquid, in whatever position the body was placed.

"It is evident, then, that patients, with thoracic extravasations, lie on the diseased side, in order not to obstruct the dilatation of the sound side of the respiratory organs, one part of which is already in a state of inaction. It is for the same reason, and in order not to increase the pain by the tension of the inflamed pleura, that pleuritic patients lie on the diseased side. The same thing is observable in peripneumony: in a word, in all affections of the parietes of the chest." (*Nosogr. Chir.* t. iv. pp. 168, 169, edit. 2.)

There may be some truth in the foregoing statement; but the experiments are far from being conclusive, with respect to the assertion that, in empyema, hydrothorax, &c. the fluid on one side of the chest does not compress the opposite lung. In the first place, the quantity of fluid is frequently much larger than that which Richerand injected. Secondly, although the mediastinum may not be apt to yield at once to the weight of a liquid suddenly injected into one side of the thorax; yet it frequently does so by the gradual effect of disease. Thirdly, many of the phenomena of empyema seem adverse to Richerand's inference.

In opposition to Richerand's view, Dr. Townsend argues, that we have direct proof of the influence of the weight of the fluid; for, in pneumo-thorax with empyema, the patient can generally lie on the sound side, so long as the effusion is principally gaseous; but, as the proportion of ponderable fluid increases, decubitus on the sound side becomes impossible. In like manner, in cases of empyema, the dyspnœa is generally greatly aggravated by this posture; but, when the fluid has been discharged, the patient is immediately able to lie on the sound side, though the necessity for its free dilation continues as great as ever, the diseased side being still in a state of inaction. Thus, in a case of empyema with pneumo-thorax, where paracentesis was performed, the patient could lie on the sound side on the night after the fluid was drawn off, though it was ascertained by auscultation that the side was then filled with air. (See *Dublin Hospital Reports*, vol. v.; and *Townsend in Cyclopædia of Practical Medicine*, art. *Empyema.*)

[In empyema with pneumo-thorax, the distension of the pleural cavity with air often occasions pressure through the mediastinum upon the healthy lung. (See Emphysema.) The proof that fluid in one pleura may compress the opposite lung is given in the fact, stated below, that the heart may be thereby pushed towards the healthy side of the chest.]

When empyema is double, the patient can seldom lie in the horizontal position; but remains seated, and with the trunk inclined forward.

Although surgeons should be aware that patients with empyema can sometimes lie in any position, without particular aggravation of the difficulty of breathing, yet, it ought to be distinctly understood, that the generality of patients cannot place themselves on the side opposite to that on which the collection of pus is situated, without their respiration being very materially obstructed. Another circumstance, also, which deserves to be mentioned while we are treating of the symptoms of empyema, is, that the œdema of the integuments is sometimes not confined to the thorax, but extends to more remote parts, on the same side of the body as the collection of matter. Both the foregoing remarks are confirmed by an interesting case published by Mr. Hey.

Sept. 3, 1788, Mr. Hey was desired to visit John Wilkinson, who had been ill ten days of the influenza. The patient was found labouring under a fever, attended with cough, difficulty of breathing, and pain in the left side of the thorax. He was bled once; blisters were repeatedly applied to the chest; and he took nitre and antimonials, with a smooth linctus to allay his cough. "He was repeatedly relieved by these means, especially by the application of the blisters; but repeatedly relapsed. At last, he became so ill, that he breathed with the utmost difficulty, and could not lie on the right side, without danger of immediate suffocation."

Mr. Hey found the patient in the state just now described on the 17th of September. "His face and especially his eyelids were a little swollen on the left side." The left side of the thorax was larger than the right, and its integuments were œdematous. Upon pressing the intercostal muscles, they felt distended; they yielded a little to a strong pressure, but rebounded again. The abdomen, especially at its upper part, appeared to be fuller than in the natural state. (See *Hey's Practical Obs. in Surgery,* p. 476.) This last symptom is also particularly noticed by Boyer. (*Mal. Chir.* t. vii. p. 357.)

Another remarkable symptom, which is occasionally produced by collections of fluids in the chest, is an alteration in the position of the heart. I have seen a patient in St. Bartholomew's hospital, who had so large a quantity of matter in the left bag of the pleura, that it completely displaced the heart, which pulsated against the inside of the chest, at a considerable distance to the right of the sternum. This man's life might perhaps have been saved, had paracentesis thoracis been performed in time. Some suspected an aneurism from the throbbing on the right of the sternum; and the case was not fully understood till after death, when the body was opened. Closer attention to the symptom, however, might have shown that it was an empyema, and that making an opening, for the discharge of the matter, afforded the only rational chance of preserving life. There had been pain and inflammation in the chest, followed by shiverings; there was very great difficulty of breathing; the heart, which previously used to beat in the usual place, no longer did so; but now pulsated on the right side of the thorax.

That the heart should be displaced in this manner by any large collection of fluid in the left cavity of the thorax, one would naturally expect. Baron Larrey has related a highly-interesting case, where the heart was not only pushed considerably to the right of the sternum, but its action was so much impeded by the derangement of its position, that the pulse in the large arteries was thereby rendered extremely feeble. In this instance, also, the diaphragm had descended so low down as to force some of the small intestines into the cavity of the pelvis. (*Mém. de Chir. Militaire,* t. iii. p. 447, &c.) Pelletan has recorded an example, in which a collection of fluid in the left cavity of the chest displaced the heart, the pulsations of which were perceptible betwixt the third and fourth ribs of the right side, near the sternum. (*Clinique Chir.* t. iii. p. 276.) Boyer speaks of one case, in which the displacement of the heart was so extensive that its pulsations were felt near the right axilla. (*Traité des Mal. Chir.* t. vii. p. 357.) In the anatomical collection at Strasburg, is a preparation exhibiting the displacement of the heart into the right side of the chest, by matter in the left pleura, the left lung being nearly annihilated. (*Lobstein, Compte de son Muséum Anat.* p. 39, 8vo. 1820.) When empyema is on the right side, the change in the heart's position is not in general so remarkable; yet, with the stethoscope, it will generally be found to pulsate considerably to the left of its natural situation. In two cases, referred to by Dr. Townsend, the pulsation was distinctly felt in the axilla between the fourth and fifth ribs. (*Cyclopædia of Pract. Med.* art. *Empyema.*) The heart is sometimes thrust downward by collections of fluid in both sides of the chest, and its pulsation is distinguishable in the epigastrium. (*Hodgson, On the Diseases of Arteries and Veins,* p. 95.) In cases of extensive empyema, even the liver has been pressed down into the right iliac fossa. (*Stoll, Ratio Medendi.*) The descent of the diaphragm, by thrusting the abdominal viscera before it, may cause an appearance as if the liver were enlarged. Of this, an instance is recorded by M. Roux, the true nature of which was detected by Bichat, who cured the patient by paracentesis. (*Œuvr. Chir. de Desault,* t. iii.)

When the cavity of the pleura contains fluid, and the surgeon strikes the thorax repeatedly with the ends of his fingers, a dull sound is produced, quite different from what would occur, were the chest in its natural state. Besides this dulness of sound on percussion, the respiratory murmur is absent on the diseased side, which remains perfectly motionless, when the cavity is entirely filled with fluid. Sometimes the lung is not completely compressed by the fluid, and then a diminished respiratory murmur, œgophony, &c., may be heard over parts of the thorax. In the opposite lung, puerile respiration is distinguishable, accompanied with violent action of the respiratory muscles.

The symptoms of empyema are frequently equivocal. Panarolius opened a man, whose left lung was destroyed, at the same time that the thorax contained a considerable quantity of pus. Although the patient had been ill for two months, he had suffered no difficulty of breathing, and had had only a slight cough. Le Dran met with a case of nearly the same kind. A patient, who had been for three days affected with a considerable oppression, and an acute pain on the left side of the chest, got somewhat better. He felt no material difficulty of breathing, on whatever side he lay. The only thing which he complained of, was the sense of a fluctuation in the thorax, and a little obstruction of his respiration, when he was in a sitting posture. These symptoms did not seem sufficiently decided to justify the operation, and it was delayed. The febrile symptoms continued, with cold sweats, and the patient died on the eighth day. Five pints of pus were found collected in the chest. (See *Le Dran's Obs. in Surgery*, pp. 109, 110, edit. 2.)

The symptoms more particularly depending upon empyema itself, that is to say, upon disease and suppuration within the chest, are nearly the same as those which accompany all large deep-seated abscesses. The fever attending the thoracic inflammation, which ends in suppuration, gradually diminishes, but does not entirely cease. On the contrary, it soon changes into hectic, attended with flushings of the cheeks, heat of the palm of the hands, and exacerbations every evening, and after meals. In the night, the upper parts of the body are covered with perspiration; the patient is tormented with insatiable thirst ; his appetite fails ; his debility becomes extreme ; he is subject to frequent fainting fits ; diarrhœa ensues ; and the finger nails become curved, shining, and of the yellow tinge observable all over the body. At length, the utmost emaciation, and the facies Hippocratica, come on, frequently attended with dilated pupils, and enfeebled vision, and indicating the approach of death.

As the operation of empyema, and some other particulars, relating to this subject, are treated of in another part of this Dictionary (see PARACENTESIS OF THE THORAX), it will only be necessary for me here to subjoin a list of works, which may be advantageously consulted for information on empyema.

A. Vater et *J. E. Mutillet*, Empyema, e vomica pulmonis, rupta in cavitatem pectoris dextram effusa, indeque pulmo hujus lateris compressus penitusque ab officio remotus, Wittemb. 1731. (*Haller*, Disp. ad Morb, 2. 4031.) *Sharp's* Critical Enquiry into the Present State of Surgery, sect. on Empyema. *Le Dran's* Obs. in Surgery. *J. L. Petit*, Maladies Chirurgicales, t. i. chap. iii. *Warner's* Cases in Surgery, chap. vi. edit. 4. Mém. sur l'Opération du Trépanus Sternum, par M. de la Martinière, in Mém. de l'Acad. Royale de Chirurgie, t. xii. p. 342. edit. 12mo. *L. G. Van Melcote*, De Empyemate, Teneramund. 1783. *Sabatier*, Médecine Operatoire, t. 2. p. 247, &c. édit. 1. *Andouard*, De l'Empyeme, Cure Radicale obtenue par l'Operation, &c. 8vo. Paris, 1808. *Flajani*, Collezione d'Osservazioni, &c. di Chirurgia, t. iii. p. 185, &c. 8vo. Roma, 1802. *Richerand*, Nosogr. Chir. t. iv. sect. des Maladies de l'Apparel respiratoire. *Hey's* Practical Obs. in Surgery, ed. 3. *Lassus*, Pathologie Chir. t. i. p. 122. &c. *Larrey*, Mém. de Chirurgie Militaire, t. iii. p. 442 ; et t. iv. p. 356. &c. *Pelletan*, Clinique Chir. t. iii. p. 236. &c. *J. Hennen*, Principles of Military Surgery, p. 384. &c. ed. 2. 8vo. Edinb. 1820. *Boyer*, Mal. Chir. t. vii. p. 351, &c. 8vo. Paris, 1821. *Andral*, Précis d'Anatomie Pathol. Also, Clinique Méd. t. ii. Archer, in Trans. of Dublin Association, &c. vol. ii. *Laennec*, On Diseases of the Chest, ed. by *Forbes*. *Duncan*, in Ed. Med. Chir. Trans. vol. i. *Graves* and *Stokes*, in Dublin Hospital Reports, vol. v. Edinb. Med. Journ. No. 93. *Townsend*, art. Empyema, in Encyclopædia of Practical Medicine, part 7.

ENCANTHIS (from ἐν, and κάνθος, the angle of the eye), at its commencement, is a small, soft, red, and sometimes rather livid, excrescence, which grows from the caruncula lachrymalis, and, at the same time, from the neighbouring semilunar fold of the conjunctiva. The inveterate encanthis is ordinarily of considerable magnitude ; its roots extend beyond the caruncula lachrymalis and semilunar fold, to the membranous lining of one or both eyelids. The patient experiences very serious inconvenience from its interposition between the commissure of the eyelids, which it necessarily keeps asunder. Thus, indeed, it keeps up a chronic ophthalmia, impedes the action of the eyelids, and, in particular, prevents the complete closure of the eye. Besides, partly by compressing, and partly by displacing the orifices of the puncta lachrymalia, it obstructs the free passage of the tears into the nose.

According to Scarpa, this excrescence, on its first appearance, is commonly granulated, like a mulberry, or is of a ragged and fringed structure. Afterwards, when it has acquired a certain size, one part of it represents a granulated tumour, while the rest appears like a smooth, whitish, or ash-coloured substance, streaked with varicose vessels, sometimes advancing as far over the conjunctiva, covering the side of the eye next to the nose, as where the cornea and sclerotic unite. In this advanced state, the encanthis constantly interests the caruncula lachrymalis, the plica semilunaris, and the membranous lining of one or both eyelids. In addition to the roots, which in such circumstances connect the excrescence with the caruncula lachrymalis, the semilunar fold, and the conjunctiva of the globe of the eye, the encanthis emits an appendage, or prominent firm elongation, along the inside of the upper or lower eyelid, in the direction of its edge. The middle, or body, of the encanthis divides near the cornea, as it were, like a swallow's tail, to form two appendages, or elongations, one of which extends along the inner surface of the upper eyelid by the margin of which it is covered, while the other shoots in a direction from the internal towards the external angle, along the inside of the lower eyelid, which also conceals it beneath its edge.

The body of the encanthis, or that middle portion of the whole excrescence, which reaches from the caruncula lachrymalis and semilunar fold, inclusively, over the conjunctiva almost to the junction of the sclerotica with the cornea, sometimes forms a prominence, as large as a small nut or chestnut. At other times, it is of considerable size, but depressed, and broken down, as it were, at its centre. Still, however, the body of the encanthis preserves that granulated appearance which prevailed at first ; while one, or both the appendages, on the inside of the eyelids, appear rather like a fleshy than a granulated substance.

Sometimes, the encanthis assumes a cancerous malignancy, evinced by the dull, red, leaden, or (as Beer says) the bluish-red colour of the excrescence ; by its excessive hardness, and the lancinating pains which occur in it, and extend to the forehead, the whole eye-ball, and the temple, especially when the tumour has been slightly touched ; by the propensity of the excrescence to bleed ; and by the partial ulcerations on its surface, which emit a fungous substance, and a thin, and exceedingly acrid discharge. The disease is constantly attended with epiphora, and preceded by a scirrhous induration of the caruncle. The eyeball, and neighbouring bones, which are of a spongy texture, soon participate in the disease, and the lower eyelid becomes everted. (*Beer*, *Lehre von den Augenkr.* b. ii. p. 187, 188.) This form of encanthis only admits of palliative treatment ; unless, indeed, an effort be made to extirpate it entirely, together with the whole of what is contained in the orbit, and, even then, the event is dubious.

Beer joins Scarpa in the statement that the operation rarely proves successful, and adds, that it is always followed by an incurable weeping, and a considerable eversion of the lower eyelid. (Vol. cit. p. 189.) Fortunately, the truly cancerous encanthis is uncommon; Mr. Guthrie has not seen it; (*Operative Surgery of the Eye*, p. 117), and Mr. Travers, who was surgeon to the London Eye Infirmary several years, never met with an instance of it. (*Synopsis of Diseases of the Eye*, p. 103.)

The benign encanthis, how large soever it may be, is always curable by extirpation. Those instances, which are small, incipient, and granulated, like a mulberry, or of a fringed structure, which originate either from the caruncula lachrymalis, or the semilunar fold of the conjunctiva, or from both these parts together, and even in part from the internal commissure of the eyelids, may be raised by means of a pair of hook forceps, and cut off from the whole of their origin, closely to their base, with the curved scissors with convex edges. In cutting out an encanthis of small size, care should be taken not to remove, together with that portion of the excrescence which originates from the caruncula lachrymalis, any more of this latter body than is absolutely necessary for the precise eradication of the disease, in order that no irremediable weeping may be occasioned.

When the little excrescence has been detached from all its roots, says Scarpa, the eye must be washed several times with cold water, in order to cleanse it from the blood, and then it is to be covered with a piece of fine linen, and a retentive bandage. On the 5th, 6th, or 7th day the inflammation arising from the operation entirely ceases, and the suppuration from the wound is accompanied with the mucous appearance already described. The little wounds are then to be touched with a piece of alum, scraped to a point like a crayon, and the zinc collyrium is to be injected into the affected eye several times a day. If these means should not bring about the wished-for cicatrisation, but, on the contrary, the small wounds situated on the caruncula and internal commissure of the eyelids should become stationary and covered with proud flesh, the nitrate of silver ought to be applied to them.

Excision is equally applicable to the inveterate encanthis, which is of considerable size, and broken down at its body, or which forms a prominence, as large as a nut, or chestnut, with two fleshy appendages extending along the inner surface of one or both eyelids. The application of a ligature to such an excrescence ought never to be regarded as a method of cure; for the large, inveterate encanthis never has a sufficiently narrow neck to admit of being tied. On the contrary, when the tumour is voluminous, its roots invariably extend to the caruncula lachrymalis, the semilunar fold, and the conjunctiva covering of the eyeball, oftentimes nearly as far as the cornea. In this state, also, the encanthis has one or two fleshy appendages, which reach along the membranous lining of one or both eyelids. Hence, though the ligature were to produce a separation of the body of the encanthis, one or both the appendages would still remain to be extirpated. The second operation could only be accomplished with the knife. In this disease, there is no foundation for the fear of hæmorrhage, to which the advocates for the ligature attach so much importance; for, cases are recorded of considerable, inveterate encanthes being removed, without the least untoward occurrence from loss of blood. To these, Scarpa observes, he could add a great number of his own, so that no doubt can now be entertained on this point.

When the encanthis is large, and inveterate, with two extensive fleshy elongations, one on the inside of the upper eyelid, and the other on that of the lower one, we are to proceed in the following manner. The patient being seated, an assistant is to turn out the inside of the upper eyelid, so as to make one of the appendages of the encanthis project outward. By means of a small bistoury, a deep incision is next to be made into the elongation, in the direction of the margin of the eyelid; and then having taken hold of, and drawn it forwards with a pair of forceps, we are to separate it, throughout its whole length, from the inside of the upper eyelid, proceeding from the external towards the internal angle of the eye, as far as the body, or middle of the encanthis. We are then to do the same to the lipomatous appendage on the inside of the lower eyelid. Afterwards the body of the encanthis is to be elevated, if possible, with a pair of forceps; but when this instrument will not answer the purpose, a double hook must be employed. This middle portion is now to be detached, partly with the bistoury, and partly with the curved scissors, from the subjacent conjunctiva, on the globe of the eye, from the semilunar fold, and from the caruncula lachrymalis; dividing the substance of this last part more or less deeply, according to the depth and hardness of the large inveterate encanthis. Here it is proper to state distinctly, that when we have to deal with an old, large tumour of this nature, deeply rooted in the caruncula lachrymalis, it is not generally in our power to preserve a sufficient quantity of the substance of this part, to prevent the tears from dropping over the cheek, after the wound is healed.

After the operation the eye is to be repeatedly washed with cold water. The rest of the treatment, consequent to the extirpation of a large encanthis, is almost the same as that explained in speaking of the small incipient case. Bathing the eye very frequently in the lotion of mallows, and employing anodyne, detergent collyria, are the best local means, until the mucous appearance, preceding suppuration, has taken place on the surface of the wound. Then we may have recourse to mild astringent ointments and collyria. The mildest topical applications are generally the best, both in the first stage of suppuration, as well as afterwards, particularly, when, together with the encanthis, a considerable piece of the conjunctiva, covering the eyeball towards the nose, and intimately connected with the body of the excrescence, has been removed.

One enlargement of the lachrymal caruncle admits of cure by the application of leeches, repeated scarifications, and the nitrate of silver. (See *Middlemore, On Diseases of the Eye*, vol. ii. p. 546.)

(*C. Bader.*)

Consult *Scarpa*, sulle Malattie degli Occhi, ed. 5. cap. 12. *Richter*, Anfangsgr. der Wundarzn. band. 2. p. 473, &c. edit. 1802. *G. J. Beer*, Lehre von den Augenkr. b. ii. p. 187. 8vo. Wien, 1817. *B. Travers*, A Synopsis of the Dis. of the Eye, p. 103, &c. *G. J. Guthrie*, Lectures on the Operative Surgery of the Eye, 8vo. Lond. 1823. p. 117, &c. *R. Middlemore*, On Dis. of the Eye, vol. ii. p. 545. 8vo. Lond. 1835. *Wm. Mackenzie*, On Dis. of the Eye, ed. ii. p. 254. 8vo. Lond. 1855. *Carron de Pillards*, Guide Pratique; tome i. p. 454. Paris 1838. For cases of extirpation, see *Purmann's* Chirurgica curiosa, translated by *Syrrengell*, p. 59. London 1706. *Bonchacourt*, Revue Médicale, Avril 1842, p. 6.

ENCEPHALOCELE. (From ἐγκεφαλον, the brain, and κήλη, a tumour.) A hernia of the brain. (See HERNIA CEREBRI.)

ENCYSTED TUMOURS. (See TUMOURS, ENCYSTED.)

ENEMA. The following are some of the most useful glysters employed in the practice of surgery.

Cathartic.

℞. Decocti hordei ℔ j.
Sodii chloridi ℥j.—Misce.
℞. Decocti avenæ ℔ j.
Olei olivæ ℥ ij.
Magnesiæ sulphatis ℥ j. — Misce.

Anodyne.

℞. Mucilaginis amyli, Aquæ destillatæ sing. ℥ ij. Tincturæ opii guttas XL.—Misce.
℞. Olei olivæ ℥ iv. Tincturæ opii guttas XL. —Misce.

The two latter are particularly useful, when great irritation exists about the rectum, bladder, or urethra. They have great effect in diminishing spasmodic affections of this canal and neck of the bladder. Hence they are often employed in retention of urine, in which cases their total quantity should not exceed two or three ounces, which will be more likely than a larger quantity to remain within the bowel a sufficient time to let the anodyne qualities of the opium have the desired influence.

Tobacco,

Employed in cases of strangulated hernia.

℞. Nicotianæ ʒj. Aq. ferventis ℔ j. The plant is to be macerated ten minutes, and the liquor then strained for use. One half should be first injected, and soon afterwards the other, unless the glyster operate with dangerous violence, as it sometimes does in particular constitutions.

ENTEROCELE. (From ἔντερα, the bowels, and κήλη, a tumour.) A hernia, the contents of which are intestine. (See HERNIA.)

ENTERO-EPIPLOCELE. (Erom ἔντερα, the bowels, ἐπίπλοον, the omentum, and κήλη, a tumour.) A hernia, the contents of which are both intestine and omentum. (See HERNIA.)

ENTROPIUM (from ἐν and τρεπω, to turn). An inversion of the eyelids. (See TRICHIASIS.)

EPIPHORA (from ἐπιφέρω, to carry with force). By this term is meant an accumulation of tears on the anterior part of the eye; in consequence of which, the person affected is not only under the necessity of frequently wiping them away, but vision is injured by the morbid refraction which they produce of the rays of light that enter the pupil. *Stillicidium lachrymarum* is distinguished by modern writers from epiphora: the cause of stillicidium lies in some obstacle to the absorption and conveyance of the tears from the lacus lacrymarum into the sac. Epiphora, on the other hand, consists in a superabundant secretion of tears, and is a disease of the secreting, not of the excreting, parts of the lachrymal organs. (See *W. M. M'Kenzie's valuable Essay on the Diseases of the Lachrymal Organs,* p. 47. 8vo. Lond. 1819; and *Beer, Lehre von den Augenkr.* b. ii., *und art.* LACHRYMAL APPARATUS.)

EPIPLOCELE. (From ἐπίπλοον, the omentum, and κήλη, a tumour.) A hernia, formed by a protrusion of the omentum. (See HERNIA.)

EPULIS. (From ἐπι, upon, and οὖλα, the gums.) A small tubercule on the gums. It is sometimes cancerous. The best plan of cure is to extirpate it with a knife.

ERETHISMUS. (From ἐρεθίζω, to irritate.) The state of irritation attending the early stage of acute diseases. Mr. Pearson has described a state of the constitution produced by mercury acting on it as a poison. He calls it the *mercurial erethismus,* and mentions, that it is characterised by great depression of strength, anxiety about the præcordia, irregular action of the heart, frequent sighing, trembling, a small, quick, sometimes intermitting pulse, occasional vomiting, a pale contracted countenance, a sense of coldness: but the tongue is seldom furred, nor are the vital and natural functions much disturbed. In this state, any sudden exertion will sometimes prove fatal. Mr. Pearson advises, with a view of preventing the dangerous tendency of this affection, the immediate discontinuance of the use of mercury; and exposing the patient to a dry cool air. The incipient erethismus may often be averted by the camphor mixture and large doses of ammonia, if mercury be also left off. Sarsaparilla is also beneficial, when the stomach will bear it. (*Pearson, On Lues Venerea,* p. 156, &c. edit. 2.)

ERYSIPELAS is a Greek word, derived, as some say, from ἐρύειν, to draw, and πέλας, vicinum, because of its tendency to draw neighbouring parts into the same state; in other words, because of its tendency to spread. Others derive it from ἐρύθρος, red, and πέλος, livid; or from ἐρύθρος, and πέλλα.

[It may be *defined* to be a fever, attended with spreading inflammation of the skin, or of the skin and areolar tissue. It begins with shivering, and other symptoms of feverishness; then come a spreading redness and swelling of the skin of the part which is the seat of inflammation. Vesications often follow; and the disease, in its milder form, may produce no worse effects than loss of cuticle, and shedding of the hair. In severe cases, widely spread unhealthy exudation into the areolar tissue ensues, with sloughing.

Much confusion has arisen from the use of the term *erythema;* which has been applied to designate sometimes the mildest forms of erysipelas, sometimes mere redness of the skin from local causes. Cullen, for instance, said, "When the external inflammation is an exanthema, and symptomatical of an affection of the whole system, I shall then name the disease ERYSIPELAS; but when the disease is an affection of the skin alone, and very little of the whole system, or when the affection of the system is only symptomatical of the external inflammation, I shall give the disease the name of ERYTHEMA." (*Cullen's First Lines,* vol. i. p. 296.) Yet Cullen really describes what is generally known as simple erysipelas under the term erythema.

The fact is, that under the word ERYTHEMA (whose consequence in nosology would soon vanish if it were replaced by its English equivalent, REDNESS,) are confounded many affections which have no alliance with erysipelas, nor with each other. For instance, there is the *erythema nodosum,* a peculiar exudation into the areolar tissue of the shins and elbows, whose real alliance is with purpura; and the *erythema intertrigo,* or *chafing* of infants when not kept clean; and there are the varieties caused by sunburn, and by frost bite, and by rubefacient and irritating applications. The better plan will be to exclude absolutely from erysipelas all erythematous affections arising from local causes, or from slight derangements of the stomach, and which do not possess the spreading character, and true alliances and tendencies of erysipelas.

A consideration of the places in which erysipelas flourishes, of the causes from which it proceeds, and of the maladies to which it may give rise by contagion or infection, shows clearly enough that its alliances are with diffuse inflammation of the areolar tissue, spreading inflammation of veins and lymphatics and of serous and mucous membranes, and puerperal fever—diseases all attended with a poisoned state of the blood, all capable of being produced artificially by contagion or inoculation, and all characterised by the production of exudations, tending to appear at many points, to spread widely, and to diffuse themselves, instead of being concentrated to one focus, like the common phlegmonous inflammation. The term *pyæmia* includes them all.

In this article we shall also treat of the diffuse or erysipelatous inflammation of the areolar tissue, for the reasons just assigned.]

[*History of Opinions.*—Erysipelas has been the subject of many a controversy, in one of which the author of this Dictionary was for some time engaged with Mr. Lawrence. The opinions, too, advanced at different epochs respecting its causes and nature are curious, because they show the gradual advance—sometimes the decay—of medical philosophy. In a surgical dictionary, therefore, some notice must be taken of the views held from time to time by the fathers of our profession. Referring to the article INFLAMMATION for a fuller account, we may here give a few brief notices only.

Hippocrates evidently considered the disease epidemic and constitutional. He gives the following history: "Early in spring, along with the prevailing cold, there were many cases of erysipelas. They were of a malignant nature, and proved fatal to many; many had sore throat, and loss of speech." "In many cases erysipelas, from some obvious cause, such as an accident, and sometimes from even a very small wound, broke out all over the body; especially about the head in persons advanced in life, if such an accident were neglected in the slightest degree, and this happened in some who were under treatment; great inflammation took place, and the erysipelas quickly spread all over. In most of them, the abscesses ended in suppurations, and there were great sloughings of the flesh, tendons, and bones, and the defluxion which seated in the part was not like pus, but a sort of putrefaction, and the running was large and of various characters." (*Works Syd. Soc.* vol. i. p. 401. *Epidemics*, book iii.)

Galen defines erysipelas as redness, with burning inflammation, often with fever and shiverings; or a red painful swelling, arising from bilious blood. It has swelling and heat like phlegmon; but whereas phlegmon is red, erysipelas is paler, and yellow. It does not throb like phlegmon. But when a sanguineous afflux is mixed with the bilious, the erysipelas is phlegmonoid. The doctrine of Galen was, that afflux of blood produced phlegmon, of bile erysipelas and herpetic affections; of phlegm, œdema; and of black bile or melancholy, schirrus; and these doctrines, sound in themselves, with certain modifications, were repeated by almost all writers down to the time of Hunter and Cullen.

The opinions held by the most part of English practitioners, during the first half of the eighteenth century, may be gathered from the works of Dr. Daniel Turner, who says: "The erysipelas, by which we understand the same with the St. Anthony's fire, may be defined a preternatural affection of the skin, taking rise from a bilious effervescence of the blood, throwing forth those particles which are no longer fit to be assimilated, to the surface of the skin; there producing a small tumour and tension upon the part, accompanied with fever, heat, pricking pain, with a redness inclined to yellow, which presently recedes upon a gentle impression of the finger, and as quickly returns after the same is removed."

To quote Ambrose Parè, Wiseman, or any of the other surgical writers of the sixteenth, seventeenth, and first half of the eighteenth centuries, would be to reproduce the ideas, and almost the words, of Galen. Thus Wiseman says, that the erysipelas is generated of a hot bilious serum in the blood, and that there is no erysipelas that hath not a fever, visible or latent, going before it.

Sydenham, the father of English rational medicine, describes the disease as erysipelatous fever. He says that it may attack any part of the body, at any time of the year, yet that the face is the part most frequently attacked, and the most frequent season the summer. The patient is seized suddenly: his face swells, and is exceedingly red and painful. There is a crop of small pustules, which enlarge and become vesicular, spread along the brow and head, and close the eyes through their puffiness. Whatever the part of the body, and whatever the time of year, there is generally the combination of chills and shivers; unless, indeed, they precede the inflammation, which they sometimes do by two or three days. "I consider," he says, "that in this disease peccant matter is mixed with the blood, and that it must be evacuated. Also that the ebullition of the blood must be regulated by cooling remedies; also that matter which has become impacted in the parts must be discussed and eliminated." (*Works by Syd. Soc.* on *Intercurrent Fevers*, vol. i. p. 260.) Sydenham wrote what he had seen and not what he had read.]

John Hunter says: "The erysipelatous inflammation is very peculiar, and most inflammations that are not of the true adhesive and suppurative kind are called so, although probably they do not in the least belong to it; and this may arise more from the want of terms than the want of discrimination. This inflammation often arises spontaneously, or in consequence of a low or debilitating fever. It often arises from accident, but then it is commonly a secondary inflammation, though not always, for the first shall have gone off, and when suppuration was about to take place it shall have come kindly on, but afterwards the erysipelatous shall take place." "It is more commonly a cutaneous inflammation than situated in the deeper seated parts, although in some constitutions every inflammation, wherever it exists, will most probably be of this kind; however, the skin appears to be most susceptible of it, because it will spread over a prodigious surface of skin, while it does not affect even the cellular membrane underneath, at least not commonly. There is an inflammation which attacks internal canals, which is classed with the erysipelatous, but how far it is the same I do not know." "It is more common to the throat than any other part, often going down the trachea

Whatever it is, it may be considered in some of its effects to be in direct opposition to the adhesive and the suppurative inflammations; for where the adhesive most readily produces adhesions, there the erysipelatous does not, as in the common cellular membrane; and where the adhesive seldom takes place, excepting from extreme violence, then this inflammation, if erysipelatous, has a tendency to produce adhesions, as in canals or outlets." "Whatever the inflammation may be, it is certainly attended with nearly the same kind of constitutional affection. The fever in both appears to be the same; viz. accompanied with debility, languor, &c. The extravasation, in consequence of the erysipelatous inflammation, is not so great as in either the adhesive or the œdematous, nor is it of that kind which produces adhesions between the parts inflamed, which in this inflammation would commonly be unnecessary, as it seldom produces suppuration, but is attended with very bad consequences when it does. It appears to support itself by continued sympathy, for it commonly begins at a point and spreads, while it shall be getting well where it first began." Hunter says, in a note: "But the inflammation may be such as to contaminate while it spreads." (*Hunter*, *On the Blood*, Palmer's ed., vol. iii. p. 314, part ii. ch. ii. sect. 70.)

[Cullen "supposed the erysipelas to depend on a matter generated in the body, and which, analogous to the other cases of exanthemata, is in consequence of fever thrown out upon the surface of the body. I own it may be difficult to apply this to every particular case of erysipelas; but I take the case in which it is generally supposed to apply—that of erysipelas of the face." "The disease is not commonly contagious, but as it may arise from an acrid matter externally applied, so it is possible that the disease may be sometimes communicated from one person to another. Persons who have once laboured under this disease are liable to returns of it." (*First Lines*, loc. cit.)

It will be seen, as we more fully show in art. INFLAMMATION, that Hunter's philosophy is a pure *solidism*, based upon the supposition of peculiar modes of action of the living parts, and not upon the notion of a change of composition. He treats of inflammation, and of each variety of it, as a specific action, or mode of action, working *in* the parts concerned, with results influenced partly by the kind of action, partly by the structure of the parts and their powers.

The abuse of this doctrine, and neglect of the ancient humoralism, led to the extravagant notions of inflammation as a process of increased action and power, which are not extinct even in our own day.]

Dr. Carmichael Smith, for example, contended that erysipelas was an inflammation of the skin, and that all its phenomena and peculiarities arise entirely from the structure involved.

Mr. Lawrence, at one time, was supposed to advocate most strongly the doctrine] of the *simple inflammatory* or *phlegmonic*, in contradistinction to the *specific* nature of erysipelas. He observes, that "a consideration of the origin, development, and effects of erysipelas, whether local or general, leads us irresistibly to the conclusion, that the nature of the affection is inflammatory. In its four leading characters of redness, swelling, heat, and pain, and in its effects of effusion, suppuration, and sloughing, it agrees with what is called common or phlegmonous inflammation; while the general disturbance, preceding and accompanying the local affection, is often exactly alike in the two cases. Erysipelas then is merely a particular modification of cutaneous, or cutaneous and cellular inflammation. If we were to class these according to their natural affinities, we should place erysipelas between the exanthemata and phlegmon. It is less diffused than the former, not so circumscribed as the latter. The exanthemata are confined to the skin; erysipelas affects both skin and cellular structure; while phlegmon has its original seat in the latter, the skin being secondarily involved."

Yet he continues: "The difference between erysipelas and phlegmon, however, is not merely in the original seat, or degree of the disturbance: there is also a difference in kind. We may indeed say, generally, that phlegmon is a more violent inflammation than erysipelas, but sloughing of the cellular substance is more frequent in the latter than the former. The most striking and important distinction between the two affections is, that inflammation is confined to one spot in phlegmon, and is distinctly circumscribed in its seat, while it is diffused in erysipelas, and spreads without limit. This difference seems to depend on the adhesive character of the inflammatory process in the former; the substance called coagulating, coagulable, or organisable lymph, effused around the inflamed part, forms a boundary between it and the sound portion, which is altogether wanting in erysipelas. In the latter, the effusion is serous; hence, when matter is formed, it is not confined to one spot, but becomes extensively diffused in the cellular tissue." (*Med. Chir. Trans.* vol. xiv. p. 17., &c.)

[Mr. Nunneley, whose most able monograph on erysipelas is the standard work on the subject, treats of it as a type and example of a class of affections which ought to be separated in idea from true phlegmonous inflammation. He speaks of two local and constitutional conditions respectively; to one of which he gives—after Mr. Travers—the name irritation and irritative fever; to the other, inflammation. "These two conditions of constitution are, when clearly exhibited, widely different from each other, and may be regarded as the two extremes of a scale between which there is every conceivable grade. In the one case, we shall have much vascular excitement, with corresponding power in the nervous energy, and if the disturbance be occasioned by an external injury, there will be a great tendency to limit the mischief by the effusion of coagulable lymph;" "or if the disturbance depend upon some more general cause, and the action be exhibited upon one of the continuous membranes, it is also marked by the effusion of plastic lymph, which is capable of becoming organised." "In the opposite condition, whether the effect be from external injury, or constitutional cause, there is no such effort made to limit the action by the effusion of plastic lymph; on the contrary, there is considerable tendency for the mischief to spread extensively, and if lymph be effused it is not of the organisable kind," "and is accompanied by much serum." "There is great vascular excitement without corresponding nervous energy; hence the pulse is always very quick, seldom full or hard, but often jerking and easily compressed." To the former of these conditions the epithet *phlegmonoid diathesis*, to the latter *erysipelatoid diathesis* may be applied.

Further, it is Mr. Nunneley's opinion, that these two diatheses may be exhibited pure, or in every degree of intermixture, "as the limited adhesive type prevails it will be phlegmonoid, as the diffuse unadhesive type, erysipeloid." (*Nunneley, On Erysipelas.* Lond. 1841.)

It will be evident from this *catena* of opinions, that erysipelas, as a specific inflammation of the skin, has been known from the earliest times; and not only so, but that it has been taken as a type or specimen of a particular sort of inflammation, to which the name erysipelatous was given. Further, it has always been taken for a constitutional, and not for a mere local malady; it is treated as a *fever*, with local accidents; and of the conditions giving rise to it, all opinion down to the antiphlogistic school of Cullen and Hunter pointed to *bile*, that is, to an impure state of blood caused by disorder of the digestive organs.]

[*Divisions.*—The divisions of erysipelas have been numberless, according to its severity, and the depth of tissues involved, and other attendant circumstances. Thus there is the *erysipelas simplex, vel superficiale, vel cutaneum*, the redness moderate, of a yellow colour; swelling slight. *Erysipelas œdematosum*, whose name declares its character. *E. phlegmonoides*, attended with great exudation into the subcutaneous tissue, and tending to wide suppuration. *E. biliosum*, *erraticum*, *gangrenosum*, and others, whose names require no commentary.

Fenger, in his elaborate Thesis (*De Erysipelate Ambulanti*, Havniæ, 1853) endeavours to establish a marked distinction between erysipelas *ambulans* and erysipelas *vulgaris;* the former he believes to be a true exanthema, the latter simple inflammation of the skin; the former has a distinct raised margin, the characteristic of specific eruptions; the fever severe, the mortality one in eight, the duration at least eleven days; the eruption tends to be symmetrical and marches regularly, just as a liquid does when imbibed by blotting-paper. The erysipelas vulgaris, on the contrary, has but an ephemeral fever; the mortality one per cent.; half the cases convalescent on the fourth day; the edge of the inflamed part diffused, and gradually lost; and that it does not march regularly. Hence that the erysipelas ambulans is a specific exanthema; the erysipelas vulgaris mere common inflammation of a patch of skin. Our own opinion is, that this division is arbitrary; and like all divisions founded on *degree*, is essentially unphilosophical. How many species of scarlet fever would there be, if the cases were classified on the like basis? It must be borne in mind, that diseases, as described in books, are *ideas* or *abstractions*, not separate entities limited by matter; and that it is impossible to select any cases to be included under any given name, of many of which it may not fairly be doubted whether they are fairly included or not. There are slight cases of erysipelas, as of typhoid, scarlatina, and the like, of which the nature is to be decided by *analogy more than by physical proof.* There seems no absolute line of demarcation between erysipelas, and unhealthy or low diffused inflammation of skin.

For our purposes it will suffice if we treat of the subject under the heads of (1) the simple or cutaneous; (2) the phlegmonous, or cellulo-cutaneous of Nunneley; and (3) the subcutaneous erysipelas, or diffuse inflammation of the areolar tissue.

Symptoms.— Simple or cutaneous erysipelas generally attacks the face and scalp, particularly if idiopathic. We may accordingly select this as a typical case for description.

For a variable number of days, the patient complains of general indisposition, loss of appetite, weakness, and dejection; violent headache, sometimes well marked sour and bilious vomiting, and shiverings of greater or less violence. Some degree of redness, puffiness, and tenderness is then usually noticed on the nose, or low down on the forehead. Sleep is excessively disturbed by dreams, or broken, or altogether lost, or is mixed with a considerable amount of delirium. Soon the swelling extends over the whole face and scalp. The skin is puffed and shining, its colour varying from the palest to the most vivid redness, or again to a dusky purple, or to a decided yellowish cast. The redness disappears immediately on pressure with the finger, and as speedily returns when the pressure is discontinued. It is circumscribed by a line usually irregular. The swelling may be very slight, yet still so that some difference is felt by the finger in passing from the sound to the inflamed parts. Again, the swelling may be very considerable on the third or fourth day, from œdematous exudation into the areolar tissue, so as to close the eyelids, and render the features indistinguishable. Some of the lymphatics at the back of the neck may be enlarged and inflamed. The heat felt is often very great, and accompanied with vivid arterial redness; but in this and other symptoms denoting sthenic intensity, there may be the greatest differences. The heat in an œdematous swelling may be scarcely above the natural. The patient feels a severe stinging, itching, smarting sensation, with intense tenderness to the touch. The whole skin is hot and dry, the pulse is frequent, the tongue white or yellowish and dirty, and the other signs of fever are present, especially headache and delirium.

Then comes the event. In one case, after the face and scalp shall have been involved,—rarely in less than five or seven days (that is, about the tenth from the commencement),—the nightly headache and the fever abate, the pulse becomes slower, and the skin cool, the swelling gradually subsides, and the only vestige of the malady is a reddened or purplish colour, with exfoliation of the cuticle in branny scales, and usually a falling off of the hair. The cases in which this favourable termination by *resolution* is most likely to occur, are those in which biliary disorder has preceded the attack, and has been treated by an effective course of purgatives.

In a second case (and, in fact, in the majority), *vesications* occur, particularly about the eyelids. Serous effusion takes place from the inflamed surface, elevating the cuticle into smaller or larger vesicles, or into bullæ like those produced by blisters; or raising it by a soft, yellow, jelly-like deposit, which remains slightly adherent to both the cutis and cuticle. The contents of the vesicles or bullæ are transparent, sometimes nearly colourless, but more commonly yellowish; sometimes they consist of a thin pus; or they may exhibit a bloody or livid discolouration. The fluid loses its clearness, becoming thicker, opaque, and whitish, or yellowish. The cuticle gives way; the fluid escapes, and incrustations form, which soon fall off, leaving the skin sound; or they may lead to superficial ulcerations. It is not often that bullæ form except on the face.

In a third case, towards the decline of the disease, there may be an increase of pain, at one or more particular spots, and abscesses may form under the skin.

Fourthly, the disease, instead of disappearing cleanly, may take on the *wandering character*. As it declines on the face it spreads down the back of the neck, and over the throat, and even down the arms and legs, disappearing on one side as it spreads on the other. The redness in such cases is usually dusky; the swelling and heat slight; the patient feeble; the cause either long-continued chronic disorder of the assimilating organs, or long confinement in foul air, or any equivalent cause of a thorough break-down of the health; and the result, in aged persons, often death from exhaustion. Mr. Nunneley quotes a case in which it lasted seven weeks.

Thus, we commonly see the various stages of erysipelas existing together at the same time in different parts of the skin; the portion last affected is red and swelled; another part is vesicated; while others exhibit incrustation and desquamation. Sometimes it leaves the part first affected to appear in a distant situation. Its origin, development, and complete termination, seldom take place in one and the same spot.

Fifthly, the malady may be complicated with congestion or effusion within the skull; marked firstly by delirium, afterwards by insensibility, and far more frequently with signs of debility, low pulse, brown or black dry tongue, teeth covered with sordes, and not accompanied with any signs of vigorous inflammation.

Lastly, a precisely similar train of symptoms attends simple erysipelas when taking its starting-point from a wound, and beginning in any other part besides the head.]

An uncommon variety of this disease is an *universal erysipelas*. No disorder is more subject than the present to relapses; but a remarkable thing, sometimes attending the return of the complaint, is its being sometimes strictly *periodical*. In chlorotic women, the erysipelatous attack is occasionally made every month just at the period when the menses should take place. (*Hoffman.*) This periodical nature of erysipelas has been observed in men: Larrey knew two male patients, one of whom used to be attacked with erysipelas twice a year at the time of the equinox; the other had only one attack annually, which was wont to happen in the beginning of the spring. My friend Mr. Maul, of Southampton, once informed me of an erysipelas, which was both periodical and universal, affecting a lady several times at intervals of two years.

In the phlegmonous, or cellulo-cutaneous erysipelas, termed by Dupuytren *diffuse phlegmon*, (*Clin. Chir.* t. ii. p. 289), the skin is more raised than in the simple form of the complaint, the swelling is harder and deeper, and of a darker colour. The redness has often a brownish or dark livid tint; and the discolouration is sometimes irregular, giving to the part a marbled appearance. The whole depth of the adipous and cellular textures may be loaded with effusion, so that the arm or leg appears of twice the natural size. The sensation of heat and pain is aggravated in a very severe degree, and may be accompanied with throbbing. The swollen part at first yields slightly to the pressure of the finger, but subsequently becomes tense and firm. Vesications, often minute and miliary, form on the surface, with purulent contents; but sloughing of the cellular tissue soon comes on, and the febrile symptoms are aggravated. According to Mr. Lawrence's observations, these dangers are not attended with increased swelling, elevation, and pointing, as in phlegmon; on the contrary, there is rather a diminution of tension, a subsidence, and a feel of softness in the part. A similar account is given by Dupuytren, who states that, when the disorder has reached the period when phlyctenæ have formed, and the cellular tissue becomes thickened and indurated, the symptoms appear for two, three or four days to be stationary; and an inexperienced surgeon is even led to hope for the resolution of the inflammation, while the danger is really urgent, and suppuration already exists. (See *Clin. Chir.* t. ii. p. 311.) Experience alone can teach the practitioner to distrust this deceitful stage, and not to neglect timely incisions. In fact, as Dupuytren observes, in two or three days, if the disease be allowed to make progress, the skin separates from the subjacent parts, and breaks, or the phlyctenæ give way; a dark-coloured serosity flows out; and white, or sometimes black sloughs are visible under the skin, which extend with rapidity. (*Clin. Chir.* t. ii. p. 312.) At first the cellular texture contains a whey-like or whitish serum. The fluid gradually becomes yellow and purulent, and we often find it presenting all the characters of good pus, and very thick. The serum is diffused through the cells at an early period, and a mixture of serum and pus often fills a considerable portion of the cellular texture, without any distinct boundary. Frequently matter is deposited in small separate portions, forming a kind of little abscesses, which often run irregularly in the cellular texture. This texture turns gray, yellowish or tawny, and sometimes appears like a dirty spongy substance filled with a turbid fluid: thus losing its vitality altogether, it is converted into more or less considerable fibrous shreds, of various size and figure, which come away soaked with matter like a sponge. The integuments over a large slough of this kind, being deprived of their vascular supply, become livid, and often lose their vitality. The suppurating and sloughing processes go on to a great extent when an entire limb is affected, sometimes completely detaching the skin, and often separating it through a large space; occasionally penetrating deeper, passing between the muscles, causing inflammation of them, suppuration between them, and often sloughing of the tendons. When the substance of a limb is thus generally inflamed, the joints do not escape; inflammation of the synovial membranes, effusion of matter into the joint, and ulceration of the cartilages take place. (See *Hutchinson's Practical Obs.* p. 115. ed. 2; and *Bibl. Med.* Sept. 1827, p. 331.) Dupuytren refers to cases, in which a quart of matter was discharged daily, and to one fatal instance in the Hôtel Dieu, where the whole leg was stripped of the skin and cellular tissue, and the tibia and patella denuded. (See *Clin. Chir.* t. ii. p. 314.) If, however, the patient should recover after tedious suppurations and discharge of sloughs, the parts which have been inflamed, are so changed in structure, and skin, fascia, muscles, tendons, and bones, are so materially agglutinated and fixed, after the extensive destruction of the connecting cellular texture, that the motions of the part are permanently and seriously injured. (See *Lawrence, in Med. Chir. Trans.* vol. xiv. p. 12.)

The integuments of an entire limb, from the trochanter to the ankle, may form huge bags of matter, and be almost entirely detached from the fascia beneath. Nay, there may be suppuration underneath the fascia.

In the body, and especially in the legs, the skin often mortifies to a large extent, owing to the cutting off of the small nerves and nutrient blood-vessels which supply it. [Hence, says Mr. Nunneley, the propriety of the caution on which Dupuytren so particularly insists, of using the utmost care in dressing an erysipelatous leg, that we do not destroy the small bands which may yet connect the skin with the subjacent parts, lest we should still further deprive it of vitality by cutting off the only remaining means of nutrition. This consecutive gangrene is rarely seen in the scalp, where, nevertheless, this form of erysipelas is frequent. The distribution of the arteries and nerves is very different in the scalp from that of the limbs; in it they are placed between the skin and the occipito-frontal aponeurosis. The temporal, frontal, and occipital arteries are so connected to the integuments, that in dissection it is very difficult to separate them. Now, as the suppuration takes place beneath the aponeurosis, the skin is not deprived of its supply of blood or nervous energy, and consequently maintains its vitality, even though the whole of the cellular tissue between the pericranium and aponeurosis be destroyed, as does sometimes happen. (*Nunneley*, op. cit. p. 169.)]

The attack of phlegmonous erysipelas, and especially of the spontaneous form of it, is announced by a greater or less degree of shivering, which is followed by heat, and febrile disturbance. The fever, though of the continued type, has paroxysms and remissions, two or three times a day. A slight uneasiness in the skin is often felt twenty-four or thirty-six hours before the shivering takes place. The skin afterwards assumes a rose colour, which is not uniform, but has a winding appearance; and in this stage, whether the case is to be simple or phlegmonous erysipelas would be difficult to prognosticate, were it not for a degree of œdema in the subcutaneous cellular texture, and the *pitting* caused by the pressure of the finger. Afterwards the symptoms increase, the fever is redoubled, and the finger, strongly pressed upon the skin, no longer makes an impression or hollow in it; but, on the contrary, feels a considerable resistance; the redness, which is intense, assumes a darker, or even a purplish colour; the skin becomes shining; phlyctenæ arise; the cellular tissue is dense and indurated; the urinous and other secretions are diminished, altered, or suppressed; and the patient is in a constipated, sleepless, and extremely agitated state. (See *Dupuytren in Clin. Chir.* t. ii. p. 310.)

[*Diagnosis.*—Erysipelas is not likely to be confounded with scarlatina, roseola, or any other of the exanthemata, which, instead of being confined to one part, or wandering slowly, appear almost universally diffused, or rapidly pass over the entire surface. So also, between erysipelas and phlegmonous inflammation, in most cases there is no ground for mistake. In phlegmon, says Mr. Nunneley, the inflammation is well circumscribed and well defined by a boundary of lymph; the swelling is at first much harder, stands out more in relief, and appears more considerable than in erysipelas; suppuration takes place in the middle, which points conically where the skin becomes thin and fluctuates. The colour is lighter, more vivid, does not disappear on pressure, as in erysipelas; the pain is of the acute throbbing kind. There is not the tendency to the formation of vesications. Inflammation and suppuration under a fascia will, of course, neither possess the redness and œdema of erysipelas, nor the *pointing* of phlegmon.

Erysipelatous or *diffuse inflammation of the areolar tissue*; *subcutaneous erysipelas* of Nunneley; *cellular erysipelas*, or *diffuse abscess*, may be defined a fever, accompanied with diffuse inflammation of the areolar tissue. It is almost the same as phlegmonous erysipelas without the inflammation of the surface of the skin; and in most of the cases recorded, it shows a greater alliance to intense pyæmia than even phlegmonous erysipelas usually does; inasmuch as it is more frequently attended with suppurations at various parts of the body; and inasmuch as death more frequently occurs from blood-poisoning, or from visceral disease, than is the case in cutaneous erysipelas. Substitute a poisoned wound for the act of parturition, in an unhealthy atmosphere, and this disease is the homologue of puerperal fever.

It has attracted considerable notice from the fact that it is frequently produced by wounds received in dissection, and that many members of our profession have fallen victims to it. Amongst the earliest and best descriptions of it, are those of Dr. Duncan, *Edinburgh Med. Chir. Trans.*, vol. i.; Dr. Colles, *Dublin Hospital Reports*, vol. iii. 1822; James, of Exeter, *On Inflammation, &c.*; Dr. Copland, author of the immortal *Medical Dictionary*; Mr. Travers, *Enquiry on Constitutional Irritation*; Mr. Adam, *Glasgow Med. Journal*, 1830; and Mr. Stafford, *Med. Chir. Trans.*, vol. xx. 1836. But above all these there is the admirable monograph on *Irritative Fever*, or *the Plymouth Dockyard Disease*, 1825, by Dr. John Butter, of Plymouth, which well deserves to be read, not merely for its accuracy as a relation of facts, and its sound therapeutical doctrine, but because the epidemic which it records is so extraordinary and so complete an illustration of the alliance of erysipelas, diffuse inflammation, and pyæmia. The following abstract of the Plymouth disease will be important to the end of time.

Case 1. On August 1st, 1824, a shipwright laid up by a punctured wound in the sole of the foot; on the 7th considerable fever came on, and inflammation extended up the leg; headache, nausea, and thirst. 9th. Whole limb enlarged and erysipelatous. 12th. Extending up thigh. 14th. To the abdomen. 15th Death. No post-mortem. *Treatment.* Bleeding to syncope twice; repeated purges.

Case 2. On 4th August, 1824, a carpenter wounded right hand by a saw. 6th. Considerable fever; hand inflamed. 10th. Whole arm erysipelatous; abscess opened on back of hand, which on 12th freely discharged pus and sloughs. 13th and 15th. Incisions made in forearm and arm; improvement to the 26th, when hand and forearm nearly sound, but a sudden pain in left thigh, which is œdematous. Sept. 15th. Immense abscess opened in thigh. 25th. Sloughing. October 2nd. Gangrene of heel ; death. *Treatment.* At first, bleeding to 34 oz., and purging ; then incisions, bark, and opium.

Case 3. 16th August, 1824, a shipwright, æt. 45, suffered amputation of last joint of left fore finger, from an accident. 20th. Pain in hand and headache. 21st. Stump *easy and looking inactive.* 24th. Great prostration, anxiety, and nausea. 25th. Death. *Post-mortem.* Sixteen oz. serum in chest; right lung adherent; left gangrenous; intestines inflamed; abscess round right kidney. *Treatment.* Bleeding to 24 oz. on the 20th, and a cruel quantity of calomel and cathartics afterwards.

Case 4. A joiner tore the nail of his finger on 10th August, 1824. On the 18th finger healthily granulating ; but a sudden attack of rigors and fever. 20th. Increased fever and headache; hand and arm much inflamed. 25th. Whole hand and arm erysipelatous and œdematous; great exhaustion; an incision into the back of the hand; areolar tissue found infected with pus ; from this, recovery is dated. *Treatment.* Bleeding to 34 oz.; leeches, calomel, and cathartics, and the incision.

Case 5. A sawyer, on 30th August, tore off nail of left great toe. Sept. 1st. Pain and shivering. 2nd. Great fever. 4th. Erysipelas of whole limb. 9th. Sphacelus over external ankle ; incisions gave vent to sloughs like wash leather. Death on 14th. *Treatment.* Twenty-four leeches to the foot ; three bleedings altogether to 60 oz.; calomel and cathartics, and incisions.

Case 6. A shipwright, on 7th, 8th, and 9th Sept. received sundry small abrasions of left shin. 13th. Shivering; pains in inguinal glands ; red lines. 15th. Fever, pain, and swelling of thigh increased. 18th. Pain in right hypochondrium. 19th. Death. *Post-mortem.* Inflammation and seropurulent effusion into abdomen. *Treatment.* Bleedings to 54 oz.; leeches and purges.

Case 7. A shipwright wounded his chin with a nail on 18th Sept. On 17th. Shivering and headache. 18th. Neck much swollen. 22nd. Erysipelas advancing over face and head. 25th. Large vesicles. 26th. Amendment began; and convalescence complete in eleven weeks. *Treatment.* Leeches, cathartics, poultices, and an incision.

Case 8. A shipwright jammed three fingers on 17th Sept. 1824. 19th. Shivering. 20th. Pain of hand; and an isolated red blush on upper arm. 24th. Whole arm enormously swelled and reddened. 25th. Death. *Treatment.* Bleeding to 40 oz.; repeated leechings; purgatives.

Case 9. Dr. Bell, on the 14th September, 1824, scratched the last phalanx of right fore-finger at the post-mortem of case 6. 19th. Rigors and fever; smarting of scratch, but no other local symptoms. 21st. Restlessness, fever, nausea ; great pain and tenderness of right shoulder, none in finger. 22nd. Very prostrate ; excruciating pain in back ; indistinct vision. 23rd. No pain; tenderness on pectoral muscle when pressed ; no redness ; finger neither inflamed nor swollen. 24th. Death. *Treatment.* Bleeding twice to 46 oz. ; calomel, antimony, purgatives.

Case 10. A shipwright, on 13th September, abraded shin over right inner ankle. 18th. Superficial sloughing and some pain. Oct. 1st. Doing well; but in the evening great pain ; red lines to groin ; tender glands, shivering and headache. Oct. 2nd. Severe headache. 3rd. *Tenderness of right hypochondrium*; leg *easy.* 4th. Delirium ; death. *Post-mortem.* Omentum, ileum, and cæcum, and right lobe of liver inflamed ; seropurulent effusion. An incision into the affected leg from the ulcer towards the calf *revealed no traces of inflammation in the cellular substance. Treatment.* Bleeding to 76 oz. ; sixty leeches ; several blisters to head and abdomen ; calomel, opium, and cathartics.

Case 11. A labourer, on 9th Oct., grazed the left shin. Nov. 1st. Wound inflamed ; pain and fever. 3rd. Erysipelas and inflammation of lymphatics of left leg. 4th. Great tension and agonising pain. Recovery. *Treatment.* An incision, five inches long, down to the fascia, between the tibia and tendo Achillis.

Case 12. A sawyer, on 2nd August, wounded his right great toe. 8th. Pain. 9th. Swelling and inflammation. 10th. Pain. 13th. Gangrene. 15th. Death. *Treatment.* Bleeding and antiphlogistics.

Case 13. A man suffered a compound fracture of right great toe on August 18th, 1824. On the 9th September he resumed his duties in the dockyard, to all appearance well. Sept. 23rd. " Fever arose ; a red patch appeared on the outside of his right calf, another on his right thigh, a third on his left arm." Vitiated secretions, delirium, and stupor followed ; extensive gangrene of right leg and foot ; matter in the cellular membrane which surrounded the extensors of the injured toe. *Treatment.* Bleeding and antiphlogistics.

Case 14. A man bruised his thumb and abraded the shin of his left leg, on 27th August, 1824. He continued at work. On the 8th September, " idiopathic congestive fever " arose, and in two days death followed.

Case 15. A shipwright wounded his hand with glass on 14th September. On the 19th he was attacked with fever, and acute pain in the right armpit and side, with a blush of redness. Death on the 24th, preceded by mortification. *Treatment.* Bleeding to 46 oz.

We have selected this unique collection of cases, in order to show the entire accordance of this " Plymouth Dockyard Disease," *mutatis mutandis*, with an epidemic of puerperal fever. In a dockyard, accidental wounds are of daily occurrence. During the six months from 24th June to 31st December, 1824, 250 men received *serious* hurts ; and of these, during six weeks of that time, fifteen were seized with the disease under consideration, and twelve died. Such an occurrence had been unknown before. Of the cause it is impossible to speak with precision—whether a peculiar state of atmosphere; or whether contagion were imbibed at some common source, or whether it were carried, as is not improbable, by the medical attendants.

Referring to the section on *causes* for some further remarks on this head, let us come to the *symptoms* and local changes.

Diffused cellular inflammation may be set up at the seat of a local injury, and may spread continuously, involving the neighbouring parts. In this case, the chief symptoms are fever with great swelling and tension ; most acute pain, without any, or with but little, of the surface redness of erysipelas.

In another set of cases, the diffused inflammation is set up at a distance from the part originally inflamed or injured, and without any direct continuity. This happens when, as we believe, the whole mass of the blood is poisoned, as by a dissection wound, and the local disease is but a manifestation of pyæmia. After shivering, headache, and nausea, the patient is stricken with a most acute pain, generally in the axilla, or under the pectoral muscle, or above the clavicle. Slight puffiness follows, and great tenderness; some redness, perhaps, not of the deep erysipelatous hue, but of a pale peach blossom tint. The swelling becomes tense and shining; the pain agonising; the countenance haggard; the pulse very frequent and jerking; and there is usually intense restlessness and despondency, or delirium. Next, the swelling feels *boggy*; the skin vesicates, becomes mottled, and sloughs; and if cut through large quantities of seropurulent matter come out, with sodden flakes of areolar tissue. The disease may have several issues. It may prove mortal by the extent of the blood poisoning; or by the exhaustion consequent on gangrene, or may wear the patient out by slow suppuration, as is often the case after phlegmonous erysipelas.

This form of erysipelatous inflammation, not always having the outward redness to distinguish it, has been mistaken for acute rheumatism; from which it may be diagnosed by the depressed nature of the pulse and constitutional symptoms, and by the existence, which will usually be discovered in the traumatic cases, of a local injury.

One of the cases above recorded had its origin in a dissection wound. Other cases of the same kind will be related in the article WOUNDS.]

[*Prognosis.*—Erysipelas is a disease that can never be lightly regarded, and is often most dangerous. As in other diseases, the patient's chance of life will be in direct proportion to his strength, and inversely to the extent of mischief. The extremes of infancy and age, drunken and dissipated habits, and the existence of previous disease, especially of the kidneys or liver, tell very much against the patient. It will be bad for him, too, if erysipelas be epidemic and severe, and if he have contracted the disease by contagion or infection from some patient who has it severely. A very extensive attack, and large suppurations, are also dangerous, particularly about the head, or the throat, or scrotum, or anus, or lower extremities. But, after all, it is the pulse, the state of breathing, the state of the mind, and the power of taking nourishment and of procuring sleep, which will guide the surgeon's prognosis. There are three sources or periods of danger: First, from extensive febrile excitement, or constitutional irritation from poisoned blood in the early stage. Secondly, from the exhaustion of pain and confinement of matter. Thirdly, from general pyæmia and visceral inflammation, or from purulent absorption, diarrhœa, and hectic, or from the profuse discharge. If local swelling seem to subside, but the pulse continues quick, or quicker, and the tongue does not improve, it is ominous, for then a portion of areolar tissue may be sloughing, or some internal part may be attacked.

The remote consequences, even if life be preserved, are often very disastrous. A limb may be withered, shrunk, and useless; or there may be a general cachexia, and tendency to diarrhœa, dyspepsia, and phthisis, or what is very frequent after every form of erysipelas, the patient may be persecuted with a succession of boils or carbuncles, or with those rheumatic pains which are so common after scarlet fever.

Metastasis.—This word really means, that a disease vanishes from one part and attacks another; but in its wider and more popular signification, it means that several parts are attacked successively. It is a common phenomenon in all blood disorders—nettle-rash, gout, and rheumatism, and in pyæmia, and the whole erysipelatous alliance. The tenth case of those which occurred in the Plymouth dockyard exhibited a metastasis of the former sort. Mr. Nunneley quotes the following, of which we give an abridged version.

A lady of 50, with erysipelas of the left foot: on the eighth day the foot became suddenly well, and within a few hours severe pain in the abdomen came on. Death in 24 hours. Intestines inflamed; sanious fluid in peritoneum.

A woman of 30, recovering from erysipelas of the throat, took laxative medicine, followed by pain in the abdomen, and death in 48 hours. Omentum inflamed; puriform fluid in peritoneum. *Quoted from Dr. Abercrombie.*

A young woman had erysipelas of breast; miscarried; was seized with symptoms of puerperal fever. Death. Bloody flabby liquid in peritoneum. *From Dr. Alison.*

A man æt. 27, had erysipelas, which supervened on syphilitic bubo. Tenderness of abdomen and vomiting of green bile were followed by death. *Post-mortem.* Lungs congested; turbid serum in pleura; abdominal viscera coated with lymph; serous effusion in peritoneum; petechiæ about kidneys; arachnoid opaque and serous effusion. (*Nunneley*, op. cit. p. 89.)

Mr. Bird gives two cases of translation—one from the leg to the face, another from the face to the thigh.

Morbid Appearances.—"After death," says Rokitansky, "the redness has generally disappeared, but the swelling is still perceptible; the epidermis is either easily separable, or actually separated, and the surface of the cutis is moist, and covered with a viscid and more or less puriform exudation. The redness is seen on a transverse section to be confined to the outermost thin layer of the cutis; the deeper layer is pale, and is somewhat infiltrated only when the inflammation is intense; the subcutaneous cellular tissue is then in like manner slightly infiltrated." (*Pathological Anatomy*, vol. iii. *Syd. Soc. Ed.*)

In the phlegmonous variety, and in the diffuse inflammation, the cuticle is wrinkled and vesicated, the skin gangrenous in patches; after death the areolar tissue will be found infiltrated with liquid, which, according to the severity and duration of the disease, will be pale or yellow serous, reddish and turbid, milky and semi-purulent, or a greenish pus; and the tissue itself reddish and vascular, or thickened and solidified by fibrinous effusion, or dead and rotten, like flakes of tow, or "wetted chamois leather," to which Mr. James compares it. The subjacent fascia may be destroyed, and intermuscular spaces infiltrated; or even portions of muscle may be invaded, and rendered pale, softened, or gangrenous; the veins and lymphatics, which pass by, reddened or suppurating. *Purulent depôts*, as they are called, may be found in the joints, or in the areolar tissue of various parts of the body, or in the viscera; in fact, the whole series of morbid appearances may be present which are common to the whole erysipelatous group of diseases, including puerperal fever, pyæmia, &c. &c. "In ten out of eleven cases of dissection of the bodies of those who had died from erysipelas in the hospital of La Charité, in Paris, Dr. Corbin detected very decided lesions of the abdominal organs, principally of the mucous membranes of the stomach and intestines. Pus is not unfrequently disseminated through the viscera, principally in the substance of the liver. The frequency of these visceral affections in erysipelas has been particularly pointed out by Dupuytren, who says he has opened a heap of bodies (*foule de cadavres*) of those who have died in consequence of diffuse phlegmon, and that he has observed among those who perished, towards the end of the malady, the external inflammation itself was much less the cause of death, than an internal inflammation produced by some imprudence. Pleurisies, pneumonia, and abscesses of the liver, have been noticed, and these maladies have happened after the patient has exposed the face, neck, chest, or limbs to the cold." (*Nunneley, On Erysipelas*, p. 196.)

The *predisposing causes* of erysipelas are in general such as produce disorders of the digestive organs and impurity of the blood. Foremost amongst these stands intemperance, especially if combined with deficiency of solid food, loss of sleep, prolonged marching or other fatigue, exposure to the weather at unseasonable times, grief, and those other influences which under any circumstances produce a low and irritable state of system. But it is probable that many of these conditions rather give rise to low or atonic inflammation, than to genuine erysipelas.

Some persons there are who are constitutionally predisposed to it. Thus, one attack, so far from conferring any exemption, only seems to render the patient liable to repeated attacks. Women are said to be more subject to it than men ; although probably it is rather to slight erythema, caused by cold, or delay of the catamenia, than to real erysipelas.

Every sort of injury or abrasion may invite an attack of erysipelas, more especially those which are irritated, or in which the exudations are disturbed, and, speaking generally, those which have most tendency to inflammation. It is of no avail to give a list, because the simplest prick or cut will give occasion for erysipelas, if the wound be infected, or the blood.

In some cases of traumatic erysipelas the local symptoms precede the constitutional. The same may be the case in all inoculated diseases.

But no injury can produce erysipelas without the presence of a peculiar poison in the blood ; of which we may assume, that

I. The erysipelatous condition in some cases arises spontaneously, or idiopathically, or primarily ; possibly from changes of temperature acting upon a system predisposed.

II. It may, without doubt, be generated by putrid miasma, under certain conditions.

III. The putrid miasm which generates erysipelas is capable of generating also each of the other forms of disease which we have enumerated as belonging to the erysipelatous alliance, and which are all included in the general term pyæmia, viz., purulent depôts, puerperal fever, deaths by shock or adynamia after operations, phlebitis, and inflammation of the lymphatics, some forms of sore throat, and of diarrhœa and dysentery.

IV. Each variety of erysipelatous disease may generate every other, by contagion and infection, using those words in the fullest sense they admit of: contagion being the application of liquid or solid poison, by the touch or by inoculation ; and infection being the effect produced by inhalation of gaseous poison into the lungs, or the contact of vitiated air with a wound or ulcer.

Respecting the first proposition, it must be remarked that there are some individuals so predisposed, that errors in diet, trifling injuries, and exposure, readily produce slight attacks of erysipelas, which seem to bear the same relation to the graver forms of the disease that febricula does to typhoid fever ; of which it cannot be proved that they arise from outward miasm, and which, under favourable circumstances of cleanliness and ventilation, soon subside, and do not propagate themselves.

The proofs of the second and third propositions have been accumulating during the last century and a half at the least, and are now so numerous that the task of selecting instances is difficult ; and so overwhelmingly convincing that it is a point little creditable to the physicians and surgeons and managers of public institutions, that the disease is still permitted to continue its ravages, even in a mitigated form.

Whilst writing, the reviser of this article receives a report from Dr. Dundas Thomson, medical officer of health for Marylebone, dated August, 1859, stating that three virulent cases of erysipelas occurred in succession on the first floor of the west wing of the Middlesex Hospital. One of the sisters complained of an offensive smell in the ward. This aroused the suspicions of Dr. Corfe, who found that the post-mortem room was immediately below, so that effluvia could enter, and still more, that the waste-pipe of the room was untrapped, and that it communicated with a cesspool and choked drain. The cesspool was filled up, the drain cleansed and trapped, and for the 12 months since not a single case of erysipelas has occurred in the ward.

All experience tends to show that the most frequent source of erysipelas is that kind of poisoned atmosphere engendered by the exhalations of the sick and wounded. Dr. George Gregory read a paper on the subject before the Med. Chir. Soc. (reported in *Lancet*, 1848, vol. ii.), in which he called the general condition of disease produced under such circumstances *ochlesis* (from ὄχλος, a crowd), and described erysipelas of the face, and every other variety of creeping, low, diffused inflammation, as the normal results.

In a conspicuous metropolitan hospital, the reviser of this article once witnessed an operation for aneurism. The patient died of low inflammation in a week. One of the hospital functionaries remarked afterwards, "I knew the patient would die, and I implored the operator to put him into a different bed, but he would not ; he does not believe in sanitary measures. Every patient in that bed dies ; it receives all the fumes of the water-closets."

"Of the connection between erysipelas and puerperal fever," says Dr. Ferguson, "I may say that those two maladies are generally co-existent in our hospital, and that when the mothers die of puerperal fever, their infants perish of erysipelas." (*On Puerperal Fever*, Lond. 1839, p. 29.) The mortality from puerperal fever in lying-in hospitals is too wide a subject for us to venture on, but whatever is true of these hospitals as causes of fever, is true in its degree likewise as regards erysipelas.

Mr. Coulson quotes from Malouin, to the effect that "out of twenty females who were confined in February, 1746, in the lying-in ward of the Hôtel Dieu, scarcely one escaped being attacked with puerperal fever, and that erysipelatous affections were equally common." In the spring of 1750, puerperal fever was again epidemic, when its connection with erysipelas was noticed by Pouteau in his "Mélanges de Chirurgie." This disease again prevailed as an epidemic in 1770, and is mentioned by Dr. Leake. Three years after, we find it devastating the lying-in ward of the Edinburgh Infirmary, and Dr. Young, then professor of midwifery, accounts for it by the contemporaneous existence of erysipelas, which not only attacked the parturient, but the wounds of those who had undergone any operation.

After alluding to the testimony of Dr. John Clarke in 1787 and 1788, and of Dr. Gordon of Aberdeen, and of Hey of Leeds in 1811 and 1812, to the effect that puerperal fever and erysipelas prevail together, Mr. Coulson gives it as his opinion "that epidemic puerperal fever is at times of an infectious erysipelatous character." (*Coulson, On the Hip Joint, &c.* 2nd ed. Lond. 1841.)

The late Mr. Storrs, of Doncaster, (in the *Provincial Med. Journal*, 2nd Dec. 1843,) published an appalling series of cases in which erysipelas had given rise to puerperal fever, and the converse. For instance, Mr. Reedal, of Sheffield, was attending a case of sloughing bubo with erysipelas, in a young man. The patient's sister, who waited on him, was seized with erysipelas of the head, and died. Five parturient women, whom Mr. Reedal went to from the house of the patient, died of puerperal fever; one other was attacked with inflammation of the mucous membrane of the bowels. Two fatal cases are recorded of puerperal fever caused by infection from erysipelas in the practice of Mr. Sleight, of Hull. Mr. Hardy, of Hull, attended twenty women between March 21st and April 20th, 1838, of whom seven died of puerperal fever. He was at the same time attending a case of large sloughing ulcer of the groin, and one of erysipelatous abscess of the breast. At the same time, to show the atmospheric condition, large numbers of pigs, sheep, and cattle died in parturition. Three surgeons in the same town performed a post-mortem examination in a case of gangrenous hernia: each had cases of puerperal fever. A physician of Boston made the autopsy of a man on March 19th, who died after forty-eight hours' illness, of œdema of the thigh and gangrene. He wounded his hand, and was laid up from the 20th March to the 3rd April. But on 20th he attended a woman, and she died; as did five others out of seven whom he attended in the following winter. The nurse who laid out the third parturient woman died of erysipelas; and the nurse who laid out the fourth died after twenty-four hours' illness. In August, 1836, a practitioner had three fatal cases of puerperal fever; his assistant took fever and foul ulceration of the throat. Mrs. Pearson laid out the body of a child who had died of gangrene of the navel; was confined a few days afterwards, and died. Her child died of erysipelas. The sister of one puerperal patient of Mr. Storrs had herpes, typhoid erysipelas, and a huge abscess in the mamma. It is far more easy to go on with such evidence than to stop. Mr. Elkington, of Birmingham, (*Prov. Med. Journ.*, 13th Jan. 1844) in 1833, after visiting a bad case of erysipelas, attended five women, four of whom died. Mr. Nason, of Nuneaton, after seeing one of Mr. Elkington's patients, attended a woman, who died, whose husband had sore throat, and whose friend had a severe feverish attack. Two of the female attendants on the other patients had erysipelas. Mr. Perry, a patient of Mr. Elkington, had severe erysipelas in 1835, which was the means of conveying contagion to one woman, who died. In Perry's house, which had not been purified, Mrs. S. was attacked by puerperal fever in 1839, her husband had sore throat, and her infant erysipelas.

That erysipelas is capable of spreading by infection, and *à fortiori* by contagion; and that it can be generated by putrescent matter in certain states; and that the same cause may produce *a very low state, in which patients sink after operation with little or no post-mortem change*, is proved by the following cases. Mr. Erichsen (*Science and Art of Surg.* Lond. 1853, p. 348) says that his wards at University College Hospital had been free from erysipelas for some time, when on 15th Jan. 1851, at noon, a man with gangrenous erysipelas of the legs was placed in Burdett's ward. *Two hours* afterwards, Mr. E. ordered the man to be removed, and the chlorides to be used. Notwithstanding this precaution, the patient in the next bed, with necrosis of the ilium, was seized with erysipelas in two days, and died of it. The disease then spread to almost every patient in the ward, and proved fatal to several. But in several instances patients were affected with the constitutional symptoms, the fever and gastro-intestinal disturbance, *without any manifestation of local symptoms* whatever.

The relation of the *diffused*, or *erysipelatous* inflammation of the areolar tissue to cutaneous erysipelas is very evident from the case of Mr. Newby (quoted in *Travers, On Constitutional Irritation*, and in *Nunneley, On Erysipelas, from Dr. Nelson*), a surgeon, who, on June 1st, pricked his thumb in examining the body of a child which had died of enteritis and erysipelas of the abdomen. On the following three days he complained of depression; on the fourth, of headache and fever, with a small pustule on the thumb, and slight pain in the axilla; on the seventh, deep-seated pain in the left breast, which assumed a pink tinge; axilla and arm more uneasy; on the eighth, increased inflammation of the breast, and great feebleness; death on the twelfth day. During Mr. Newby's illness, his assistant had inflammation of the fauces of erysipelatous appearance, and suppuration of the tonsil. His pupil had low fever; the housemaid cynanche tonsillaris; the nurse an attack of pyrexia, followed by phlegmonous erysipelas, of which she died. A woman who assisted in the room after Mr. Newby's death had phlegmonous erysipelas, but recovered.

Here is another case, showing, as Mr. Nunneley observes, that diffuse inflammation and erysipelas are one and the same disease. James Craig, whose master had just died of some febrile disease, was brought to his father's house with erysipelas of his face. The disease was severe, spread to chest and abdomen, and led to extensive suppuration. Vent was given to the matter, and he recovered. His father was attacked in both hands and arms; the disease spread to his face, and after his death, extensive suppurations were discovered along the back and loins, from the neck to the sacrum. (Quoted from (*Gibson*, *Edinburgh Med. Chir. Trans.* vol. iii. p. 96.)

That erysipelatous inflammation of the throat and fauces has a common origin with the other members of the alliance, may be seen from incidental notices of sore throat in the preceding cases. It is proved more fully by the reports of several epidemics, collected by Mr. Nunneley, in which the association of livid, or dusky, or sloughing, or croupy sore throats with erysipelas, and their ultimate origin from the same causes, is plainly set forth. (Op. cit. p. 107, &c.) See also case of erysipelas of the mucous membrane of the throat, fatal from submucous serous infiltration, with false membrane, and evidently epidemic, if not contagious, (in *Travers*, *Further Enquiry*, Lond. 1835, p. 160.) See also the case of a young man, nursing his mother ill of erysipelatous sore throat, when he was smitten with an offensive fume, and was seized with diffuse cellular inflammation of the trunk, of which he died. (*Graves's Clinical Medicine.*) In fact, there is no lesion common to the *pyæmia* group which may not be met with in erysipelas.

Mr. P. H. Bird (*On the Nature*, *Statistics*, *&c. &c. of Erysipelas*, Lond. 1858) met with sore throat in 60 per cent. of the cases of idiopathic erysipelas of which he has notes.

Dr. Gross (*System of Surgery*, Philadelphia, 1859) says that in 1844, '45, and '46, the disease was so common in the Louisville Hospital, and also throughout the city of Louisville, that no operations were performed save of necessity. Whole families were sometimes cut down by it. Every case of disease admitted into the Louisville Hospital received its peculiar impression, and "wore its livery." When the affection was at its height, many patients convalescing from other diseases were suddenly seized with diarrhœa, pneumonia, and bronchitis, over which the usual remedies exercised no control.

Dr. Gross also describes a peculiar and most fatal epidemic of erysipelas which prevailed from 1842 to 1847 in various parts of the United States, particularly the south-western, and in Canada. It was known by the names, "black tongue," "swelled head," and "erysipelatous fever." It began in the throat, with a deep red glossy swelling, which extended to tongue, uvula, tonsils, and face, which was most hideously swollen and distorted. Delirium and prostration accompanied it from the first. Some died early; others from local sloughing; others from pyæmia and abscesses in the lungs and other parts; if lying-in women were attacked, they usually exhibited high evidence of metritis, peritonitis, and phlebitis. In one instance, the immediate cause of death was a large abscess in the left lung, erysipelas being seated in the corresponding leg.

The following example of the connection of pyæmia and phlebitis with diffuse inflammation and phlegmasia dolens is most instructive. It is taken from *Travers*, *Constitutional Irritation*, Lond. 1826, p. 374. Mrs. C., æt. 40, mother of a family, and suckling, complained on 12th October, 1825, of redness and pain of the knuckle of her middle finger, and slight fever. A slight recent wound on the metacarpus. On the 14th, pain and heat all up the arm and neck. Slight fulness and tenderness above clavicle. That night delirium. 16th. Violent delirium; fulness and tension over flexor tendon of middle finger; which was laid open and yielded a teaspoonful of healthy pus. "There was no absorbent nor glandular inflammation, nor any cutaneous blush, but a little more fulness from the elbow upwards, and about the subclavian region, than on the opposite side." Bleeding to 20 oz.: ten gr. of calomel, epsom salts, and jalap. The blood was slightly buffed and cupped. At night antimony and laudanum. 19th. No rest; delirium unabated. Two or three faint lines of inflamed absorbents on forearm, which was puffy, and tender when grasped. Pulse very rapid. Bleeding to 12 oz., "which occasioned a sensible depression;" more calomel and salts; opium at night. 20th. More tranquil; pulse as rapid, but softer; leeches and anodynes. 21st. Hysterical and feeble, but tranquil and rational. 22nd. A quiet but sleepless night; profuse sweating; bark and acid. Up to 25th seemed improving, though the pulse remained at 130 and upwards; great nervous debility; bark and opium, and a moderate quantity of wine, which was "withdrawn because it seemed to overstimulate." 28th. A violent rigor, followed by profuse colliquative sweating. 29th. Another rigor. 31st. Death. The wound in the finger continued to discharge freely, and the hand was free from pain. On post-mortem examination, a small quantity of pus found in the tendinous sheath of the forearm; a straw-coloured serum exuded into the upper arm; the humeral and axillary vein plugged with coagulum. The viscera not examined.

The maid servant who fomented Mrs. C.'s hand suffered from abscesses in the hand and forearm, and above the inner condyle of the humerus: restlessness, delirium, and phlegmasia dolens of both legs.

The laundress who washed Mrs. C.'s sheets, in opening them, turned pale as death and complained instantly of pain in the axilla. Nausea; faintness, rigors and delirium followed; and a deep and extensive abscess above the left breast.

If we recur to that remarkable series of cases which occurred in the Plymouth dockyard, we shall see that out of the fifteen patients, each of them suffered evidently from the same cause; two died from intense fever, without adequate local change to cause death; ten had symptoms of phlegmonous erysipelas, or of the diffused inflammation locally; and three died of visceral or distant disease, without local symptoms at the spot by which the poison entered the veins. From one and the same poisonous source, whatever that was, every variety of erysipelatous disease proceeded. Every feature of pyæmia and puerperal fever was produced.

We have thus laboured to show, that the "*irritation*" of Hunter and Travers, and the "*constitutional susceptibility*" and "disorder of the chylopoietic viscera" of Abernethy, are figures of speech, which, in modern language, are rendered by the term impurity of the blood. And in the mass of evidence we have presented of the origin and alliances of erysipelas, we have shown how the simpler cases arise from the common causes of illness, especially if aided by cold, or blight, as it was called in Sydenham's time, and that the deviation from the sthenic, or healthy adhesive inflammation may be slight; whilst the graver cases arise from the workings of a putrid poison. Here the question arises, will *any* putrescent matter suffice? or is there anything *specific* in the cause of erysipelas, as there is, for example, in the cause of syphilis?

In answer to the former question it must be said, that putrescent matter evidently requires some atmospheric conditions to be superadded, of which we know nothing, in order to create the erysipelatous poison; and to the second, that there seems every reason to believe that once having arisen by any means, it possesses the power of propagation just like the diseases called specific.]

[*Treatment.*—In treating this branch of the subject, we will first give a short *catena* of the opinions of eminent men at various epochs; and then sum up the measures expedient in each variety of erysipelas.

Hippocrates says that cold water is of use in erysipelas, but not if ulcerated; Celsus prescribed blood-letting, if the strength permits; then refrigerants and astringents, such as Cimolian chalk and water, covered with a leaf of beet, (a remedy which the vulgar use to this day, in the form of fullers' earth and water). Galen and his followers adopted maxims of the soundest. Since, says he, refrigeration is dangerous in common inflammation without evacuation, much more is it so in erysipelas, in which there is danger lest the bile be diverted to some nobler part; so instead of venesection, we use cholagogue medicines; then cooling applications; and if the colour becomes livid, warm poultices, or fomentations of salt water. (*Galen*, *Meth. Medend.*, *Op. Om. Kühn*, vol. x.) Serjeant Wiseman says, that if it fall upon the head or throat, phlebotomy is permissible, to avoid phrenitis or squinancy; but if it be simple, and only in the skin, we ought only to evacuate the redundancy of humours, and prevent the ebullition of choler. If it arise from a wound, cooling and lenient applications are permissible, if preceded by purgatives; but in erysipelas of the head and face, the greatest caution is necessary in the use of repellants. Sydenham considers that in this disease peccant matter is mixed with the blood, and must be evacuated; also, that the ebullition of the blood must be regulated by cooling remedies; also, that matter which has become impacted in the parts must be discharged and eliminated. To do this, he bleeds freely, and finds the blood like that of pleurisy the next day, then gives a mild cathartic, and a paregoric draught of syrup of poppies at night. The purging being over, an emollient fomentation was used warm twice a day; and after the fomentation, an application of a stimulating tincture of Venice treacle, that is, pepper and cloves with spirits of wine. The patient lives on barley water, gruel, and toasted apples, with a little of the smallest beer. Usually, says Sydenham, the purging and bleeding suffice. This treatment evidently applies only to mild idiopathic cases of a sthenic sort.

Cullen, whose experience, like Sydenham's, was medical and not surgical, treated erysipelas of the face by bleeding and antiphlogistics; but confessed that the disease might be attended with putrid symptoms, and require bark, though he had never seen such cases. John Hunter, in cases of diffused inflammation in irritable habits, was averse to much bleeding, and recommended bark. Abernethy believed the erysipelatous group to be produced rather by something wrong in the constitution of the patient, which predisposed, and particularly disorder of the digestive organs, than by inoculation of poison. He gave alteratives, and was averse to bleeding.] The most modern advocate of bleeding is, or was, Mr. Lawrence, whose opinions at the date 1828 were that as erysipelas resembles other inflammations in its causes, symptoms, and effects, it should be treated on the same principles; that is, on the antiphlogistic plan. Venesection, local bleeding, purging, and low diet are the first measures, to which saline and diaphoretic medicines may be afterwards added. He says, the earlier these means are employed the better: vigorous treatment in the beginning seems to him most calculated to shorten the attack, and prevent the disease from spreading beyond its original seat. At the same time, he admits, that as the skin and cellular texture are of secondary importance, it is not so urgently necessary to arrest inflammation in them, as in the vital organs; neither does the same reason for very active treatment exist as in affections of the eye, where a slight change of structure may seriously impair the utility of the organ essential to our comfort and pleasure; but the extensive suppuration and mortification, which erysipelas sometimes produces, may render a limb, in a great measure, totally useless, or may even destroy life. "The disposition of erysipelas to terminate by resolution, is another reason against resorting indiscriminately to active depletion. In many cases, the disease passes through a certain course, and ends spontaneously: it is sufficient to put the patient on low diet, to clear the alimentary canal, and then to use mild aperients and diaphoretics. When it proceeds, as it often does, from an unhealthy condition of the alimentary canal, the removal of the internal disorder leads to the cessation of the local complaint. It must, however, be observed, that venesection is sometimes useful both in curing the internal cause and in promoting the termination by resolution." Mr. Lawrence afterwards observes, that he does not mean to recommend that measures equally active, and, in particular, that bleeding, whether general or local, are to be employed in all cases. In young persons, in the robust, and those of full habit; in instances where the pulse is full and strong, or where there is headache and white tongue; in erysipelas of the head, attended with symptoms denoting affection of the sensorium, and more especially in the very beginning of the affection, venesection will be proper; and it may be necessary to bleed largely, to repeat the evacuation, or to follow venesection by local abstraction of blood. Under such circumstances, the other parts of the antiphlogistic plan must also be employed, that is, the alimentary canal should be cleared by an active purgative, which may be followed by salines and antimonials, with the occasional use of milder aperients; and low diet should be enjoined. As Mr. Lawrence adds, nothing can be more different from such a case, than that of an elderly person, with a small and feeble pulse, in the advanced stage of the disease. The interval between these extremes is filled by numerous gradations, requiring corresponding modifications of treatment. The antiphlogistic plan itself embraces a wide range in point of degree; from blood-letting local and general, with purging, vomiting, the free use of mercury and antimony, and low diet, to the exhibition of a mild aperient, with some saline medicine. Mr. Lawrence believes, that the treatment of erysipelas, like that of any other inflammation, should be modified according to the age, constitution, previous health, and habits of the patient, and the period of the complaint. "When the affection occurs in old and debilitated subjects, the powers of life are soon seriously impaired, and our efforts must be directed rather towards supporting them, than combating the local affection. I have often seen such subjects, labouring under erysipelas of the face in its advanced stage, with rapid and feeble pulse, dry and brown tongue, recovered, under circumstances apparently desperate, by the free use of bark and wine." The same writer deems local bleeding sufficient in the milder cases of erysipelas, and often necessary in the more severe ones, as an auxiliary measure. Cupping, when practicable, he sets down as more efficacious than leeches, though objectionable on account of the painful state of the skin. Leeches, he remarks, when applied to the sound skin of some individuals, produce an effect analogous to erysipelas, but they exert no such influence over the inflamed skin, to which they may be applied freely and safely. In order to produce any decided benefit, he thinks they should be applied in large numbers.

Mr. Lawrence adds, that after the inflammation has been checked, the surgeon should not be in too great a hurry to prescribe tonics, stimulants, and a full diet. "Medical practitioners in general (says Mr. Lawrence) are anxious to begin the strengthening plan; they seem to have the fear of debility constantly before their eyes, and lose no time in directing the employment of bark, and recommending animal food, with beer or wine. In this way relapses are frequently produced; the inflammation and fever are renewed; further local mischief is caused, and recovery is retarded." When it is doubtful whether stimuli should be employed or not, he deems subcarbonate of ammonia the best medicine. Bark comes next in order to it, and the sulphate of quinine is the most eligible preparation. Wine is sometimes necessary; but Mr. Lawrence thinks it should be given sparingly. (See *Med. Chir. Trans.* vol. xiv.)

[The reviser of this article thinks it right to repeat these portions of the former edition, inasmuch as they contain the materials for a history of opinion and practice in medicine. But it is necessary to add, that the illustrious surgeon referred to does not now hold the antiphlogistic doctrine here described. Not indeed that he is likely ever to have bled, where bark and wine ought to have been given; but in an interview with which he favoured the reviser, he stated as his present opinion that treatment should, as a general rule, be decidedly tonic and supporting.

The full force of the antiphlogistic treatment, employed, as it was at a time when all humoral pathology was in abeyance, and inflammation and increased action were the popular bugbears, is exhibited in the series of cases which we have abridged from Dr. Butter. How remarkable it seems that patient after patient should have been submitted to exactly the same treatment: bleeding as long as blood would flow; purgation till blood passed from the irritated bowels; and wine only when subsultus tendinum announced the near approach of death. For example, in *Case 5*, after leeches, cathartics, tartar emetic, and bleeding; here is an extract.

"Eight o'clock, P.M. Fever again increasing; erysipelas extended even to the knee; the integuments over the tibia looked mottled or variegated, like the colours of a rainbow; red lines and patches were also seen to run up the limb to the groin. Tension very great. Delirium. Venæsectio ad ℥ xvi. Ten o'clock, P.M. Not relieved; headache most severe. Rep. V. S. ad ℥ xxiv." It must be remarked, that Dr. Butter, throughout his work, shows the most advanced and sound views, and repudiates all this cruel practice, of which he shows the bad results.]

In *bilious* erysipelas, or that originating with strongly marked gastric disorder, Desault gave, in the first instance, a grain of tartarised antimony dissolved in a considerable quantity of fluid. He had seen the symptoms entirely subside, although the medicine produced no other sensible alteration in the animal economy than an increase of the insensible perspiration and urine. When the symptoms resisted these evacuations, he was obliged to have recourse once or twice, or even more frequently, to the emetic mixture. When the erysipelas was cured, and the bitterness in the mouth and fever had subsided, two or three purges of cassia and manna, with a grain of emetic tartar, were exhibited. As soon as the symptoms were mitigated, the diet of the patient was allowed to be more generous. In bilious erysipelas, Desault observed, that the cases of the patients who had been bled previously to their admission into the hospital, were invariably the most obstinate.

When the tongue, without being red at its point and margins, was furred, and marks of gastric disorder prevailed, unattended with tenderness of the epigastrium, Dupuytren found emetics useful. (*Clin. Chir.* t. ii. p. 320.)

In cases of bilious erysipelas, many modern practitioners, says Mr. S. Cooper, would be bolder with antimonials than Desault, first, by imitating Richter, and giving an emetic at the commencement of the attack, and then by exhibiting more freely either antimonial powder, or tartarised antimony, with a dose or two of calomel.

In *phlegmonous* erysipelas, Desault was an advocate for bleeding in the beginning of the disorder, and this practice he followed up by the administration of tartarised antimony and evacuants.

In the beginning of phlegmonous erysipelas, Dupuytren likewise had recourse to general and local bleeding, emollient applications, or, what he considered still more efficacious, cold sedative lotions. If inflammation of the cellular texture had begun, he not only practised these antiphlogistic measures, but repeated them. But if there was a narrow wound, seemingly attended with strangulation of the parts, he made a simple or crucial incision without delay. (See *Clin. Chir.* t. ii. p. 320.)

[But side by side with the extreme antiphlogistic school of the last century there was one which saw in erysipelas and its allies the characters of putridity or malignity only, and which repudiated evacuants, and employed tonics and antiseptics.] Dr. George Fordyce declared that he always found bleeding and evacuations hurtful, and Peruvian bark the best remedy. "It should be exhibited (he says) in substance, if the patient's stomach will bear it, and in this disease it will almost always bear it, and in as great a quantity as the patient's stomach will bear, which is commonly to the quantity of a drachm every hour!" (*Trans. of a Society for the Improvement of Chir. Knowledge*, vol. i. p. 293.)

Dr. Wells was also an advocate for the treatment recommended by Fordyce.

[The tincture of sesquichloride of iron has been recommended of late years by Dr. Ranking and others. The reviser has seen it of eminent service in an apparently hopeless case of puerperal fever with diphtheritis, which he attended in consultation with Dr. Frere, and in which, when the patient seemed evidently dying, she recovered under the use of this tincture in immense doses—one or two teaspoonfuls every two hours.

Of local measures the most important in the phlegmonous and diffuse erysipelas are *incisions*, which, relieve the tension, give vent to exudations and to blood, and hinder the exudations, which, as James says, are neither walled in by adhesions, nor discharged by pointing, from spreading and contaminating sound parts. The older surgeons, if men of genius, always used them, more or less. Le Dran is very explicit: "*Of a gangrene proceeding from an erysipelas*," he says, "the fluids fermenting require a larger space to act in, and the skin being of too close a texture to yield immediately to this increased bulk, will compress the parts which it contains, hence the adipous parts mortify, and a putrid serum diffuses itself over the limb." In this case, he continues, we must discharge the putrid serum by incisions. These, he says, should be made right through the diseased parts to the quick; and they should be carried lengthwise into the inflamed part surrounding the gangrene. They should be about two inches long, and an inch distant. If necessary, others may be made below, but rising partially into the intervals. (*Le Dran, translated by Gattaker*. Lond. 1752.) Baron Boyer gave the same advice. (*Traité des Mal. Chir.* t. ii. p. 22.)]

It is, however, one thing to propose a remedy; quite a different, but equal credit belongs to him, who without being the first discerner, yet is the first to obtain universal sanction and the stamp of authority for it. This credit belongs to Mr. Copland Hutchinson, formerly surgeon to the Naval Hospital at Deal, where seafaring men are very liable to phlegmonous erysipelas of the legs, ascribed to the irritation of the salt water, and the friction of their loose coarse trousers. In this description of patients, the disease frequently proceeds rapidly to the gangrenous state, and the consequence is the loss of many lives and limbs. Even when the danger of mortification is avoided, abscesses often occur, which spread between the muscles and under the integuments to a surprising extent: "from the ankle to the trochanter, and over the glutæi muscles." In the first few cases which came under the care of Mr. Hutchinson, this gentleman's plan of treatment, in addition to the usual medical means, consisted of local bleeding by means of cupping glasses, followed by fomentations. Subsequently, however, he adopted the method of making several free incisions with a scalpel on the inflamed surface, in a longitudinal direction, through the integuments, and down to the muscles, as early in the disease as possible, and before any secretions had taken place. These incisions were about an inch and a half in length, two or three inches apart, and varied in number from six to eighteen, according to the extent of surface which the disease is found to occupy. Mr. Hutchinson states, that these incisions will yield between fifteen and twenty ounces of blood, and give relief to the tense skin, at the same time that they form channels for the escape of fluid, and the prevention of bags of matter. After the operation, fomentations, or saturnine lotions, were employed.

By the preceding kind of treatment, Mr. Hutchinson found the fatal termination of the disease rendered less frequent, and gangrenous mischief wholly prevented. He adds that he never lost a case in the Deal Hospital for the last five years, during which the practice was followed. (See *Med. Chir. Trans.*, 1814, vol. v. p. 278, &c.)

Instead of several moderate cuts, Mr. Lawrence thought the most powerful means of arresting the complaint was making one or more long incisions through the inflamed skin and the subjacent adipous and cellular textures. These incisions, he asserts, are followed very quickly by relief of the pain and tension; and this alleviation of suffering, he assures us, is accompanied by a corresponding interruption of the inflammation, whether it be in the stage of effusion, or in the more advanced period of suppuration and sloughing. Mr. Lawrence further maintains, that this treatment is employed to the greatest advantage at the beginning, since it prevents the further extension of inflammation, and the occurrence of suppuration and sloughing. At a more advanced stage the incisions limit the extent of suppuration and gangrene; and, at a still later time, they afford the readiest outlet for matter and sloughs, and facilitate the commencement and progress of granulation and cicatrisation. (*Med. Chir. Trans.* vol. xiv. p. 67, &c.)

Respecting the treatment by incisions, Mr. Samuel Cooper thus delivered his judgment in the earlier editions of this Dictionary. That the practice of incisions with moderation and judgment has been the means of saving many limbs and lives, I consider as fully established as the opposite fact, that immoderate incisions have occasionally accelerated the patient's death. I have heard of instances in which a cut was made from the shoulder down to the hand, or from the trochanter major to the foot. Whoever looks over the reports of the consequences of incisions of immoderate length, as detailed in the *Lancet* and other works, cannot fail to be struck with the following facts: — Several patients, treated in this way, instead of being saved, went out of the world in a very sudden manner, sometimes from the shock of an enormous wound on the constitution in its disturbed state; sometimes from profuse hæmorrhage. In one or two instances, the cutaneous nerves, as well as large veins and arteries, were not spared, and a partial paralysis ensued.

I know of more than one case in which the patient died of hæmorrhage in a few minutes after an immoderate incision had been made. Dr. M'Dowel, a decided advocate of free incisions, candidly relates the following fact:—"The following case (says he) I witnessed ten years since; and at a more remote period than this, incisions in phlegmonoid erysipelas were constantly practised. A strong and healthy young man had severe phlegmonoid erysipelas of the leg, after an injury of the patellar bursa. The limb, from the foot to half way up the thigh, was enormously swollen, extremely tense and painful. There was high inflammatory fever. A free incision was made in the leg through the fascia, which retracted widely after its division; the parts were much gorged with blood, and disorganisation of the cellular membrane and aponeurosis had commenced at one part. There was profuse bleeding from the entire almost of the cut surface. The extent of bleeding was not attended to by the person in charge of the case, and in twenty minutes life was nearly extinct. Every plan of stimulation and support was adopted, except transfusion; but death occurred in an hour and a half after the operation." (*M'Dowel, in Dubl. Journ. of Med. Science*, vol. vi. p. 179.) This case teaches us, at all events, that the bleeding must not be neglected. I am of opinion, therefore, says Mr. Cooper, that incisions of preposterous length are not the most prudent practice; by preposterous, I mean such as require a foot ruler or a yard for their measurement; for nobody is more convinced than I am that free incisions of less extent are often of the highest service.

[The controversy is forgotten now; yet, thirty years ago, Mr. Lawrence and the author of this dictionary were engaged in a severe pen and ink battle as to the length of incision.]

As a substitute for incisions, Sir W. Dobson proposed many small punctures, which he repeats twice a day to the number and extent required; and often, in bad cases, three or four times in the twenty-four hours. The quantity of blood and serous fluid discharged from these punctures, although sometimes considerable, he says, need never create any alarm. (See *Med. Chir. Trans.* vol. xiv. p. 206.)

There is no doubt that such punctures, whether merely deep enough to draw blood from the skin, or to let out some serosity from the subcutaneous tissue, give great relief when the skin is very tense. [In some cases *they are very painful*, and, in fact, more painful and less effectual than incisions.

Mr. Lawrence now advocates *one* free and early incision; not many; not yet of extravagant length. The patient must always be watched, to take measures against excessive loss of blood.]

Leeches, and even cupping, have been at times employed to draw blood from the inflamed part—sometimes with relief in sthenic cases, but they are almost, if not quite, disused at present.

[Cold applications are decidedly to be condemned when they cause any feeling of shivering or discomfort; and in cases of idiopathic erysipelas they are objectionable on *à priori* grounds. The cases in which they are applicable seem to be those of slight erysipelas or erythema, threatening an inflamed wound, when the patient likes them; but in all cases tepid or warm are safer.

Blisters, inapplicable as they seem, have been largely used, particularly by the English of 150, and the French of 50 years back. There seems no reason to doubt that they occasionally cut short a wandering and declining erysipelas, and at least they imitate the vesications of the disease. But the reviser would be very unwilling to sanction so barbarous a remedy. (See *Roche and Sanson, Nouveaux Elém. de Pathol. Méd. Chir.* t. i. p. 352.)]

A large blister was sometimes applied by Dupuytren over a wound, and to the surrounding skin; and he found that the irritation and suppuration which were thus excited, occasionally succeeded in preventing phlegmonous erysipelas. (See *Clin. Chir.* t. ii. p. 320.)

Indeed, it was only for the prevention of the disorder that Dupuytren sanctioned this practice, which, as he particularly explains, he was afraid of resorting to, after the disease had resisted bleeding and cold sedative lotions, because he had sometimes, though not often, seen sloughing produced by it. (*Ib.* p. 322.)

The application of the nitrate of silver in substance, or in the form of a lotion, so as to blacken the part, was proposed some years since by Mr. Higginbottom, as a means of checking the peculiar action of the vessels, on which erysipelatous inflammation was believed at that day to depend. It was said to repress the effusion of serosity in the cellular tissue; and, if applied beyond the erysipelas, to form an obstacle to its spreading in any particular direction. By forming a black line with it, the inflammation may thus be kept from running up the neck to the face and head. (*On the Use of Nitrate of Silver.*) In the early stages of erysipelas, Mr. S. Cooper often employed it with advantage in the North London Hospital. Experience has since shown, that although the application will sometimes give the *coup de grâce* to a languid eruption, yet that it has no certain power of preventing erysipelas from spreading. Mr. Higginbottom directs the part to be first washed with soap and water, and then dried. The inflamed and surrounding skin is then to be moistened, and the nitrate of silver passed over it once, twice, or thrice, or more frequently, if rapid vesication be required. The part is then to be exposed to the air and kept cool.

[Mr. Lawrence uses a solution of 30 grains to a *drachm*; for the purpose of checking exudation into the tissue of the eyelids; and of drawing a line of demarcation round the inflamed part: and has great faith in its efficacy.

Stimulating applications, such as the pepper and spirit lotion of Sydenham, soap liniment, solution of carbonate of ammonia, and the like were used, even up to a late date, and perhaps are now, to get rid of the last stage of simple erysipelas of the head. The tincture of iodine has been used largely by Mr. Norris. (*Med. Times*, Dec. 10, 1852.)

The *sulphate of iron* in solution (ʒiv. to a pint), was employed by M. Velpeau as a lotion, in order to act on the blood in the inflamed tissues. In the course of some clinical observations (*Med. Times and Gaz.* March 10, 1855) that the efficient cause of erysipelas is decomposition of the fluids at the injured part, whether primary, or caused by infection. These altered fluids spread by imbibition into the adjoining tissues. To attack them is therefore to extinguish the disease in its focus; that is in cases of local infection. M. Velpeau believes that the iron lotion thus cuts short the erysipelas. At least it iron-moulds the linen.

Of other remedies on our list, M. Velpeau gives an opinion in which we fully concur. In twenty five cases he had employed compression by bandages with no good result. In thirty-three flying blisters were applied with equal want of benefit. The same with the nitrate of silver in thirty cases. In 200 cases mercurial ointment was resorted to, and sometimes seemed to diminish the duration of the disease by a day or two; but it is very dirty, and mischievous if it salivate.

Collodion has also been used, but the results are not encouraging.

We will now sum up the precepts of treatment in a few words. Without denying that cases have happened, or may happen again, in which the sthenic excitement and plethora of the patient may induce the practitioner to draw blood moderately, it must be observed that the cases usually met with require a soothing, supporting, and tonic treatment.

In idiopathic erysipelas of the head, the patient must be confined to his room, if not his bed. If there is sickness, foul tongue, and evidence of a loaded state of bowels, he may have a cupful of warm chamomile tea for an emetic; a grain of calomel, and a little castor-oil or colocynth. If there is no such evidence, and the thing looks like a *blight* from cold, it is sufficient if the bowels be well opened. If there is pungent heat and thirst, and dry white tongue, the patient may quench his thirst with effervescing saline draughts, ginger-beer, oranges, and lemonade, and live on broth and slops. In other cases, with less strength, wine and soda-water, and beef-tea, fish, or puddings; and in others with a feeble pulse, stupor, dull colour of the eruption and decided signs of debility, port wine, or brandy, or (in the case of a Scotch or Irishman) whisky, with good beef-tea, and decoction of bark or quinine, with mineral acid. In most cases some soothing remedy at night is advisable to allay irritation and procure sleep. In the former set of cases, henbane with camphor mixture and Mindererus' spirit; in the graver cases, opium or morphia in sufficient doses.

In cases of simple erysipelas supervening on wounds, or after operations in hospitals, wine and tonics are indicated.

In simple erysipelas, the local applications should be such as make the patient feel more comfortable. The reviser used to see the warm poppy decoction used at Winchester with the best effect. In other cases the patient prefers bathing, with tepid soft water; in others, flour; in others, cotton wool. If the vesications break, an unguent of bismuth and glycerine is recommended. Of course, if there be any fair suspicion of suppuration, a knife should be thrust in.

In the phlegmonous erysipelas, at the beginning of shivering and other signs of fever, if there be signs that nature is tending to purify the blood by vomiting or purging of dark bile, an emetic and good dose of calomel with colocynth or castor-oil may be given first; always having respect to the use of these remedies, which is, not to follow routine, nor "lower the system," but to bring away fetid matters from the bowels. If they do this, they do good; if they bring away inoffensive mucus, they do harm. Then the patient's strength must be supported by good soup and wine, sleep be procured by opiates, and it were better to incise rashly, than to omit incision when needed. How different the fate of those Plymouth Dockyard patients (*C.* 1.) might have been if free incisions had been practised instead of such cruel and hopeless bleeding. At the commencement soothing applications should be made to any wound that is irritated. If discharges are fetid, whether from an original wound, or from the erysipelatous sloughs, they should be well deodorised, by solutions of chloride of lime, or by Condy's disinfectant, and by the application of bismuth and creosote ointment. The spread of chemical education amongst the rising generation of surgeons may result in a saving of human life from these pestilential diseases. The incisions should not be permitted to bleed too much, and pressure with strips of lint dipped in turpentine may be used to restrain it if excessive. The *liquor cinchonæ cordifoliæ* of Battley, is, as the reviser believes, the best tonic, mixed with water acidulated with nitric acid. (See Abscess *Diffused.*)

In the cases of diffuse inflammation which arise as local manifestations of pyæmia, the treatment is the same. The reviser once experienced the effect of the *anatomical poison;* an inflamed finger, and intense general depression were the symptoms; old, hard, bright sparkling ale (which he cannot think of without gratitude) was the remedy. In the intense and well-marked cases of poisoning, as in puerperal fever, tonics and wine are required from the first. Wherever exudation takes place, hot fomentations should be applied, such as steaming bran poultices, sprinkled with camphorated spirits, to localise the malady, and incisions to give vent to the poison. It was well observed by Mr. Stafford, that in every case of dissection wound followed by diffuse inflammation, in which no incision was made, the result was fatal.

Respecting the use of leeches for the relief of pain in the axilla or side, in these cases, although they have the sanction of Sir A. Cooper, and although local depletion stands (as we show in art. Inflammation) on a very different footing from general bloodletting, yet we cannot advise it. The results are not satisfactory; and hot fomentations to encourage suppuration are better. Contrary to the doctrine of the antiphlogistic school, it is a fact in these cases that gangrene is caused by a truly venomous state of the exudation, and not by mere violence of inflammation. (See *Dr. Graves's Clin. Med.* Dublin, 1843, p. 576.)

In the case of *metastasis*, stimulants, such as bran poultices, moistened with turpentine, may be applied to the part whence disease has receded, and hot brandy and water and other stimulants be freely supplied. Turpentine in purgative doses is greatly recommended by Dr. Copland, in this, and other apparently hopeless cases. Enemata of beef tea and brandy, as given by Dr. Todd, may also help to turn the scale.

Prevention.—Every case, not merely of erysipelas, but of offensive wound or fracture, should be isolated; great care should be taken that no effluvia can reach any bed, from closets or the like; bedding should be purified from time to time; the wards should be limewhited; floors should be scrubbed and not wetted; and above all, *sponges* should be abolished. No sponge used in any suspicious case should be used again; and the house-surgeons and dressers should deodorise their fingers by chloride of lime after dressing such cases. Moreover, operations should not be performed, nor accidents be admitted, during an epidemic of pyæmia or erysipelas. Patients can but die as they are.]

[*Erysipelas neonatorum.*—The erysipelas which attacks newly born children deserves a special notice, if only because it exhibits the causes and alliances of the disease generally, in their greatest perfection, and because the diminution in late years of mortality from this cause is an encouraging instance of the value of cleanliness and ventilation in extirpating disease.

It may occur within a very few days after birth, and although it may affect almost any part of the body, the vicinity of the umbilicus is naturally the far most frequent seat. It soon spreads, especially to the genital organs and thighs, and produces vesication, suppuration in the subcutaneous tissue, and gangrene of the skin, if it be severe or phlegmonous. The constitutional symptoms are those of great debility, restlessness, whining, perhaps convulsions or coma. "The genital parts," say Drs. Maunsell and Evanson, "are not unfrequently destroyed altogether ; and we have sometimes seen the scrotum become black and slough away, leaving the testicles bare and hanging loosely by the cords." So little, they add, spite of the intense mortality of the disease, are we justified in despairing of children under the most unfavourable circumstances, that we have seen a case recover after the whole scrotum and skin about the pubes had sloughed away, the bare testicles being again covered up by an extension and cicatrisation of the neighbouring integuments. (*Diseases of Children*, 4th ed. p. 223.)

Of the cause of this affection, all observers speak with one tongue. Foul air, especially hospital air. It attacks chiefly children born in lying-in hospitals, and comes, say Drs. Maunsell and Evanson, at periods when other malignant diseases, as diffuse inflammation, puerperal fever, scarlatina, &c. prove the *constitutio anni* to be of a typhoid character.

The treatment is that of erysipelas generally, modified to suit the age and feebleness of the patients. In the first place, as in all other cases, removal to a pure air is essential, and the utmost cleanliness of clothes and person. The navel should be dressed with an unguent of the nitrate of bismuth and glycerine, which will effectually absorb any putrid matter. Good breast milk should be supplemented by occasional teaspoonfuls of beef-tea and port wine and water. The practitioner may relieve the bowels by enema, and if he can do it without neglecting nourishment, may give tonics, of which the *liquor cinchonœ flavœ* of Battley, in the dose of a drop or two in sweetened water, is the best. Half-grain doses of quinine are recommended by many.]

[ERYSIPELAS, *Statistics of*:—The materials for this branch of our subject are either entirely wanting or very imperfect. The following brief notes may, however, be of interest.

The proportion which erysipelas bears to the total sickness of the whole population is unknown ; but we may refer to the returns published by the metropolitan medical officers of health, during parts of the years 1857 and 1858. These returns were set on foot in the hope that they would prove a record of the *amount* of sickness, and of its *nature*, amongst that large part of the population which receives medical attendance gratuitously, whether from parishes, or from dispensaries, or within the walls of hospitals, and other charitable institutions. The project was abandoned at last, from the impossibility of obtaining the required information with sufficient regularity and completeness. But, from the returns that were published, it appears that during the last forty weeks of 1857, and the first forty of 1858, out of 791,506 cases of illness, there were 2649 of erysipelas. This is more than three times the number returned of cases of small-pox ; and is nearly equal to the number of cases returned of acute pneumonia and pleurisy combined.

During the seven years 1848–54, the entire mortality, in England and Wales, from erysipelas was 14,950. There were thirty-eight other diseases more fatal. In 1855 the deaths were 2256.

In *London*, during the years 1844–58, 5768 deaths occurred from erysipelas, being at the rate of 384·4 per annum. The highest mortality was 579, in 1848 ; the lowest, 299, in 1857. Deaths from erysipelas are evidently not on the increase.

With regard to the *seasons*, Mr. P. H. Bird (in the pamphlet in which he gives a summary of his Jacksonian prize essay) says that 260 cases occurred in the following order :—

Spring, 66 ; summer, 49 ; autumn, 56 ; winter, 89. He quotes from the Registrar-General also, to show that during the years 1845–54, the total deaths in London were :—Spring, 1117 ; summer, 972 ; autumn, 875 ; winter, 1076.

Out of Mr. Bird's 260 cases, the deaths were 7·5 per cent. Dr. W. H. Stone (*Med. Times*, Nov. 12, 1859) states that the mortality of erysipelas in St. Thomas's Hospital is 7 per cent. Of 260 cases of erysipelas ambulans observed by Fenger, in the Frederick Hospital, at Copenhagen, 33 died, or 12·8 per cent. ; of 194 cases of *erysipelas vulgaris*, there were 2 deaths ; taking the 454 cases of both kinds together, the mortality is 7·7 per cent. Assuming 7 per cent. as the mortality, it is probable that, in 1857, there were 2100 cases of the disease in London.

Out of 217 of Fenger's cases, 198 arose within the hospital; 17 idiopathic, 200 traumatic. Of the 200 traumatic, 140 cases followed surgical operations. In this hospital, at Copenhagen, erysipelas seems, of late years, to have taken the place of hospital gangrene, which ravaged it previously. Puerperal fever has been prevalent throughout in the adjoining lying-in hospital.

The sexes, notwithstanding the greater liability of the male to traumatic diseases, die equally of erysipelas. In the seven years 1848–54, the males who died were 7464 ; the females, 7486.

Respecting the ages—

Males, under 1, 1725 ; 5, 2100; 5 to 15, 290 ;
Females, „ 1, 1805 ; 5, 2363; 5 to 15, 278.

After these ages, the mortality in each sex is distributed pretty equally during each succeeding decenniad ; but with an evident rise, as age increases. Between 55 and 65, 884 men, and 816 women died of erysipelas.] (*R. Druitt.*)

ERYTHEMA (from *ἐρυθρὸς*, red). A redness of any part. A mere rash or efflorescence, not accompanied by any swelling, vesication, or fever; circumstances which, according to Dr. Bateman, distinguish it from erysipelas. (*Synopsis of Cutaneous Diseases*, p. 119, ed. 3.) Its six varieties are described in the latter work. For the erythema mercuriale, see *Mercury*. The term is often wrongly applied to eruptions, attended with redness, and distinct papular and vesicular elevation, as we see in the instance of mercurial erythema, which Dr. Bateman says should be named *eczema*.

ESCHAR (from *ἐσχαροω*, to form a scab, or crust). This term is applied to a dry crust, formed by a portion of the solids deprived of life by the action of concentrated heat. When any living part has been burnt by the actual or potential cautery, all that has been submitted to the action of this application, loses its sensibility and vital principle, becomes hard, rough on the surface, and of a black or grey colour, forming what is properly named an *eschar*, a slough, produced by caustics, or actual fire.

ESCHAROTICS (from ἐσχαρόω, to form a crust over). Applications, which form an eschar, or deaden the surface on which they are put. By escharotics, however, surgeons commonly understand the milder kinds of caustics, such as the *hydrargyri nitrico-oxydum, the nitrate of silver, subacetate of copper*, &c.

EXÆRESIS (from ἐξαιρέω, to remove). One of the divisions of surgery adopted by the old surgeons; the term implies the removal of parts.

EXCORIATION (from *excorio*, to take off the skin). A separation of the cuticle; a soreness, merely affecting the surface of the skin.

EXFOLIATION (from *exfolio*, to cast the leaf). The process by which a dead piece of bone is separated from the living is termed *exfoliation*. One part of a bone is never separated from another by the rotting of the dead part, for what comes away is as firm as it ever was. Before any part of a bone can be throne off by exfoliation, it must be dead. But, even then, till the process of exfoliation begins, the bone adheres as strongly as ever, and would remain for years, before it could be separated by putrefaction alone. A dead bone acts on the system, in the same manner as any other extraneous body. It stimulates the adjacent living parts, in consequence of which, such a process is begun, as must terminate in its being thrown off. The effects of this stimulus are, first, that the living adjacent bone becomes more vascular; a circumstance which always takes place when a part has more to do than is just sufficient for the support of life. Secondly, that the earth of the living part, when it is in contact with the dead bone, is absorbed; and there the bone becomes softer, and adheres by its animal matter only. As Mr. Wilson has stated, "before any mark of separation is seen on the surface, the living bone surrounding the dead, for the extent of a mere line, has become as soft as if it had been steeped in acid." (*On the Skeleton and Diseases of the Bone*, p. 281, 8vo. Lond. 1820.) Thirdly, that the living animal part is at last absorbed along the surface of contact: this part of the process commences, however, long before the removal of the earthy matter is finished; and both of these processes begin at the surface; though, in their course, they do not every where take place in an equal degree at the same time Fourthly, in proportion to the waste made by this ulcerative absorption, granulations arise from the living surface, and fill up the intermediate space, so that there is no vacuum. These different stages together constitute ulceration. When any part of a bone is once loose, it is pushed to the surface in the same manner as most other inanimate bodies would be, and this stage is partly mechanical, and partly a continuation of ulceration. A proof of the third stage, above mentioned, may be derived from cases in which people die while exfoliation is going on. A small groove, or worm-eaten canal, can then be discovered, which becomes gradually deeper, and follows the irregularities of the living and dead surfaces. After the application of the trepan, an annular piece of bone is frequently thrown off, which is always less than the space from which it came. This, as Mr. Hunter observed, would never be the case, were there not a loss of substance. However, in what manner this loss of substance is produced, has frequently been a question, many pathologists, and amongst them, I believe, is Mr. Gulliver, adopting the belief, that dead bone is not absorbed.

"Although (says Mr. Wilson) in general the absorption takes place in the living bone, it still appears, that, under peculiar circumstances, the absorbing vessels have the power of acting on and removing the substance of dead bone. This happens after the dead part has been separated from the living, and when, from its shape, and the form of the living surrounding bone, it is prevented from obtaining a passage to the surface of the body; as in exfoliations of the cranium, when the inner table of the exfoliated part is broader and wider than the outer table." (*On the Skeleton, &c.* p. 282.) In very hard bones, the colour of the dead exfoliating portion is generally white; but, in softer bones, it is yellow, dark, and sometimes black. (*Wilson*, op. cit.)

It was anciently believed, that whenever a bone was denuded, the exposed surface must necessarily exfoliate; and this being taken for granted, the old surgeons used to put immediately in practice whatever they thought best calculated to bring on an exfoliation as quickly as possible. For this purpose, the actual cautery was usually applied to the part of the bone, which was uncovered; and as, under such treatment, a portion of the bone was of course killed, and then exfoliated, the prejudiced practitioner believed, that he had only accelerated a process, which must of necessity have followed in a more slow and tedious manner.

According to Mr. Hunter, neither caustics nor the actual cautery hasten exfoliation; they only produce death in a part of the bone, which is the first step towards exfoliation; and if they ever hasten exfoliation, when the bone is already dead it must be by producing inflammation in the adjacent living bone; a change that makes it exert a power of which it was previously incapable.

Exfoliation is not a necessary consequence of a bone being laid bare, and deprived of its periosteum. If the bone be in other respects uninjured, healthy, and enjoy a vigorous circulation of blood through its texture, granulations will be generated on the surface of such bone, and they will cover and firmly adhere to it, without the smallest exfoliation being thrown off; especially in young subjects. But, if caustic, stimulating, or drying applications be made use of, or the bone be left for a considerable time exposed, the circulation in the superficial portion of it will necessarily be disturbed and destroyed, and that part of the surface, through which the circulation ceases to be carried on, will be separated, and cast off, by the process of exfoliation.

If any application to an exfoliating portion of bone be at all efficacious, it must be one which will stop the mortification in the affected bone, and promote the absorption of those particles of phosphate of lime, which form the connection between that which is living and that which is actually dead. And as the bone dies from the same causes as the soft parts mortify, we should at least follow in practice the same principles which we adopt in the latter instance; and though, from the inferior vascularity and vital power of bones, we cannot expect surgery to have as much control over their affections, as over those of the soft parts, yet, every good will thus be obtained, which it is possible to acquire. Attention to such principles will at least teach us to refrain from making the death of part of a bone more extensive than it would be, if the cautery, caustics, and strong astringents were not employed.

The best mode of attempting to prevent an exfoliation from occurring at all in a bone, that has been exposed by a wound, is, to cover the part again, as soon as possible, with the flesh, which has been detached from it. This, as I shall hereafter notice, (see HEAD, INJURIES OF,) may generally be practised with advantage, when the scalp has been detached from the cranium, provided the flap still retain even the most limited connection with the rest of the integuments.

When the exposed bone cannot be covered, it should be dressed with the mildest and simplest applications, with plain lint, or lint spread with the unguentum cetacei.

The dead pieces of bone, when very tedious in exfoliating, when wedged in the substance of the surrounding living bone, and when so situated as to admit of being safely sawn, or cut away, may sometimes be advantageously removed in this manner. (See CARIES and NECROSIS.) In such operations, bone nippers, elevators, or Hey's saws may be employed with great convenience; and where these are not applicable, the saw invented by Machell, and described in Sir A. Cooper's *Surgical Essays*, or another devised by Graefe, and explained by Schwalb (*De Serra Orbiculari*, 4to. Berol. 1819), deserve to be recollected.

Tenon published three Memoirs on Exfoliation. The two first are inserted at pages 372 and 403 Mem. de l'Acad. des Sciences, 1758; the third at p. 223 of the same work, for 1760. *P. Poissonier*, An recenti vulnere nudatis ossibus exfoliatis? conclusio negans, 4to. Parisii, 1760. Journ. de Méd. par *Le Roux*, t. xxxi. p. 801; t. xxxii. p. 181; t. xxxiii. p. 168; t. xxxvi. p. 537; t. xxxviii. p. 153; t. xxxix. p. 132. *Theden*, Neue Bemerkungen, &c. kap. 3, 8vo. Berlin, 1782. Trans. for the Improvement of Med. and Chir. Knowledge, vol. ii. p. 277, &c. *Wiedmann*, "De Necrosi Ossium," Dict. des Sciences Méd. art. Exfoliation. *J. Thomson's* Lectures on Inflammation, p. 394, 398. *P. Boulay*, sur l'Exfoliation des Os, 4to. Paris, 1814. *J. Wilson*, on the Structure and Physiology of the Skeleton, and on the Diseases of the Bones, &c. p. 230, &c. 8vo. Lond. 1820. *R. Liston's* Essay on Caries, &c. in Edin. Med. Surg. Journ. 78.

EXOMPHALOS (from ἐξ, out of, and ὀμφαλὸς, the navel). A hernia at or near the navel.

EXOPHTHALMIA (from ἐξ, out, and Οφθαλμος, the eye). In *exophthalmia*, *ophthalmoptosis*, *ptosis bulbi oculi*, the eyeball is of its natural size, and free from disease: it merely changes its situation, and partly or completely protrudes from the orbit. It is only confusing the subject to consider, as specimens of this disease, the cases in which the globe of the eye is affected with enlargement, and, on that account, projects from the orbit in a preternatual degree, as happens in hydrophthalmia, staphyloma, and cancerous disease. When the globe is pushed entirely out of the orbit, it generally lies upon the temple or cheek, and vision is totally destroyed. There are instances, however, in which a considerable degree of sight was recovered, notwithstanding the exophthalmia was complete, and had lasted several years. (*Hope, in Phil. Trans. for* 1744. *Richter's Bibl.* bd. 4, p. 343.)

There are three descriptions of causes which may occasion exophthalmia:

1. The first and least common is a violent concussion of the head. A man fell from a height of about fifteen or sixteen feet, and pitched upon his head. The right eye was forced out of its socket, and hung over the cheek. The patient was deprived of his senses immediately after the accident, and affected with coma. There was a contusion over the right parietal bone; but no fracture. The eye spontaneously resumed its natural position a short time after the accident, and, in the course of a month, with the assistance of low diet and repeated bleeding, the cure was completed. (*Mém. de l'Acad. de Chirurgie*, t. 1, p. 198, 4to.) It is alleged that the eye has been forced out of the orbit in a violent fit of sneezing. But such cases must be very uncommon, and imply a considerable relaxation of those parts which serve to retain the eye in its socket, or some other predisposing causes, to which attention should be paid in the treatment. (*Richter*, *Anfangsgr. der Wundarz.* bd. iii. p. 407, ed. 1795.)

2. A far more frequent cause of exophthalmia is a thrust in the eye with an instrument, which is narrow enough to pass between the orbit and the eyeball, so as to push the latter out of its place. A stick, a tobacco-pipe (*White's Cases in Surgery*, p. 131), a foil, &c. may cause the accident. Repeated experience proves, that, in such cases, though the optic nerve and muscles of the eye may be forcibly stretched, the interior parts of the organ seriously injured, and the dislocated eye generally deprived of the faculty of seeing, yet, when the organ is replaced as speedily as possible, it not only sometimes recovers its natural motion, but also its original power of vision. (See *Scultet. Appendix*, *obs.* 69. *Covillard*, *obs.* 27. *Borellus*, *centur.* 3 *obs.* 54. *Rhodius*, *centur.* 1 *obs.* 84. *White's Cases*, p. 131.) Previously to reducing the eye, we should examine the instrument which was pushed into the orbit; as, when it is brittle, a fragment of it may remain behind in the socket, and require to be extracted by means of the finger or a probe. When the weapon is pointed or hard, it sometimes pierces the bones of the orbit, and enters the brain, nose, or antrum. In the first case, which is often difficult to ascertain immediately, though after a time, it is generally rendered plain enough by the symptoms induced, the consequences are mostly fatal. In the two other cases, although the danger is not pressing, the surgeon should be very attentive, in the event of suppuration, to procure and maintain a ready outlet for the matter.

There is generally little difficulty in replacing the eye. Frequently it returns of itself into its natural situation, as soon as any trivial obstacles to its reduction are removed; and in other instances, it easily admits of being put into its proper place with the hand. The indication, says Richter, is always accomplished with more facility the sooner it is attempted. When the protrusion has existed several days, and the eye and other parts in the orbit are already inflamed, Richter recommends us to endeavour to diminish the inflammation by general antiphlogistic means, and external emollient applications, before we try to replace the eye, and the reduction of this organ is afterwards to be effected in a gradual manner. When the optic nerve, and one or more of the muscles of the eye are torn, no hope can be entertained that the eyesight and motion of the organ will ever be regained. But this degree of injury, as Richter observes, cannot always be immediately detected, because the optic nerve and muscles are concealed by the conjunctiva ; and, if the nature of the case were known, still it would be advisable to replace the eyeball.

When the instrument with which the eye has been pushed out of its socket is blunt and thick, like a finger, a stick, a foil, &c. the eyeball itself always sustains a violent contusion, which brings on vehement inflammation, and lessens or destroys all hope that, after the reduction, the eyesight will be restored. Sometimes an extravasation of blood in the orbit occurs, the iris is lacerated, the cornea burst, and a part of the humours of the eye discharged. Although, under such circumstances, it is scarcely to be expected that the eyesight can be recovered, yet, it is proper to reduce the eye, because, should the organ be destroyed by suppuration, or the loss of its humours, the deformity may be obviated by an artificial eye, which is not the case when the eye has been cut away. It is also to be considered, that the mischief often seems to be worse than it really is, and the eyesight is sometimes regained, contrary to all expectation.

After the reduction of the eye, the first care of the surgeon should be to prevent and diminish inflammation. In some cases, the inflammation is slight ; while, in others, especially when the eyeball has been severely struck, it is extremely violent. All the usual antiphlogistic means, both general and topical, are to be employed, and, of the latter, Richter says, astringents are the best, as the inflammation arises from the contusion and stretching which the parts have suffered. The possible consequences of inflammation, such as suppuration, opacity of the cornea, &c. are to be treated according to the rules laid down in other parts of this dictionary. (See CORNEA, OPACITY OF ; HYPOPIUM ; OPHTHALMIA.) In general, the sight is restored in proportion as the inflammation is diminished. Should this not happen, after the ophthalmia has been entirely removed, the surgeon must try what effect such remedies as stimulate the nerves will have upon the optic nerve.

3. The third cause of exophthalmia is a preternatural tumor in the orbit or neighbouring parts. The swelling, as it enlarges, gradually pushes the eyeball out of its socket. The tumors, which may be formed in the orbit, are of several kinds. The principal, however, are encysted swellings, which contain either fat, an aqueous fluid, a pappy substance, or a thick matter. Sometimes, the cellular tissue in the orbit is affected with induration and swelling, so as to force the eye partly or completely out of this cavity.

Adipose swellings occupy the interspace of the recti muscles, emerge between the globe and the orbitar circumference, and have an oblong figure. When the conjunctiva is freely divided, the fatty mass is easily drawn forwards with a hook, and dissected out. (*Travers, in Synopsis of Dis. of the Eye*, p. 225.)

An abscess in the orbit may cause a protrusion of the eyeball. (*Pellier.*) Exostoses may have the same effect. Sir Astley Cooper has related one case, which proved fatal, in consequence of the exostosis making its way to the brain through the orbital plate of the os frontis. (*Surgical Essays*, part i. p. 157.) Mr. Guthrie has seen two instances : in one, the disease attained the size of a large marble, and then became stationary ; in the other, it was much larger, and a portion of it had been ineffectually removed by means of a hot iron, which increased the inconvenience, without giving any relief. Hence, if an operation were deemed advisable, Mr. Guthrie would prefer the cautious use of a small chisel or saw. (*Operative Surgery of the Eye*, p. 154.) This author is at the same time aware of the case, in which M. Brossaut brought about the exfoliation of a considerable part of an exostosis of the os planum and internal angular process with caustic, so that the eye returned into its place, and the cure was completed. (*Mém. de l'Acad. de Chir.* t. v. p. 171, 4to.) In the records of surgery may be found examples, in which the displacement of the eye was produced by a tumor that grew out of the frontal sinus. (See *Langenbeck's Neue Bibl.* bd. ii. p. 247.) In some cases, in consequence of suppuration in the antrum, the lower part of the orbit is raised, and the eye forced out of its place. Fungous diseases of the antrum may occasion the same mischief. (See *Parisian Chir. Journal*, vol. i. p. 104, &c.)

Schmidt records two cases of exophthalmia, produced by an hydatid of the lachrymal gland. One had a fatal termination; but, in the other, a puncture gave vent to an ounce of clear fluid, and cured the protrusion of the eye ; but the eyesight was lost. (*Ueber die Krankheiten des Thränenorgans*, p. 54. Farther particulars of the latter case may be seen in Mr. Guthrie's work, p. 157.)

Not long ago, Langenbeck extracted from the frontal sinus of a girl, a large hydatid, which had forced the outer table considerably forwards, and depressed the orbital plate of the os frontis so far, that the eyeball was propelled as low as the extremity of the nose. After the front of the sinus had been perforated, and the hydatid removed, there was a cavity left two inches and a half in depth. (*Neue Bibl.* b. ii. p. 247, Hanover, 1819.) My friend Mr. Lawrence mentioned to me a remarkable case, which presented itself at the London Eye Infirmary : it was an exophthalmia, which arose from a collection of hydatids in the orbit, and was cured by making an incision, and afterwards promoting their discharge. In all these examples, the eyeball is displaced from the orbit gradually, and vision is at length impeded. Instances, however, are on record, where the sight was never lost, though the eye was protruded for years. (See *Richter's Chirurg. Bibliothek*, bd. iv. st. ii. p. 243. *White's Cases in Surgery*, p. 135.) In one instance, the sight was not at all lessened, and the iris retained its natural mobility. *Langenbeck, Neue Bibl.* bd. ii. p. 245.)

Experience proves, also, that after the reduction, the motion of the eye and power of seeing may be regained in cases where the eye has been gradually pushed out of the orbit, and been displaced a considerable time, even as long as several years, during all which period vision was lost. (*Acrell, Brocklesby, in Med. Obs. and Inquiries*, vol. iv. p. 371.) Langenbeck relates a case of exophthalmia from a steatoma in the orbit, where, though vision was entirely prevented during the displacement, the pupil was of its regular shape, and the iris capable of motion: after the extirpation of the tumor, the eyesight became so good, that the patient could discern the smallest objects. (*Neue Bibl.* bd. ii. p. 240.) In order to reduce the eye into its natural position, it is necessary to remove the cause by which its protrusion is occasioned. Suppuration and fungous tumors in the antrum must be treated according to directions laid down in the article ANTRUM. The induration and swelling of the cellular substance in the orbit may be sometimes dispersed by means of mercury. (*Louis, sur Plusieurs Maladies du Globe de l'Œil, in Mém. de l'Acad. Royale de Chirurgie*, t. xiii. éd. 12mo.) When such treatment fails, we are recommended to extirpate the eye. (*Richter, Anfangsgr. der Wundarzn*, bd. iii. p. 413.) Exostoses, situated in the anterior part of the orbit, may sometimes be removed. The continental surgeons generally advise us to expose the tumor by an incision, and to apply caustic or the actual cautery to it, in order to kill the protuberant part of the bone, and make it exfoliate. In this country, most practitioners would prefer the employment of cutting instruments for removing such exostoses. When, however, the tumor lies deeply in the orbit, if it cannot be got at, and it should resist the effect of mercurial and other medicines, we are directed to extirpate the eye. (*Richter*, op. et loco cit.) Abscesses in the orbit ought to be opened, and after this has been done, the eye generally returns into its proper position. (*Pellier.*) When encysted tumors in the orbit admit of being extirpated in the customary manner, the plan should be adopted; but, when this cannot be done, Richter's advice may be followed, which is to open them, press out the contained matter, and afterwards extract the cyst. Considerable difficulty, however, frequently attends every effort to remove the whole cyst, and unless this be done, a permanent cicatrisation cannot be expected. (See *Travers's Synopsis*, p. 225. See TUMORS, ENCYSTED.)

On account of the vicinity of the brain, and the communication between the parts within the orbit, and the dura mater, the extirpation of tumors from that cavity is not exempt from risk of fatal consequences, as two cases, published by Langenbeck, fully prove. (*Neue Bibl.* bd. ii. pp. 241—244.) I remember a young lady who was referred to Mr. Lawrence and myself, by Mr. Maul of Southampton, for advice respecting a tumor, occupying the inner and upper portion of the orbit, and attended with a degree of exophthalmia, constant exacerbation at the period of the menses, and occasionally double vision. (See DIPLOPIA.) We refrained from advising any immediate attempt at extirpation, the swelling being so firm and immovable, that the disease was suspected to be partly of a bony nature. However, on seeing this case, about a fortnight afterwards, I was surprised to find the tumor not more than half its former size, and all the firm and (what was conceived to be) bony induration below the superciliary ridge of the os frontis gone, as well as the exophthalmia, and derangement of vision. Some sharp bony irregularities, however, could now be most plainly felt, projecting in front of the diminished swelling.

A memorable case of exophthalmia is related by Mr. Travers: the globe of the eye appears to have been gradually forced upwards and outwards, and to have had its motions considerably impeded, in consequence of the orbit being partly occupied by two swellings, which were of the nature of aneurism by anastomosis. (See ANEURISM.) The swellings could not have been removed, without at the same time extirpating the eye. Mr. Travers was therefore induced to try whether applying a ligature to the carotid artery would have the effect of checking and curing the disease; an expectation which was warranted by analogous instances, in which the growth of swellings, and their dispersion, are brought about by lessening the quantity of blood determined to them. The experiment completely succeeded; the swellings in the vicinity of the eye subsided; the patient was freed from several grievous complaints, to which she had been previously subject; and, amongst other benefits, a cure of the exophthalmia was one result, which most interests us in the present place. The case is also highly important on other accounts, and, more particularly as confirming the fact, that the carotid artery may be tied, without any dangerous effects on the brain, and as proving, that, in cases of aneurism, the surgeon should not be afraid of proceeding to such an operation. (See *Med. Chir. Trans.* vol. ii. art. 1.) The judgment and decision with which Mr. Travers acted in this case, appear to me highly meritorious.

The carotid artery was also tied by Mr. Dalrymple, of Norwich, in a case very similar to the preceding, and with equal success. (See *Med. Chir. Trans.* vol. vii. p. 111, &c.)

Mr. Guthrie has seen an exophthalmia on each side, the result of an aneurism of each ophthalmic artery, and other disease in the orbits. (*Operative Surgery of the Eye*, p. 158.)

When the causes of exophthalmia have been removed, the eye must be put into its natural situation. If the organ has been long displaced, the surgeon often finds the fulfilment of this indication attended with difficulty. Indeed, he is frequently obliged to employ methodical bandages for the purpose of promoting the gradual return of the eye into the orbit. Yet, even in such cases, the eyesight is often regained: but, if this should not happen spontaneously, stimulants and tonics are to be applied.

[Mr. Poland, in a paper published in the *Ophthalmic Hospital Reports*, October 1857, gives the most recent systematic view of the causes of protrusion of the eyeball.

1. *Congenital.*—*a.* Real protrusion; *b.* Apparent from shortening of levator palpebræ and lids.

2. *In the eye itself.* — *a.* Inflammation of the globe, ophthalmitis; *b.* Phlebitic ophthalmitis; *c.* Hydrophthalmos; *d.* Tumors (1. Scrofulous; 2. Encephaloid; 3. Melanotic; 4. Osseous degeneration; 5. Hydatid).

3. *Within orbit.* — *a.* Inflammation of cellular tissue, idiopathic and traumatic; *b.* Suppuration and abscess; *d.* Erysipelatous and phlegmonous inflammation; *e.* Foreign bodies; *f.* Excess of development of fat; *g.* Tumors (1. Encysted; 2. Hydatid; 3. Encephaloid; 4. Osseous); *h.* Aneurism and effusions of blood; *i.* Venous congestion; *k.* Paralysis of muscles of eyeball—ophthalmoplegia; *l.* Spasm of muscles of eyeball, as in tetanus.

4. *External to orbit.*—*a.* Above: nodes, hydrocephalus, fungus of dura mata, polypi in frontal cells and diseases thereof, tumors of brain; *b.* Below: diseases of the antrum; *c.* Internal: nasal

polypi and tumors; *d.* External: exostosis; *e.* In front: contraction of lids and eye slipping through —hernia oculi.] (*C. Bader.*)

Fab. Hildan. centur. vi. obs. 1. Vander Wiel, centur. ii. obs. 9. Paw. Obs. Anat. 23. Tulpius, lib. i. cap. 28. *Hope*, in Phil. Trans. for 1744. *Louis*, sur plusieurs Maladies du Globe de l'Œil, &c. in Mém. de l'Acad. de Chirurgie, t. xiii. in 12mo. *Brocklesby*, in Medical Obs. and Inquiries, vol. iv. p. 371. *White's* Cases in Surgery, pp. 131—135, &c. *Warner's* Cases in Surgery, p. 108, édit. 3. *Lassus*, Pathologie Chir. t. ii. p. 144, édit. 2. *Richerand*, Nosogr. Chir. t. ii. p. 117, édit. 2. Méd. Chir. Trans. vol. ii. art. 1; vol. iv. p. 316; and vol. vi. p. 111, &c. *Richter's* Anfangsgr. der Wundarzn, b. iii. p. 406, &c. Gött. 1795. *Langenbeck* Neue Bibl. bd. ii. *B. Travers*, Synopsis of the Diseases of the Eye, p. 225, &c. Lond. 1820. Dr. *Monteath*, in *Weller's* Manual, vol. i. p. 195. *Petitbeau*, in Journ. de Méd. par Corvisart, t. xiv. *G. J. Guthrie*, Operative Surgery of the Eye, p. 145, &c. 8vo. Lond. 1823. [*A. Poland*, On Protrusion of the Eyeball, Ophthalmic Hospital Reports, October 1857. *Mackenzie*, On the Diseases of the Eye, fourth edition, 1854. *Desmarre's* Traité théorique et pratique des Maladies des Yeux, édit. 2, Paris 1855. Dr. *Stellwag von Carion*, die Ophthalmologie, &c. 1853.]

EXOSTOSIS (from *ἐξ*, out, and *ὀστέον*, a bone). An exostosis is a tumor formed by an exuberant growth of bony matter on the surface of a bone, or it is formed by the more or less considerable enlargement of a part, or the whole, of a bone. (*Boyer, Mal. Chir.* t. iii. p. 541.)

In general, however, it is only when the enlargement is partial that it is termed an exostosis. As Mr. Mayo has pointed out, some hypertrophies of bone are connected with a salutary principle; while others constitute curable, or incurable diseases. The arm of a blacksmith acquires, through daily exertion, additional muscular force, weight, and size; the bones in it enlarge; their crust becomes harder, and of a more compact grain; and the lines upon the surface, which give attachment to tendons, become rough and prominent ridges. This is health. When Mr. Cheshire's apparatus for supporting the spine is worn, the pressure on the lower jaw generally causes this bone to enlarge, and to throw out a bony swelling, where the chin strap is applied. This tumor is an exostosis, yet it evidently results from the salutary principle, which strengthens a part in proportion to the exertion imposed upon it. (See *Mayo's Outlines of Human Pathology*, p. 11.)

While the growth of the whole body is proceeding rapidly, abnormal swellings of parts of bones are common, especially of the clavicle, sternum, or ribs. These are exostoses, which require no treatment, as they generally subside of themselves in the course of a year or two. Exostoses are still more common at the period when the body has recently attained its full growth. But the disease is not limited to the early, nor to the middle periods of life. (*Ib.*)

One division of exostoses is into *true* and *false*; the former being of a truly osseous consistence, the others being more or less hollow, spongy expansions of the bones, sometimes containing a quantity of cartilaginous, fibrous, medullary, or fungous matter within the shell of the disease. Periostoses, or mere thickenings of the periosteum, are also sometimes classed amongst *false* exostoses. (*Dict. des Sciences Méd.* t. xiv. p. 218.) According to Sir Astley Cooper, exostoses have two different seats: by *periosteal* exostoses he means an osseous deposition seated between the external surface of the bone, and the internal surface of the periosteum, and firmly adherent to both; by *medullary* exostoses, he signifies a similar formation, originating in the medullary membrane and cancellated structure of a bone. The same experienced surgeon makes two other general divisions of exostoses into the *cartilaginous* and *fungous*, the first being "preceded by the formation of cartilage, which forms the nidus for the ossific deposit," while the second is a tumor softer than cartilage, yet firmer than fungus, in other parts of the body, containing spicula of bone, being of a malignant nature, and depending "upon a peculiar state of constitution and action of vessels." It is a disease similar to "fungus hæmatodes, but somewhat modified by the structure of the part in which it originates." (*Surgical Essays,* part i. p. 155.)

If a true exostosis be immersed in diluted muriatic acid, so as to separate the earthy part of it, the tumor will yet retain its form, and present the same kind of fibro-cartilaginous matrix which exists in healthy bone. (*Ib.*)

[Rokitansky arranges the non-malignant outgrowths of bone under two heads—1. Exostoses, which he subdivides into the compact (*osteosclerosis*) and the porous (*osteoporosis*); the former consists of the hard ivory exostoses, the latter comprises the remainder of the simple bony outgrowths, whatever their form or the arrangement of the osseous or cartilaginous tissue composing them may be; that is to say, whether their cancellated interior be more or less open, whether they possess a medullary canal or not, whether they originated as bony or cartilaginous growths, and whether the cartilage, when present, was central or cortical in position. 2. Osteophytes. Under this term he ranges all those numerous deposits or bone resulting from simple or specific inflammatory action. These he designates according to the various appearances they assume—the villous osteophyte, the laminated, the warty or stalactitic, the thorny or styloid, and one which resembles drops or small streams of osseous matter. He excludes from this classification the bony bases, internal skeletons, or capsules of the several morbid growths occasionally invading the osseous tissue, such as are found in enchondroma, osteosarcoma, cancer, &c.

M. Nélaton divides all non-malignant exostoses into the osseous and the osteo-cartilaginous. Under the first head he includes ivory exostoses, as well as all purely bony growths. Under the second he ranges all exostoses in which cartilage is found blended with bony tissue. Of these he makes two varieties, one in which the cartilage forms a cortex to the osseous growth; a second, in which the cartilage will be found in the centre of the bony mass. The general enlargement of the whole shaft of a cylindrical bone, or the general thickening of the cranial bones, he describes under name of hyperostosis or hypertrophy. The malignant growths of bone he separates entirely from exostoses, and describes under their appropriate forms of cancerous disease.

Osseous and osteo-cartilaginous exostoses are found to possess the same chemical constituents and in the same proportions as in normal bone or cartilage. Their microscopical appearances are also identical. The ivory exostoses, however, form an exception in some degree to these remarks. Nélaton gives from Berzelius the following comparative analysis of sound bone and of ivory exostoses :—

	Bony exostoses or sound bone.	Ivory exostoses.
Animal matter	33·30	28·57
Phosphate of lime, of magnesia, &c.	54·20	68·88
Carbonate of lime, alkaline, chlorides, &c.	12·50	2·00
Loss	00·00	00·55
	100·00	100·00

(*Nélaton*, *Elémens de Pathologie Chirurgicale*, tom. ii. p. 3.)

The microscopical characters also in the ivory exostoses are less distinct and more irregular than in ordinary bone. According to Rokitansky, " the Haversian canals are small and far apart, and many of them are surrounded by a distinct and completely defined (völligabge-schlossenen) lamellar system. With regard to the corpuscles, we find large tracts without any of them, while at other spots they are clustered together in dense groups."—(*Manual of Pathological Anatomy, by Rokitansky, translated for the Sydenham Society by C. H. Moore*, vol. ii. p. 127.)

In describing a particular specimen of ivory exostosis, Mr. Paget says (*Lectures on Surgical Pathology*, vol. ii. p. 236), " in the hardest parts there are neither Haversian canals nor lacunæ ; in the less hard parts the canals are very large, and the lacunæ are not arranged in circles around them, and everywhere the lacunæ are of irregular and distorted forms."]

Exostoses differ in *size.* Those of the cranium are generally small and circumscribed, yet exceptions occur ; for Sir Everard Home removed a very large tumor, which had a bony base, and was situated on the head. (*Sir A. Cooper*, *Surgical Essays*, part. i. p. 156.) The largest *true* exostoses are formed upon the long bones. In the history of surgery may be found numerous cases of enormous exostoses ; but nearly all of them of the species termed *false*, and many of them were situated on the jaw, the clavicle, or the extremities of the long bones. Observations of this kind are abundant in l'Histoire de l'Acad. des Sciences ; les Mém. de l'Acad. de Chir. ; the Sepulchretum Anatomicum; the writings of Morgagni, &c. (*Dict. des Sciences Méd.* t. xiv. p. 219.)

The bones most frequently affected with exostosis are those of the cranium, the lower jaw, sternum, humerus, radius, ulna, bones of the carpus, and particularly the femur and tibia. There is, however, no bone of the body which may not become the seat of this disease. It is not uncommon to find all the bones of the cranium affected with exostosis, or, rather, hypertrophia, and the ossa parietalia sometimes an inch thick.

The exostosis which forms between the outer table of the skull and the pericranium, is of extremely hard consistence, and generally attended with little pain, while the *fungous* exostosis, springing from the diploe of the skull, is less firm, more vascular, and of a malignant nature, making its way through the inner table, and occasioning disease of the dura mater, and fatal effects on the brain. (See Dura Mater.)

Sometimes an exostosis is confined to a small part of the affected bone, composing a mass superadded to its surface, and of various shapes. Sometimes it rises insensibly, having no very distinct limits, and resembling a more or less regular portion of a sphere. In some instances its figure is styloid, and it projects in a greater or less degree. On other occasions its base is rendered distinct by a pedicle, or contraction, which varies in breadth and length in different cases. In particular instances, evidently resulting from inflammatory action, the exostosis, or rather osseous enlargement, though limited to the surface of a bone, occupies the whole extent of it. Thus the external surface of one of the bones of the skull has been found occupied by an exostosis, while the inner table was in the natural state. The whole circumference of the femur sometimes acquires an enormous size, at the same time that the medullary surface continues entirely unchanged. These are the *periosteal* exostoses of Sir Astley Cooper. In other examples, on the contrary, the two surfaces and the whole thickness of the bone are deformed by an augmentation of bulk; and when this happens in a cylindrical bone, the medullary cavity is more or less reduced, or even totally obliterated. In a few extremely uncommon cases, the substance of a bone acquires great solidity (osteo-sclerosis), and a hardness compared to that of ivory, without any material increase of bulk. An exostosis sometimes, though rarely, occupies the whole extent and thickness of a bone; but when this happens in a cylindrical bone, the articular surfaces generally remain in their natural state.

Common situations of exostoses are the upper part of the humerus and tibia, and the lower part of the femur, especially near the insertion of the tendon of the adductor magnus. (*Sir A. Cooper.*) In the long bones exostoses are generally narrow, and of greater height than thickness ; sometimes largest at their base, sometimes the reverse. In the flat bones they are usually broad, but they form flat discs, connected to such bones by means of short narrow pedicles. In the round bones they are rounded and nodular. To these laws, as Mr. Mayo observes, there are many exceptions. (*Outlines of Human Pathology*, p. 12.)

The *structure* and *consistence* of exostoses present great differences. Sometimes, especially when the tumor is not very large, and situated on the surface of a cylindrical bone, one may trace with the eye the diverging of the osseous fibres, in the interspaces of which we might say that there is deposited a new bony substance, the organisation of which is less distinct. Sometimes the tumor is entirely cellular, and formed of a few broad laminæ, intercepting extensive spaces, which are filled with matter different from the medulla, and of various quality. This case is denominated the *laminated exostosis*. Sometimes the enlarged portion of bone makes a sort of hollow sphere, with thick hard walls, and the cavity is filled with a firm indolent fibrous substance. One form of exostosis Sir Astley Cooper has named the *cartilaginous exostosis of the medullary membrane*. " In this case, the shell of the bone becomes extremely expanded, or rather the original shell is absorbed, and a new one deposited ; and within this ossified cavity thus produced, a very large mass of cartilage is formed, elastic, firm, and fibrous." It is not malignant, but often ends in a very extensive disease. (*Surgical Essays*, part i. p. 173.)

In other instances the tumor is perfectly solid, exceeding in consistence that of the hardest bones, and equalling that of ivory. The ivory exostosis is thought by Mr. Mayo to be occasionally malignant; and he mentions that Mr. Stanley has a preparation of one, which is combined with medullary sarcoma. (*Human Pathology*, p. 14.) I suspect that this must have been an accidental concurrence with the more solid exostosis. Here the surface is sometimes smooth, and like that of the bone in its natural state; sometimes irregular, full of little projections, and in some degree stalactical. It is uncommon to find a large portion of an exostosis converted into a pultaceous substance; but it is not at all unfrequent to see this substance composing part of the tumor. Lastly, it often happens that the same exostosis presents an assemblage of the ivory substance, and of the cellular laminated substance, the cavities of which are partly filled with a pultaceous matter, and partly with a sort of gelatinous substance.

An extraordinary instance of what is sometimes called *spiculated* exostosis, is related. Laminæ, or ramifications of bone, are represented as projecting from the various bones, and causing ankylosis of every joint, with the exception of the wrists and knees. One branch is seen to extend from the coccyx to the femur. Another case is also reported by Freke, where the exostoses are compared to the branching of coral, the bony formations projecting from the cervical and other vertebræ, and joining others from the ribs, so as to make a kind of bodice on the back. (See *Phil. Trans.* vol. 41; and *Wickham*, *On Diseases of Joints*, p. 8.)

When an exostosis is not very large, it hardly affects the surrounding soft parts; but when it has made considerable progress, the muscles become stretched and emaciated, the cellular tissue is thickened, and, its layers being adherent together, a kind of confusion is produced amongst all the adjacent parts. Exostoses not of considerable size may, however, seriously interrupt the functions of certain organs. The action of the flexor muscles of the leg has been known to be obstructed by an exostosis in the vicinity of the knee. An osseous tumor, arising near the symphysis pubis, need not be very large to impede considerably the functions of the urethra, as experience has proved. An exostosis in the orbit has been known to displace the eye and destroy vision. Lastly, exostoses, when situated near certain important organs, and of large size, may affect with different degrees of gravity the functions of these parts, as the brain, the lungs, &c. (See *Boyer*, *Mal. Chir.* t. iii. p. 541—544.)

Sir Astley Cooper has related a case, in which the eyes were pushed out of their sockets by two exostoses, which grew from the antra, and one of which destroyed the patient by making its way to the brain through the orbitar process of the os frontis. (*Surgical Essays*, part i. p. 157.) In one instance, reported by the same author, an exostosis from the sixth or seventh cervical vertebra abolished the pulse at the wrist, by pressing upon the subclavian artery (p. 159). In another, a *cartilaginous* exostosis of the medullary membrane of the lower jaw extended so far back that it pressed the epiglottis down upon the rima glottidis, and caused such difficulty of respiration, and so much irritation, that the patient was destroyed (p. 175).

[Mr. Paget refers to an enormous specimen of exostosis in the Museum of the College of Surgeons. It formed an irregular oval mass surrounding the upper two-thirds of the tibia. It was composed of cancellous structure, surrounded by a thin layer of compact tissue. It measured exactly a yard in circumference, and the limb, after amputation, weighed forty-two pounds. He also refers to a very extensive and fine specimen of ivory exostosis in the Museum of the University of Cambridge, of which he gives a wood-cut (p. 236, op. cit.) The disease appears to occupy the os-frontis, all the bones of the face, and to encroach considerably on the interior of the skull. (*Lectures on Surgical Pathology*, vol. ii. p. 233.)]

Some particulars of an exostosis are recorded which projected from the posterior surface of the symphysis pubis into the bladder. The case, while the patient lived, might have been mistaken for an adherent calculus. (See *J. Cloquet*, *Pathol. Chir.* p. 130, 4to. Paris, 1831.) Dupuytren had a case in which an exostosis of the femur obliterated the femoral artery. (See *Clin. Chir.*) A patient had an exostosis of the first rib, which threw forward the subclavian artery, so as to give the appearance of a subclavian aneurism. (See *Mayo's Outlines of Human Pathology*, p. 12.) I find a case referred to, in which an exostosis of the anterior surface of the sacrum pushed the rectum so far forwards as to render the introduction of a small bougie into that bowel very difficult. (*B. Bell*, *On Diseases of Bones*, p. 115, 12mo. Edinb. 1828.) Frequently exostoses interrupt the free movement of a joint; thus, Mr. H. Lyford removed one which was of the size and shape of the little finger, and situated just on the inside of the capsular ligament of the shoulder joint, on the front and inner part of the humerus. The direction of the point was upward and inward toward the clavicle and sternum, and the motion of the humerus inwards was interfered with. (See *W. J. Wickham*, *On Diseases of the Joints*, p. 7.)

Venereal exostoses, or nodes, are observed to arise chiefly on compact bones, and such of these as are superficially covered with soft parts, as, for instance, the bones of the cranium, and the front surface of the tibia, the sternum, the anterior part of the clavicle, the outer surface of the radius just above the wrist, the back part of the ulna just below the elbow.

The causes of exostoses are obscure. They may be induced, however, by a blow, or by pressure. Most writers impute the disease to internal causes, such as scrofula and lues venerea. That the latter affection is the cause of nodes, which are certainly a species of exostosis, no one will deny: but that scrofula is concerned in producing exostoses is more doubtful. Sometimes I have suspected that some of those bony swellings, which are so common in children during the rapid growth of the body, are connected with a scrofulous constitution. At all events, I have noticed them with great frequency in children of this description, though it might only be an accidental coincidence.

The readiness with which bony tumors form in some persons, renders it probable that constitutional causes have great influence. Thus, such a blow as, in the generality of persons, would hardly excite notice, will in others bring on swellings of the bone which is struck. Sir Astley Cooper adverts to a young friend of his, in whom an exostosis, which was undoubtedly caused by a blow, is growing on the metacarpal bone of the little finger. (*Loc. cit.*) Mr. Abernethy used to mention in his Lectures, the case of a boy, from Cornwall, who was so excessively afflicted with an apparent predisposition to exostoses, or an exuberant deposition of bony matter, that a very trifling blow would occasion a bony swelling on any bone of his body. His ligamentum nuchæ was ossified, and prevented the motion of his neck; the margins of his axillæ were also ossified, so that he was, as it were, completely pinioned. Besides all this, the subject in question had numerous other exostoses on various parts of his body. Mr. Abernethy gave, in this case, muriatic and acetic acids, with the view of dissolving the lime, which it was conceived might be too abundant in the system; but, even if this theory had been correct, and the acids capable of the chemical action intended, after passing into the circulation, how could they be expected to dissolve only the redundant depositions of phosphate of lime, and at the same time leave the skeleton itself undissolved?

When an exostosis depends upon lues venerea, it is almost always preceded by an acute pain, which in the beginning extends to nearly the whole of the affected bone, but afterwards becomes fixed to the point where the exostosis forms, and it is most severe in the night-time. When an exostosis is caused by scrofula, says Boyer, the pain is duller, or rather it is quite inconsiderable. It is the same with the exostosis which succeeds a blow, or contusion, without any manifest general cause. In the latter example, the pain, immediately excited by the accident, subsides in a few days, and the swelling occurs so slowly, that no notice is taken of it till it has attained some magnitude. (*Mal. Chir.* t. iii. p. 545.)

The disposition to the formation of ossific tumors may prevail throughout the system, and display itself in other textures besides the bones. Thus, Mr. Mayo refers to a specimen of ossification of the lungs, taken from a patient, who died of pulmonary disease after amputation of the leg for ivory exostosis. (See *Outlines of Human Pathology*, p. 14.) The alliance between the ossification of ligament, muscle, tendon, and exostoses, is well illustrated in Jeff's skeleton in the Hunterian Museum. In this remarkable instance, some of the ossifications form exostoses, while others pass from one part of the skeleton to another. The first prevail especially in places where muscles are inserted. The second have generally followed the course of the larger muscles, and may be seen on the right side, joining the clavicle and acromion to the humerus, in the situation of the supra spinatus, and passing from the lower angle of the scapula to the humerus in the course of the teres major and latissimus dorsi. On the back more extensive ossifications appear, which affix the scapulæ to the sacrum and ilium, and to the spines of the lumbar and dorsal vertebræ. From the pelvis, ossifications extend in the direction of the glutæus maximus, biceps, and triceps. Ossifications of the tendinous and ligamentous parts are still more common, producing ankylosis of the vertebræ, left elbow, tibia and fibula, and of the bones of the tarsus to one another. (See *Museum Catalogue of the College of Surgeons.*)

Hydatids are occasionally found within exostoses, in which circumstance the former are supposed to be the cause of the enlargement of the bone. A remarkable specimen of such a disease in the tibia is mentioned by Sir Astley Cooper. (*Surgical Essays*, part i. p. 163.) He refers also to a humerus, in the museum of St. Thomas's Hospital, where the shell of the bone is considerably expanded, the periosteum over it thickened, and in the seat of the cancellated structure are several hydatids, supposed to have been the cause of the enlargement of the exterior surface of the bone, as well as of the increase of its cavity. (Vol. cit. p. 161.)

A most interesting case of a bony tumor on the forehead, containing hydatids, was published by Mr. R. Keate. (*Med. Chir. Trans.* vol. x. p. 278.)

An exostosis constantly feels hard; but its size is various, and it may be indolent or painful. By these signs, and its firm adhesion to the bones, it may be always distinguished from other tumors. Some exostoses cannot be ascertained before death. Such was the case in which the parietal bone was found, after death, to be three times thicker than natural. Such also was the example, related in the memoirs of the Academy at Dijon, in which a person died from an exostosis on the internal side of the os pubis, the tumor having prevented the discharge of the urine, and the introduction of a catheter, by its pressure on the neck of the bladder.

Exostoses may be either *acute*, or *chronic*, in their progress. In the first case, which, according to Boyer, happens most commonly in the *cellular* or malignant exostosis, the appearance and formation of the tumor are quick; the swelling rapidly acquires a considerable size; and it is always preceded by, and accompanied with, continual violent pain, which the external and internal use of opium has little effect upon, and the intensity of which is not increased by pressure. The pain is sometimes so severe that it occasions a good deal of symptomatic fever. Boyer, who seems not to be aware of the origin of what he terms the *cellular*, and what Sir Astley Cooper has named *fungous exostosis*, from the medullary membrane, finds difficulty in accounting for the rapid growth and great sensibility of the tumor, considering the natural density of the bones, and the little energy of their vital properties.

In the hardest kinds of exostosis the tumor is preceded by no pain, or, if any, it is very slight; the tumor grows slowly; and although it sometimes attains a considerable size, its increase is attended with no particular sensibility, and no disturbance of the animal economy. (*Boyer*, op. cit. t. iii. p. 546.)

Our ignorance of the pathology of exostoses, particularly their causes, accounts for the imperfection of our treatment of them. With the exception of the venereal exostosis or node, there is no species of this affection for which it can be said that we have any medicine of efficacy.

Boyer advances it as a principle that the resolution of exostoses hardly ever happens, and that the greater part of the examples recorded in proof of the occurrence were nothing more than periostoses (p. 547).

However, a young woman was in the Middlesex Hospital with an exostosis of the humerus. It was sawn off, but grew again. A rubefacient plaster was applied, an abscess followed, and the new bone was absorbed. (See *Mayo's Human Pathology*, p. 13.) When abscesses form, exostoses are very subject to be attacked with caries, or necrosis.

When an exostosis is hard, chronic, and free from pain and alteration of the structure of the bone, it is more common for it to cease to enlarge and remain stationary during life, without producing inconvenience, provided it be so situated as not to impede the functions of any vital organ.

But, in the *cellular* exostosis of Boyer, which I take to be the same disease as the *fungous* exostosis of the medullary membrane of Sir Astley Cooper, and which is of a malignant character, the acute and rapid progress of the disease indicates a deeper and more serious alteration of the texture of the bone. A part of the tumor usually consists of a pultaceous, or gelatinous matter, and the rest, still endued with its natural organisation, though altered by the disease, soon presents one or several cavities, in which there is suppuration. At the same time, the external soft parts, being excessively and rapidly distended, inflame, ulcerate, and leave exposed a more or less extensive portion of the tumor, the disease of which has in many cases been very wrongly supposed to be caries. It is not, observes Boyer, that the part of the swelling denuded by ulceration is not sometimes affected with caries; but then it exists as a complication of the original disease, and as a particularity, by no means the result of the ulceration of the soft parts, and of the exposure of the diseased bone to the contact of the air. When the soft parts are thus ulcerated, the opening contracts to a certain point, and becomes fistulous. The suppuration is always of bad quality, and in a quantity proportioned to the size of the cavity of the abscess and the strength of the patient. The fever, which commences at an early period of the disorder, assumes a slow type, and its continuance, together with the copiousness of the ichorous discharge, the irritation, &c. may bring on the patient's dissolution.

The following are the symptoms of what Sir Astley Cooper denominates the *fungous exostosis of the medullary membrane.* The disease begins with a general enlargement of the affected part of the limb, extending a considerable way around the seat of the exostosis itself. This form of the complaint mostly occurs in young persons, though Sir Astley Cooper has seen it in an individual fifty years old. "Its increase proceeds very gradually; and even when it has acquired considerable magnitude, although it produces some diminution of motion in the limb, it does not occasion pain, nor prevent the patient from using it. When any pain does arise, it is of an obtuse kind, only being acute in the event of a nerve being stretched by the tumor. Thus an exostosis of the thigh-bone sometimes causes great agony, by pressing on the sciatic nerve. Paleness, debility, and irregularity of the bowels are observed to attend the early stage of the disease; and afterwards the complexion becomes sallow. In the mean time, the diseased part of the limb attains an enormous size; but the skin retains its natural colour. At many points the swelling feels hard; at others, it is so elastic as to cause the presence of fluid to be suspected; but, if an opening be made, only blood is discharged. The surface of the tumor next becomes tuberculated, and the prominences tender, and their surface is often slightly inflamed. The rest is now broken, the appetite impaired, and the bowels become extremely irregular. At length the tubercles ulcerate; the skin secretes pus; but, when the swelling itself is exposed, it discharges a bloody-coloured serum. A fungus then forms, which sometimes bleeds profusely, and, after it has risen very high, sloughing occurs, and considerable portions of the swelling are thrown off. But, although the swelling may be lessened by this process, Sir A. Cooper has never known the disease cured by it; and, in the end, the patient is destroyed by the effects of the repeated bleeding, immense discharge, and constitutional irritation." In this disease, as in common fungus hæmatodes, tumors of a similar nature are often formed in other parts of the body, and, after the amputation of the affected bone, frequently make their appearance in organs of the greatest importance to life. The swelling is described as originating from the medullary membrane, and as removing the muscles to the distance of three inches, or more, from the bone, so that they represent a thin layer spread over the tumor. The blood-vessels and large nerves are also similarly displaced. The tuberculated appearance of the skin, which is itself sound, is caused by projecting small masses on the surface of the tumor. Under the muscles is the periosteum, pushed to a considerable distance from the bone. A part of the swelling itself is yellow, like fat; another portion resembles brain; and a third is composed of coagulated blood with interstices filled with serum. In some parts, the white substance is found nearly as firm as cartilage; but in general it presents a more spongy appearance, and is interspersed with spicula of bone. The shell of the bone itself is in part absorbed; in some places it is only thinner than usual; while in others it is immensely expanded, so as to form a case like wire-work over the tumor. The fungous granulations, proceeding from the medullary membrane itself, are exceedingly vascular, and often shoot from the cavity of the bone beyond the level of the integuments. *Sir A. Cooper, Surgical Essays,* part i. p. 165—168.)

One termination of exostosis, not sufficiently noticed by writers, but which has been observed, especially in the hard and stalactical exostosis, is that by necrosis. Tumors of this description, after acquiring a large size, have been attacked by necrosis, separated from the bone which served them as a base, and been surrounded with a reproduction in every respect similar to that with which nature surrounds sequestra formed under any other circumstances. This termination is undoubtedly the most favourable of all, because nature proceeds in it slowly, without any violent disturbance; but, unfortunately, it is the least common. Art can imitate it; but her means are very inferior to those of nature. (*Boyer, Mal. Chir.* t. iii. p. 547—550.) A few years ago a most interesting case of an enormous exostosis of the upper maxillary bone, which followed the preceding course, was under my notice. It was believed at first to be a malignant tumor of the antrum; but the bony formation, after exciting abscesses, was attacked with necrosis, and was ultimately thrown off by exfoliation.

The hardest exostosis, which has grown slowly and without causing severe pain, is the least dangerous of all. After the disease has attained a certain size, it may become stationary, and continue in this state, without inconvenience, during life. This is most frequently observed in the *ivory* exostosis; and I join Boyer, and others, in not considering this case as at all disposed to malignancy. Without having precisely this extreme hardness, however, some exostoses, which are tolerably solid, and in which the natural organisation of bone is still distinguishable, are capable of undergoing a slight reduction, after the removal of their cause by nature or art. Boyer states that this sometimes happens in a few scrofulous exostoses, and particularly in such as are venereal, and not of large size.

The *cellular* exostosis of Boyer, the *fungous* exostosis of Sir A. Cooper, and the cases which are named *osteosarcomata*, are the most serious of all, especially when the texture of the bone is considerably altered, and the disease is in a state of ulceration. The rapid formation of the disease, the violent shock which it imparts to the constitution, and the hectical disturbance which it excites, generally bring the patient into imminent danger, and commonly leave no other resource but that of amputating the limb.

The treatment of exostoses is to be considered in a medical and surgical point of view. When any general cause of the disease is known, or suspected, such cause is to be removed by those means which experience has proved to be most efficacious. Thus Boyer recommends mercurial and antiscrofulous remedies, &c. according to the nature of the case. At the present day, iodine, and the iodide of potassium are frequently prescribed.

Whatever may be the species of exostosis, or the nature of its cause, relief, says Boyer, may be derived from the outward use of opium, whenever the disease is attended with severe pain. He speaks favourably of the application of a linseed-meal poultice, mixed with a decoction of the leaves of nightshade and henbane, to which a strong solution of opium has been added. But he thinks that an antiphlogistic plan, with bleeding, is hardly ever admissible, because it weakens the patient too much in so tedious a disease, and can only be a palliative, incapable of curing, or preventing, the ravages of the disorder.

When there is no pain, or it has been appeased, during or after any general method of treatment, the surgeon may try resolvent applications, particularly soap, and mercurial plasters, the tincture or ointment of iodine, the liniment of ammonia, bathing in water containing a small quantity of soda, or potassa, hydro-sulphuretted washes, &c. It must be confessed, however, that the progress of exostoses can scarcely ever be checked by any general methodical treatment. The muriatic and acetic acids have been administered, but without effect; nor am I acquainted with any remedies which possess efficacy, except iodine and mercury, which last we know will rarely answer, except in cases of nodes. In the commencement of any deep-seated disease in a bone, Sir A. Cooper thinks that the best medicine for internal exhibition is bichloride of mercury in small doses, together with the compound decoction of sarsaparilla. (*Surgical Essays*, part i. p. 169.) Boyer is firmly of opinion that, with the exception of recent small exostoses, the nature of which is even doubtful, the resolution of such tumours is almost impossible. A slight diminution of the swelling, and its becoming perfectly indolent, are the most favourable changes which can be hoped for, whether they occur spontaneously, or are the fruit of surgical assistance. (*Mal. Chir.* t. iii. p. 554—557.)

Blisters have often been applied to the skin over exostoses, and kept open for a long period with savine ointment; but, although they tend to diminish venereal nodes, after they have been lessened as much as they can be by specific treatment, their efficacy in cases of exostoses has not been considerable. However, a trial of them in some examples is rational; and Sir Astley Cooper approves both of leeches and blisters, a discharge from the latter being kept up with equal parts of the mercurial and savine ointments. (*Surgical Essays*, part i. p. 169.)

When non-malignant exostoses merely occasion a deformity, and no pain, nor inconvenience, from the pressure which they produce on the neighbouring parts, it is certainly most advisable not to undertake any operation for their removal; for, as Boyer has truly observed, in by far the greater number of instances the local affection is much less to be dreaded than the means used for removing it.

Caustics and the cautery have occasionally been applied to exostoses; but they mostly do mischief. Boyer mentions a woman, in whom some caustic was applied to an exostosis at the inside of the tibia; but which, instead of removing the tumor, caused a necrosis, of which she was not well two years afterwards. In a few instances, however, after the removal of cartilaginous exostoses, of the interior of a bone with cutting instruments, the application of the cautery has prevented a reproduction of the diseased mass, as we find exemplified in a case recorded by Sir Astley Cooper, where such a disease of the jaw was thus extirpated. (*Surgical Essays*, part i. p. 158.) The bold and successful manner, also, in which the hydatid exostosis of the head was attacked with the saw, caustics, and the actual cautery, by Mr. R. Keate, is particularly entitled to the attention of the surgical practitioner. (*Med. Chir. Trans.* vol. x. p. 288, &c.) I have already noticed the occasional cure of true exostoses, not malignant ones, by an accidental attack of necrosis. Mr. Travers, aware of this important fact, has suggested the practice of removing the periosteum in some cases, for the purpose of producing the death and exfoliation of the swelling, or a part of it, when circumstances render some attempt to get rid of it urgently necessary.

So far as my information extends, no attempts to stop the progress, and effect the cure of a fungous or malignant exostosis, by tying the main artery of the limb, has ever yet succeeded. Two cases, proving the inefficiency of this practice, are detailed by Sir A. Cooper. (Vol. cit. p. 170.)

As the *fungous exostosis of the medullary membrane* is evidently connected with a state of the constitution analogous to what prevails in fungus hæmatodes (see *this word*), the permanent success of amputation should never be too boldly promised; but as no medicines have any material power over the disease, and the operation is the only chance of relief, it ought to be advised.

Cartilaginous exostoses of the medullary membrane may sometimes be extirpated by removing their outer bony covering, and then cutting away the cartilaginous matter closely from the bony surface to which it is attached. Sometimes, as I have noticed, these measures are followed by the use of the actual cautery.

Periosteal exostoses are also either *cartilaginous*, or *fungous*, which latter are attended with less general swelling of the limb, and are more prominent than fungous exostoses of the medullary membrane. Ulceration, bleeding, sloughing, and great discharge ensue, and, unless some operation be performed, the patient loses his life. (*Sir A. Cooper, Surgical Essays*, part i. p. 180).

The *cartilaginous exostosis, between the periosteum and bone*, arises from inflammation of the periosteum, and subjacent part of the bone; and a deposition of firm cartilage, adherent to both these surfaces, takes place. In this substance bony matter is secreted, which is first thrown out from the original bone. As the cartilage increases in bulk, the quantity of phosphate of lime augments, and fresh cartilage is constantly deposited upon the outer surface of the tumor. On dissection;—1st, the periosteum is found thicker than natural; 2ndly, immediately below the periosteum, cartilage; and 3rdly, ossific matter, deposited within the latter from the shell of the bone, nearly to the inner surface of the periostum. When the growth of such a swelling ceases, and the disease is of long standing, the exterior surface consists of a shell of osseous matter, similar to that of the original bone, and communicating with its cancelli, in consequence of the primitive shell having been absorbed. (*Sir A. Cooper, Surgical Essays*, part i. p. 186.) The *periosteal cartilaginous* exostoses constitute the indolent, hard forms of the disease. In their early stage, especially when dependent on syphilis, they may be checked by small doses of mercury, the decoction of sarsaparilla, and the emplastrum ammoniaci cum hydrargyro. (Vol. cit. p. 196.) When large, or troublesome, they may be sawn away, as Sir A. Cooper states, without danger, if the disease be well discriminated from the fungous swelling.

When non-malignant exostoses are productive of much pain, and injure the health, and their situation admits of their being safely removed, with the aid of suitable saws, bone-nippers, or even of a gouge and mallet, the operation may be undertaken. Many tumors of this kind, however, have bases so very extensive and deep, that, when situated on the limbs, amputation becomes preferable to any attempt made to saw or cut away the exostoses, and preserve the members on which they are situated.

When the part by which they are connected to the bone is slender, their removal is generally a business of facility. I have heard of cases in which they were accidentally broken off, and lay loose, before the operation was begun.

In removing an exostosis, its base must be as freely exposed by the knife as circumstances will allow, and to this part a small fine saw may be applied. In cutting away some exostoses, the flexible saw, described by Dr. Jeffray, of Glasgow, has been occasionally employed. Mr. Hey's saws, and the semicircular trephine, are now so well known to the profession, that I scarcely need recommend them to be remembered in the present cases. Mr. Machell, a surgeon in London, invented a saw, well calculated for cutting a bone at a great depth, without injuring the muscles. It is a small, fine, perpendicular wheel-like saw, turned by means of a handle connected with machinery. It is highly commended by Sir A. Cooper, who has given a drawing of it in his *Surgical Essays*, part i. An orbicular saw, invented and used by Professor Graefe, of Berlin, likewise merits particular notice on account of its ingenuity. (See *C. G. E. Schwalb, De Serra Orbiculari*, 4to. Berol. 1819). I would likewise recommend to the notice of surgeons the ingenious rotation saw, contrived by Professor Thal of Copenhagen, and of which a description and engraving may be found in the *Edin. Med. and Surgical Journal*, No. lxxiv. A strong pair of bone-nippers, and especially cutting forceps, the edges of which are in the line with the handles, will also be useful.

[The reader will observe that, in this article, Mr. Cooper has included under the head of Exostosis most of the tumors occurring in the bony tissue, whether of an innocent or of a malignant character; whether composed entirely of bone, of cartilage, or of these materials combined with various morbid products. Further information on many of the diseased states touched upon in this article will therefore be found under the appropriate heads of TUMORS, OSTEO-SARCOMA, CANCER, FUNGUS HÆMATODES, &c. Mr. Stanley, in his "Treatise on Diseases of the Bones," published in 1849, enumerates the following products as occurring in the tumors of bone:—1. Cartilaginous substance. 2. Osseous substance, including the ivory and chalk-like deposits. 3. Encephaloid, or brain-like substance. 4. Fibrous substance. 5. Gelatinous substance. 6. Fatty substance. 7. Soft and very vascular substance, of the character of erectile tissue. 8. Fluids of various kinds, sanguineous, serous, or gelatinous. Mr. Cooper has treated sufficiently of the majority of these morbid conditions, causing outgrowths or tumors of bone. The osteoid cancer of Müller (*Archiv*, 1843, p. 396), or, as Mr. Stanley calls it, "Malignant osseous tumor," has been made known to the profession since the last edition of this Dictionary: the following brief outline of this affection is therefore here added.

The osteoid or malignant osseous tumor usually selects for its site the lower extremity of the femur, just above the condyles, or the upper extremity of the tibia, immediately below the head of the bone. It occurs also, but less frequently, in the flat bones, such as the ilium, or bones of the skull. According to Mr. Paget (*Lectures on Surgical Pathology*, p. 496), out of twenty-five cases, as many as thirteen occurred in the lower part of the femur. The skull, tibia, humerus, ilium, and fibula were each affected in two cases, and the ulna and metacarpus each in one case.

It may spring from the interior or exterior of the bone, and be composed of an osseous blended with a fibrous tissue. The former may be of an ivory hardness, or of a chalk-like consistence, and the latter, which is of a greyish-white colour, is found to pervade the osseous material, and to cover its surface.

The tumor is generally of an oblong form, with smooth surface and outline, and when occurring in a cylindrical bone, usually surrounds the whole circumference of the bone. The malignancy of this affection is chiefly indicated by the osseous contamination of the absorbent glands in the neighbourhood of the disease, and by the co-existence of malignant growths, and occasionally of osseous deposits in some of the internal organs, as revealed by post-mortem examination. In one instance numerous osseous tubercles were found after death deposited under the pleura pulmonalis; in another, encephaloid matter invaded some of the viscera. These cases are usually as rapidly fatal as soft cancers, but marked exceptions occasionally occur.

The following case, one of three related by Mr. Stanley, sufficiently exemplifies the characters and nature of the malady:—A woman, thirty years of age, was admitted into St. Bartholomew's Hospital, with a hard and immovable tumor, occupying the upper half of the leg, and in the popliteal space there were two smaller, hard, but movable tumors. The large tumor had been eighteen years in progress, and the small tumors were of recent formation. The malignant character of the disease was indicated by sallowness of countenance, and collapse of the features. The limb was amputated through the lower third of the thigh. The large tumor was found to consist almost wholly of bone, which in one part presented the yellow colour and density of ivory, and in another was cancellous. The ivory-like portion of the tumor was continuous, with the same kind of deposit within the medullary tube of the tibia. The walls of the tibia were yellow, and of ivory-like density. The exterior of the tumor was composed of soft substance, which in some parts was fibrous and in others encephaloid. The smaller tumors in the ham were composed of osseous substance, partly ivory-like, and partly cancellous; and it appeared probable that they were formed by ossification of the absorbent glands. Within the medullary tube and cancellous texture of the femur there were deposits of ivory-like bone, and of soft substance, in some parts fibrous, in others encephaloid.

The stump healed soundly. Cough and difficulty of breathing ensued, and continued to the death of the patient, two months after the removal of the limb.

Numerous isolated ivory-like deposits, mixed with fibrous and encephaloid substance, were found within the medullary tube of the remaining portion of the femur. The femoral, iliac, and cervical absorbent glands were converted into fibrous and encephaloid substance, with osseous deposits in its centre. Many encephaloid growths were found in the pleura, pericardium, and lungs; and there was a large mass of the same substance deposited around and within the coats of the vena cava superior.]

E. Victorin, De Ossibus tuberosis. Upsal, 1717. *Haller*, Disp. Chir. t. iv. p. 561. *P. H. Mæhring*, De Exostosi Steatomatode Claviculæ, ejusdem felici Sectione-Gedani, 1732. *J. Caspart*, De Exostosi Cranii rariore. Argent, 1730. *J. R. Fayolle*, De Exostosi, Monsp. 1774. *Abernethy*, in Trans. for the Improvement of Med. and Chir. Knowledge, vol. ii. p. 309. *Bonn*, Descriptio Thesauri Ossium Hoviani. *Dumont*, Journ. de. Méd. t. xiii. Hist. de l'Acad. des Sciences, 1737. p. 28. *Houstet*, in Mém. de l'Acad. de Chir. t. iii. *Matani*, De Osseis Tumoribus, p. 20. *Petit*, Traité des Mal. des Os, t. ii. *Morgagni*, De Sedibus, &c. ep. 50, art. 56. *Kulmus*, De Exostosi Claviculæ. *Haller*, Collect. Dis. Chir. t. iv. *R. Keate*, in Med. Chir. Trans. vol. x. Sir *A. Cooper*, Surgical Essays, part i. 8vo. Lond. 1818. *J. F. Lobstein*, Compte de son Musée Anatomique, p. 24, &c. 8vo. Strasb. 1820. *B. Bell*, on Dis. of Bones, chap. iv. 12mo. Edinb. 1828. *W. J. Wickham*, On Dis. of the Joints, p. 6, 8vo. Winchester, 1833. *Herbert Mayo*, Outlines of Human Pathology, p. 11. 8vo. Lond. 1835. Catalogue of the Museum of the Royal College of Surgeons, London, 4to. [*Müller's* Archiv, 1843. *Chelius*, Translated by *South*, 1847. *Nélaton*, Elémens de Pathologie Chirurgicale, vol. ii. 1848. *Stanley*, Treatise on Diseases of the Bones, 1849. *Paget's* Lectures on Surgical Pathology, 1853.]

EXTRAVASATION (from *extra*, out of, and *vas*, a vessel). A term, applied by surgeons to the passage of fluids out of their proper vessels, or receptacles. Thus, when blood is effused on the surface, or in the ventricles of the brain, it is said that there is an *extravasation*. When blood is poured from the vessels into the cavity of the peritoneum, in wounds of the abdomen, or when the contents of any of the intestines are effused in the same way, surgeons call this accident an *extravasation*. The urine is also said to be *extravasated*, when, in consequence of a wound, or of sloughing, or ulceration, it makes its way into the cellular substance, or among the abdominal viscera. When the bile spreads among the convolutions of the bowels, in wounds of the gall-bladder, this is a species of extravasation. In wounds of the thorax, or abdomen, an extravasation of blood also frequently happens in the cavity of the pleura or peritoneum. Large quantities of blood are often extravasated in consequence of vessels being ruptured by violent blows: in the scrotum, on the shoulder, and under the scalp, this effect is observed with particular frequency. (See ECCHYMOSIS.) In the articles, HEAD, INJURIES OF, and WOUNDS, I have treated of extravasations of blood in the cranium, chest, and abdomen.

EYE, CANCER AND EXTIRPATION OF,

One of the well-known characters of carcinoma in general is to attack persons advanced in age, rather than children and young subjects.

According to Scarpa, and, indeed, the sentiments of several other surgeons of the present day, cancer is always preceded by scirrhus, or a morbid induration of the part affected. As the disorganisation increases in this hard scirrhous substance, an ichorous fluid is formed in cells within it, and afterwards extends towards the external surface of the tumor, causing ulceration of the investing parts. The compact and apparently fibrous mass is then converted into a malignant fungous ulcer, of a livid, or cineritious colour, with edges everted, and irregularly excavated, and with a discharge of acrid, offensive sanies. The scirrhus, composing the base of the malignant fungus, instead of increasing in size, now rather diminishes, but retains all its original hardness, and, after arising a certain way above the ulcerated surface, is destroyed at various points by the same ulcerative process from which it originated. And, if any part of the livid fungous sore seem disposed to heal, it is a deceitful appearance, as, in a little time, the smooth points are again attacked by ulceration. To relate in this place all the differences between cancer and fungus hæmatodes of the eye would be superfluous, as the subject is elsewhere considered (see CANCER and FUNGUS HÆMATODES); but I may briefly advert to a few remarkable points of diversity. 1st, The primary origin of fungus hæmatodes is generally in the choroid. 2ndly, True cancer of the eyeball, when it begins on any part of the organ itself, instead of commencing as fungus hæmatodes at the deepest part of the eye, may originate in any of the coats of the eye. 3rdly, Cancer of the eye appears to Scarpa less destructive than fungus hæmatodes, because it begins on the exterior parts of the eye, so that whatever relates to the origin and formation of the disease is open to observation; and because a cancerous fungus on its first appearance, is not, according to his views, actually malignant, but becomes so in process of time, or from improper treatment, previously to which period good surgery may be employed with effect. In this light Scarpa regards many excrescences on the conjunctiva and anterior hemisphere of the eye, which appear in consequence of a staphyloma of the cornea long exposed to the air and ulceration; those which arise from relaxation and chronic inflammation of the conjunctiva; from ulceration of the cornea, neglected or improperly treated; from violent ophthalmia, not of a contagious nature, treated in the acute stage with astringent and irritating applications; from suppuration of the eye, rupture of the cornea, and wasting of the eyeball; or from blows or burns on the part. Nothing, says Scarpa, is more probable than that all these ulcerated fungi were, on their first appearence, not of malignant character, or certainly not *cancerous*, and that many of them were not actually so at the time of a successful operation being done.

Now, in the opinion of the same valuable author, there is no criterion as yet known of the precise time when a sarcoma of the eye changes from the state of a common ulcerated fungus to that of carcinoma; for the exquisite sensibility, darting pains, rapidity of growth, colour, and ichorous discharge, are not an adequate proof of cancer. The symptom, however, on which he is inclined to place the greatest dependence, as a mark of the change in question, is the almost cartilaginous hardness of the malignant ulcerated fungus, which induration, he asserts, is not met with in the benign fungus, and never fails to precede the formation of cancer. (See *Scarpa*, *On the Eye*, *transl. by Briggs*, edit. 2, p. 511—513.)

4thly. The last difference of fungus hæmatodes from cancer of the eye, here to be noticed, is the pulpy softness of the whole of the diseased mass, in the first of these diseases; a character completely opposite to the firm almost cartilaginous consistence of the carcinomatous fungus.

What is termed fungus hæmatodes may be composed of a combination of medullary, erectile, and melanotic matter; but in other instances, either of the latter may exist as a separate disease, different from fungus hæmatodes. (See ANEURISM by ANASTOMOSIS, NÆVI, and MELANOSIS.) For the diagnosis of cancer in the interior of the eye see OPHTHALMOSCOPE.

Before describing the operation of removing an eye, affected with malignant disease, the following corollaries, drawn by Scarpa, should be recollected.

1. The complete extirpation of the eye, for the cure of fungus hæmatodes, although performed on the first appearance of the disease under the form of a yellowish spot, deeply seated in the eye, is useless, and rather accelerates the death of the patient. But, although this statement, made by Scarpa, is mostly true, modern experience justifies the hope that exceptions to the foregoing melancholy inference are possible. Thus Mr. Wishart removed from a boy, nine years old, an eye that had been affected with fungus hæmatodes about four months, and no relapse had taken place eighteen months after the operation. (See *Edin. Med. and Surg. Journ.* No. lxxvi. p. 51.)

2. The exterior fungus excrescence of the eye, commonly called carcinoma, beginning on the conjunctiva and anterior hemisphere, *while it is soft, flexible, and pulpy*, although accompanied with symptoms similar to those of carcinoma, is not actually this disease, nor does it become malignant and strictly cancerous, until it is *rigid, hard, coriaceous, warty, and, in every respect, scirrhous.*

3. The inveterate fungous excrescence, hard to the touch in all its parts, covered with ulcerated warts, which has involved the whole of the eyeball, optic nerve, and surrounding parts, and rendered the bones of the orbit carious, and contaminated the lymphatic glands behind the angle of the jaw, and in the neck, is incurable.

4. On the contrary, the partial or total extirpation of the eye will succeed, when attempted before the external fungous excrescence has changed from the state of softness to that of a scirrhous, warty, and carcinomatous hardness. (Vol. cit. p.526.)

The operation of removing the eye is commonly believed to have been first performed in the sixteenth century by Bartisch; but, as M. Velpeau observes, it had probably been executed at a much earlier period, for J. Lange, who published in 1555, states that he succeeded in reducing into the orbit an eye, which some other surgeons wished to extirpate. (*Nouv. Elém. de Méd. Opér* t. i. p. 781.) Bartisch employed an instrument, shaped like a spoon, with cutting edges, and by means of which the eye was separated from the surrounding parts, and taken out of the orbit. Fabricius Hildanus preferred a sort of probe-pointed bistoury. Bidloo made use of scissors and a pointed bistoury.

Until the time of M. Louis, no precise directions had been given about the mode of performing the operation: his method consists in dividing the attachments of the eye to the eyelids; then those of the inferior oblique muscle; next, those of the superior oblique muscle; then those of the levator palpebræ superioris, varying, according to their insertions, the manner of holding the knife. The eyeball is afterwards detached, and the four recti muscles, and optic nerve, divided with a pair of scissors.

The following is the ordinary method: —

1*st Stage.* Two semilunar incisions are first to be made at the base of the orbit, and the eyelids are to be detached from it, and dissected away with the rest of the tumor. But, when the eyelids are to be preserved, the first step consists in making an incision about an inch in length, through their external commissure. The eyelids are then to be everted, and the front of the tumor is then to be taken hold of with a tenaculum, single or double, or a ligature may be passed across it.

2*nd Stage.* The point of the knife is then introduced at the inner angle, and passed close to the ethmoid bone nearly down to the foramen opticum. It is then to be conveyed across the floor of the orbit, so as to divide the attachment of the inferior oblique muscle, the connection of the conjunctiva to the eyelid, and some adipose and cellular tissue. It is next to be brought again to the inner angle, and, with the edge turned upward, the superior oblique muscle is to be cut, and the blade carried across the upper part of the orbit, in which movement some operators endeavour to cut out also the lachrymal gland, as the knife is about to unite the two incisions near the external angular process.

3*rd Stage.* The eye is now only retained in the orbit by a kind of pedicle, composed of the four recti muscles and the optic nerve. Supposing the operator prefers dividing it with scissors, they may be introduced on the nasal side of the orbit, with their concavity towards the swelling, and while the swelling is drawn forwards and outwards the pedicle may be divided at one stroke. If any fibres should remain uncut, their division must now be completed. If a long, narrow knife is preferred, it may also be introduced on the nasal side of the orbit, as recommended by Velpeau. (*Nouv. Elém. &c.* t. i. p. 787.) This gentleman, however, does not object to introducing the knife or scissors on the temporal side as preferred by Desault, Travers, Lawrence, and Malgaigne. The lachrymal gland is best removed by seizing it with a hook, and then dissecting it out of its fossa. Dupuytren used to begin with detaching the eye from the upper part of the orbit; he then divided the pedicle, and drew the swelling towards the cheek. The operation was finished by detaching the tumor inferiorly, from within outwards. Thus, there were only two stages. (See *J. F. Malgaigne, Manuel de Méd. Opér.* ed. ii. p. 402, 12mo. Paris, 1837.)

Mr. Travers, with a straight double-edged knife, freely divides the conjunctiva and oblique muscles, so as to separate the eyeball and lachrymal gland from the base of the orbit. Drawing the eye then gently forwards with the ligature, he introduces a double-edged knife, "curved breadthwise," at the temporal commissure of the lids, for the purpose of dividing the muscles, vessels, and nerves, by which the globe remains attached. The hæmorrhage he represses with a small bit of fine sponge put into the orbit, and a light compress, applied over the eyelids, and supported with a bandage. The sponge, he says, should not be suffered to remain longer than the following day, when a soft poultice in a muslin bag may be substituted for the compress. He approves of giving an opiate at bed-time, and joins Ware in condemning the practice of cramming the orbit with lint or charpie, and leaving it to be discharged by suppuration. (*Synopsis of the Diseases of the Eye*, p. 308.)

As soon as the eyeball has been removed, the surgeon should examine with his finger whether any indurated or diseased parts have been left behind, and, if they have, he should next cut them away with scissors or the knife.

The employment of sponge is objected to by Velpeau as likely to cause some mischief by its expansion within a solid cavity. (See *Nouv. Elém.* t. i. p. 788.) If a dossil of lint be held for a little while on the bleeding vessels, the hæmorrhage will generally stop, and the plan of forcibly distending the orbit with lint, or sponge, will be unnecessary. The bleeding is from the ophthalmic artery and its branches. The bleeding having been stopped, the edges of the incision at the outer commissure are to be brought together with a suture; the eyelids approximated to one another; and some soft pieces of lint, or fine linen, wetted with cold water, laid over them.

For a few days after the operation antiphlogistic treatment is proper. The patient should be kept in bed until all risk from inflammation is past, and suppuration has been freely established. In one case, operated upon by Mr. Guthrie, the symptoms of inflammation were so violent that it was necessary to take away 250 ounces of blood in the course of the three first days. (*Operative Surgery of the Eye*, p. 183.) Sometimes, fungous granulations continually form in the orbit, notwithstanding they are repeatedly destroyed; and sometimes the disease extends even to the brain, and produces fatal consequences. When malignant fungous excrescences grow from the cornea alone, it is necessary to extirpate the whole eyeball.

[The operation of excision, as above described, has been superseded by a method which was first performed by Mr. Critchett, at the Royal London Ophthalmic Hospital, Moorfields. The following remarks respecting the operation and its indications are taken from a paper of Mr. Critchett. (*Original Observations, founded on a series of cases of Extirpation of the Globe, &c.* reprinted from the *Lancet* of Nov. 17th and 24th, 1855.) ". . . and secondly to describe my method of extirpating the globe, an operation I first performed at the Ophthalmic Hospital, in October 1851, and one that I was the first to perform and to describe in this country. I have since learnt that it was first suggested by O'Ferrall, in 1841, in the *Dublin Journal*, and by Bonnet, in 1842, in the *Annales d'Oculistique*, but of this I was unaware at the time of my operation, as was Bonnet probably of O'Ferrall's priority when he wrote upon the subject a year subsequently. The patient is brought under the influence of chloroform. I then commence by dividing the conjunctiva as close as possible round the margin of the cornea. I then cut through the external rectus muscle, close to the sclerotic, then the superior and inferior rectus and the obliqui; then draw the globe forwards, and divide the optic nerve; turn the globe out of the orbit, and complete the operation by dividing the internal rectus. If rapidity of execution, absence of hæmorrhage, freedom from constitutional or local disturbance, and a speedy cure, form the elements of a mild operation, then I do not hesitate to rank this procedure, formerly deemed so severe, amongst the simplest and safest operations of surgery."

Mr. Dixon has modified this operation, by first dividing the internal rectus, so as to leave a considerable portion of its tendon by which to hold the eye, then dividing, without using the hook, the tendons of the superior and inferior muscles and the optic nerve; the globe is then turned out of the orbit, and the external rectus tendon, and the remainder of its soft attachments are divided. Mr. Bowman contracts the opening in the conjunctiva by a suture, when the bleeding has entirely ceased. The bleeding (generally inconsiderable, as only small vessels are divided) is best stopped by continued application of cold water, whilst the lids are kept open by the speculum. The introduction of lint does not answer as well.

Mr. Critchett proceeds to consider the cases for which he has performed this operation, and for which it seems applicable. He says, "I may mention that I have lately performed this operation in cases that I would group as follows:—1st. Extensive staphyloma of the globe, with and without recent inflammatory disease. This class of cases, however, is now treated by abscission. See STAPHYLOMA. 2nd. Cases where there is reason to suspect the presence of a foreign body within the globe. 3rd. Cases of severe symblepharon or adhesion of the globe to the eyelid, causing pain, irritation, and deformity, and for which no operation is of any avail. 4th. Acute inflammation and pain in the globe, with loss of vision, occasioning great distress, and preventing the use of the other eye, or showing a constant tendency to severe relapses. 5th. Cancer; deep-seated disease of the globe, the result either of accident or of deep-seated inflammation, with disorganisation of all the structures, in which the other eye exhibits symptoms of sympathetic affections, threatening gradual failure of sight.

I am anxious, says Mr. Critchett, to explain and to illustrate each of these groups, and to show my reasons for performing this operation. 1st. In some of the more severe cases of staphyloma, where the entire globe is enlarged, the sclerotic thin, and the deep-seated vessels, both in the choroid and retina, much dilated, it is found that the ordinary operation of opening the globe is liable to certain rather serious inconveniences. When the humors have escaped, the vessels, deprived of the support to which they have been accustomed, give way, and rather profuse and protracted hæmorrhage often takes place, which first painfully distends the globe and then escapes through the lids. This is usually followed by severe inflammation and suppuration of the globe, which continues many weeks, is attended with very severe pain, and often leaves a considerable enlargement, which is prone, from time to time, to take on inflammatory action. In such cases, I am of opinion, that the removal of the globe is a far milder operation than opening it in the usual way for the operation of staphyloma. 2nd. I have now to consider those cases in which the presence of a foreign body is suspected in the globe, and is out of sight and out of reach, but produces pain, and sympathetically affects the other eye. In such cases I believe the removal of the globe is the best proceeding. I have also performed this operation in two cases of extensive adhesion between the globe and the lids. The one case was a girl, aged fourteen, whose eye had been extensively burnt with lime. The lower lid was completely adherent to the globe, and the upper lid was partially adherent; the entire rows of lashes of both eyes were turned in upon the globe, causing constant severe distress and preventing the use of the other eye. The operation perfectly relieved all the symptoms and deformity, and was, I believe, the only effectual means that offered. Extensive separation of the globe from the lids had been previously tried, and had quite failed. 3rd. I have now to consider, in the last place, those cases of deep-seated disease of the globe, the result either of accident or of idiopathic inflammation, with disorganisation of all the structures, in which the companion eye exhibits symptoms of sympathetic affection, threatening gradual failure of sight. The idea upon which this operation is founded, and which, I am free to admit, requires for its confirmation a large mass of evidence, takes its origin in the well-known sympathy that exists between the two eyes; in the symmetry of disease in these organs; in the frequent observation that when one eye has been destroyed, either by accident or disease, the other sooner or later becomes seriously compromised. The important problem to resolve is, how far the one is the result of the other. In those cases that result from accident, there can be little doubt of the close connexion between the two; in those resulting from disease, this is, perhaps, not quite so clear.

The removal of the globe has been until a recent period regarded as a very severe and repulsive operation; and such a remedy may be considered by some as somewhat heroic and hardly justifiable except in very extreme cases. If, however, we divest the inquiry of all preconceived prejudice, and carefully examine the naked facts of the case, how does it stand? Even suppose, for the sake of argument, that there is no truth in the idea that incipient disease in one eye may be so far dependent upon and connected with a disorganised condition in the other, that the removal of one suspends the disease in the other, still the operation may be useful. It is proposed to remove a part that is only termed by courtesy an eye, for it has forfeited every claim to that appellation: it is a mere bag distended with water, and containing, perhaps, some fibrinous and chalky debris, without any remains of that delicate nervous membrane to which the optical machine is subservient, and without a vestige of that function for which the eye was created. It is the seat of a slow inflammatory action, and forms a nidus for the sudden lightening up, at any moment, of acute disease, and is in itself a constant source of trouble. Surely it is no very cruel or unjustifiable act towards a patient to remove, by a safe and speedy operation, an organ that has lost its characteristic appearance, has ceased to perform its functions, and is a constant source of suffering, when its place may be artificially supplied so as to produce a much more satisfactory appearance than the diseased globe presented. If, however, we superadd to these considerations the possibility of removing incipient disease in the other eye, or even of arresting it at the point where we find it, the arguments in favour of the operation obtain an immense accession of strength, and a new element is introduced into the pathology and treatment of certain forms of eye-disease.

Since writing the above it has occurred to me that it may be objected to the views that I have endeavoured to set forth, that there is a large mass of cases constantly coming before our notice in which one eye has been lost, either from injury or disease, without the other sustaining any kind of damage. This circumstance does not, of course, invalidate the equally well-observed fact, that in many cases the second eye does suffer; but it seems, at first sight, to stand in curious antagonism to it, and requires some explanation. It has often engaged my careful attention, and after much observation I am inclined to think that it will be found that in those cases in which the second eye remains sound and healthy no disease is going on in the lost eye; it is in a perfectly quiescent state. On the other hand, wherever the second eye is becoming involved, the disorganised globe, whether from traumatic or idiopathic causes, is in a smouldering state, and breaking out, from time to time, into active disease.

It may also be objected to the views I have been endeavouring to set forth, that there seems no reason why the removal of a diseased globe should be followed, not only by arrest of disease in the other, but also by perfect recovery of its function. After all, the chief court of appeal must be to experience and to well-observed facts, which are at present necessarily scanty, from the short time that has elapsed since the operation was suggested. At the same time it appears to be in accordance with analogy, that the removal of a serious source of irritation may not only produce an arrest in the progress of mischief in the other eye, but, by leaving the curative efforts of Nature in full force, undisturbed and undiverted by the presence of contiguous and incurable disease, may contribute towards perfect recovery.]

For information relating to the subjects of this article, consult particularly Mémoire sur plusieurs Maladies du Globe de l'Œil; où l'on examine particulièrement les cas qui exigent l'extirpation de cet organe et la méthode d'y procéder; par *M. Louis*, in Mém. de l'Acad. de Chir. t. xiii. p. 262. édit. in 12mo. *C. F. Kaltschmeid*, Programma de occulo ulcere canceroso laborante feliciter extirpato, &c. Jenæ, 1748. *J. G. G. Voit*, Oculi Humani Anatomia et Pathologia ejusdemque in statu morboso Extirpatio, 8vo. Norimb. 1810. *Bertrandi*, Traité des Opérations de Chirurgie, p. 519, éd. 1784. Paris. *Sabatier*, De la Médecine Opératoire, t. iii. p. 54, éd. 1. *Richter*, Anfangsgr. der Wundarzn. b. iii. p. 415. Gött. 1795. Mémoire sur l'Extirpation de l'Œil Carcinomateux, in Œuvres Chir. de Desault, par Bichat. t. ii. p. 102. *Richerand*, Nosographie Chir. t. ii. p. 103, &c. édit. 2. *Ware*, in Trans. of the Medical Society of London, vol. i. part 1, p. 140, &c. *Lassus*, Pathologie Chir. t. i. p. 450, édit. 1809. *Wardrop*, On Fungus Hæmatodes, p. 93, &c. *Scarpa*, On the principal Diseases of the Eye, chap. 21, edit. 2, trans. by *Briggs*, 8vo. Lond. 1818. *B. Travers*, A Synopsis of the Diseases of the Eye, sec. iv. 8vo. Lond. 1820. *J. H. Wishart*, in Edin. Med. and Surg. Journ. No. 74. *G. J. Guthrie*, Operative Surgery of the Eye, p. 178, &c. 8vo. Lond. 1823. *Wm. Lawrence*, *R. Middlemore*, and *Wm. Mackenzie*, in their respective Treatises on Dis. of the Eye. *Alf. Velpeau*, Nouv. Elém. de Méd. Opér. t. i. 8vo. Paris, 1832. *J. F. Malgaigne*, Manuel de Méd. Opér. p. 401, éd. 2, 12mo. Paris, 1837. [*Mackenzie*, On the Diseases of the Eye, 1854, fourth edit. *Dr. Stellwag von Carion*, Die Ophthalmologie, &c. 1853. *Desmarres*, Traité théorique et pratique des Maladies des Yeux, &c. Paris, 1855.]

[EYE, EXAMINATION OF THE. It is often difficult to obtain a satisfactory view of the cornea, especially in children suffering from that irritable form of inflammation known as scrofulous ophthalmia. In such cases the surgeon should sit and spread a folded towel across his knees; opposite to him sits the attendant, who secures the child's hands, and lowers him backwards until his head is received between the surgeon's knees, and there held as in a vice. The extreme tip of the fore-finger, with a bit of rag twisted over it to prevent its slipping, having been laid upon the middle of the upper tarsus, at the very edge—between the roots of eyelashes and the globe—the lid, without any dragging of the skin, is to be steadily pushed in a direction which, in the erect position of the body, would be upwards and backwards. In this way the greater part of the cornea is at once exposed; but if the finger is allowed to drag the skin of the lid, the tarsal cartilage becomes instantly tilted over, and the conjunctiva, bulging forwards, hides the eyeball from view. The lower lid may be depressed by a similar manœuvre, but this is not necessary in examining the cornea, for that part is always rolled upwards under cover of the upper lid.

If a more prolonged examination of the eyeball be required, as in a case of ophthalmia neonatorum, a spring speculum must be employed, adapted, as regards width and strength of the spring, to the size of the palpebral fissure. (*Dixon, Diseases of the Eye*, 1858, p. 1.)

For examination of the parts behind the pupil, see article OPHTHALMOSCOPE.]

EYE, INJURIES OF THE. Wounds and other injuries of the eye, regarded as causes of ophthalmia, Beer divides into three kinds; namely, *mechanical*, *chemical*, and *mixed*. A prick of the eye with a fine needle is an example of a simple mechanical injury; the action of quick-lime upon the organ is an instance of one purely chemical; and the violent propulsion of a red-hot bit of iron against the eye is a lesion, which may be said to be both mechanical and chemical. The same author makes a variety of original reflections upon the differences connected with the extent and intensity of such injuries. Their intensity, he views only as something relative; thus, either the force, with which the eye is injured, is of itself too great ever to be resisted, as is seen in a gunshot wound; or the organic powers of the patient are, from age, sex, or constitution, much too feeble for the eye to bear favourably any considerable injury, as is the case with children and weak unhealthy females ; or the organisation of the eye itself may be weak, and the effects of the violence therefore greater, as exemplified in the fact of a brown or black eye generally bearing a wound better than a gray, or blue one; or, lastly, the organic powers of the texture of the eye, immediately injured, may be too feeble to bear even a slight lesion, as is the case with the retina. (B. i. p. 95.)

Mechanical injuries of the eye may be made either with sharp, or obtuse bodies. Sharp, pointed and cutting instruments are capable of readily penetrating the eye, without occasioning, at the moment of their entrance, any violent compression or laceration of the neighbouring textures, and consequently the injury inflicted is a simple puncture, or an incision. Sabre-cuts of the eye, however, are to be excepted; for, though the weapon may be sharp, the blow is always attended with more or less concussion, and injury of the textures adjoining the wound, which are very delicate and readily spoiled. Blunt weapons, or bodies, can only enter the texture of the eye by dint of great force, and in this case always cause a serious degree of compression, stretching, and laceration; but sometimes, when they do not penetrate the organ, the contusion is such as is productive of not less mischief.

In the case of a simple puncture, or incision of the eye, Beer seems to think that the subsequent ophthalmia is generally more owing to the incapacity of the wounded organ to bear the effects of the light, air, &c. than to the injury itself abstractedly considered. He observes, that a proof of the truth of this opinion is seen in the extraction of cataract; for if the operator is careless in the operation itself, opening the flap of the cornea very wide, so as to let the atmospheric air have free access to the inner textures of the eye; or if after the operation is finished he do not apply the dressings with caution, and properly darken the patient's chamber, he is letting the eye be subjected to some of the most active causes of inflammation. But though Beer is unquestionably correct in regard to the injurious effects of light on the wounded eye, it may be doubted whether his theories do not make him attribute too much to the irritation of the air and too little to that of the mechanical division of the parts.

In Beer's general observations on the treatment of inflammations of the eyes, the first indication specified is *to remove immediately everything, which is obviously producing an irritating effect upon the eye, and to take care that no fresh source* *of irritation to the organ incidentally takes place.* And as it frequently happens, even in healthy, strong individuals, that ophthalmia is occasioned by foreign bodies, either lodged under the eyeballs, or inserted in some part of the eyeball, and not suspected to be there, the earliest attention should always be paid to their gentle and skilful removal. Easy as this object is of accomplishment, when not delayed, when the eye has not been seriously irritated by friction and pressure, and the patient is not of a weak, irritable constitution, it is often attended with great difficulty under one or the other of these circumstances, especially the last. In this case, strong convulsive rotations of the eyeball, followed by a violent and obstinate spasmodic closure of the eyelids, render it impossible to separate them; and the spasm is the stronger and more lasting, the more the extraneous substances are calculated, by their shape and chemical quality, to irritate the eye; and the greater the irritability of the patient is. In this state of things, every attempt forcibly to open the eye, or to examine it in the light, is not only useless, but increases and keeps up the spasm, which nothing will lessen and shorten except darkness and perfect repose. But, as timid, irritable persons are exceedingly apprehensive of the consequences of the lodgment of extraneous substances in the eye, the surgeon should endeavonr to lessen their inquietude, by assuring them that every thing will be right again, which is strictly true when the foreign bodies are of the first class. Then the spasmodic closure of the eyelids will cease, and the extraneous substance admit of being properly taken away.

Success, however, does not always attend this simple method; for, in very weak subjects, the spasm of the orbicularis palpebrarum is so violent and obstinate, especially when a foreign body lodges in the eye, and at the same time mechanically and chemically irritates it (as is the case with particles of snuff), that it becomes indispensable to have recourse to medicinal applications. For this purpose Beer's experience has convinced him, that the best thing is a bread poultice, made either with milk or water, and containing some of the vinous tincture of opium. Care is to be taken, however, never to let it become quite cold during its application; for then the spasm would only be aggravated by it; and if such spasm has been of long continuance when the surgeon is first sent for, the poultice, according to Beer, may be rendered more efficacious by the addition of hyoscyamus to it. In irritable, hysterical, and hypochondriacal persons, such local treatment alone is frequently insufficient, and recourse must be had to the internal exhibition of antispasmodic anodyne medicines. At length, when the spasm of the orbicular muscle is so far diminished that the eyelids can be effectually opened without any force for the extraction of the foreign body, great caution and gentleness will yet be necessary, and, in particular, the eye should be kept in a very moderate light, as the spasm would be immediately excited again, either by sudden exposure of the eye to too much light, or rough handling of the eyelids.

Sometimes a person rubs his eye at first awaking in the morning, and if the eyelashes are very numerous and rigid, one of them will lodge between the eyeball and lower eyelid; it may readily be taken away with the end of a fine moist sponge, or camel-hair pencil, the eyelid being depressed as much as possible, and the eye itself turned upward, so that the hair may not be concealed in the fold of the conjunctiva. When the hair is situated under the upper eyelid (which Beer says rarely happens), it always lodges in the fold of the preceding membrane, whence it may be extracted in the manner above directed, with the difference that the eyelid must be raised or everted and the eye rotated downwards. (*Lehre von den Krankh.* b. i. pp. 128—130.)

Small globular smooth extraneous bodies, lodged under the eyelids, are very easily extracted, when the eyelid is gently taken hold of both by its edge and the eyelashes, and lifted up from the eye, while the patient inclines his head forwards, and the eye is turned completely downwards: the effusion of tears, excited by these manœuvres, will now generally wash these extraneous substances out of the eye, as they are not at all fixed. When the fissure between the eyelids is wide and open, but the eyeball at the same time very prominent, the object may also be easily accomplished, when the upper eyelid is gently and repeatedly stroked with the finger from the outer towards the inner canthus; in which case, the round smooth foreign body soon makes its appearance above the caruncula lachrymalis, whence it falls out of itself, or may be taken with the corner of a pocket-handkerchief.

The worst cases are those in which the eyes are very prominent, and the fissure of the eyelids small, as all the above methods are then useless, and only productive of irritation. In this circumstance, the eyelid is to be simply everted by taking hold of the ciliæ, and drawing them forward and upward, while a probe is used for pressing back the upper portion of the tarsus. The foreign body may then be plainly seen, and easily removed.

Particles of common dust, and of sand and powders thrown over letters, which frequently get into the eyes of persons who open their letters carelessly, or, from short-sightedness, are obliged to bring them close to the nose, are generally more difficult of extraction. In the attempt, however, the eye must never be subjected to too much irritation. According to Beer, these extraneous particles of dust, or sand, may sometimes be removed by washing the eye well, or by droping into it milk, or some other viscid fluid, while the patient lies upon his back, and the eyelid is lifted up from the eye. But, the most expeditious and certain plan is to employ a syringe, the pipe of which is to be introduced under the upper eyelid near the outer canthus, and the fluid thrown briskly in the direction towards the nose. If all the extraneous matter cannot be thus removed, the rest may sometimes be taken out, if the eyelid be everted in the manner above directed, which seems to me the right method to be adopted in several cases, for which Beer recommends other proceedings.

When particles of sugar, or other soluble, not very irritating substances, happen to insinuate themselves into the eye, professional aid is seldom requisite, as they generally dissolve in the tears, and are voided before a surgeon can arrive. Snuff, pepper, and other minute irritating bodies, as well as small winged insects, are to be removed in the same manner as particles of dust and letter-sand;

but particular care is to be taken afterwards to wash the eye well with some lukewarm mucilaginous collyrium, until the irritation, caused by the chemical effect of such foreign bodies, has been completely obviated.

The removal of foreign bodies of the second class is usually attended with more difficulty, because they, as well as those of the third class, more frequently produce a violent and obstinate spasmodic closure of the eyelids, and are seldom loose, being generally fixed in the cornea. However, when they happen to be detached, they may be extracted in the same way as small round smooth extraneous bodies, except that the stroking of the eyelid with the finger should be omitted, not only as useless, but likely to press any of these substances, which are of a pointed shape, into the loose conjunctiva, so as to injure the eye itself, which would otherwise not be hurt. The nibs of pens, the parings of the nails, and small hard-winged insects, when lodged in a depression of the cornea, or white of the eye, Beer says, may be easily dislodged by means of a small silver spatula, or a probe. Other foreign bodies of the second class are not only fixed in a depression, but even penetrate more deeply than the conjunctiva; and, in old subjects in particular, they often insinuate themselves into the loose cellular tissue under the conjunctiva, partly in consequence of the convulsive motions of the eyeball and eyelids, and partly by reason of the attempts made to loosen them. Hence, they frequently become situated a great way from the place of their entrance, and are completely covered by the conjunctiva. But, even when they lie immediately in the wound, they are so intimately connected with the subjacent loose cellular tissue, that every attempt to remove them with forceps is not only unavailing, but hurtful to the eye, inasmuch as the injury is thereby rendered deeper. They may be taken away with facility, however, when lifted up with a pair of small forceps, and cut away with a pair of scissors, together with the piece of cellular membrane, with which they are directly connected. If such extraneous substance should be actually underneath the sclerotic conjunctiva, Beer recommends the eyelids to be well opened, and the eye to be brought into a position, in which the part of the conjunctiva, covering the foreign body, is rendered tense, when an incision is to be made with a lancet down to the extraneous substance, which is to be taken hold of, and removed with a pair of scissors, the assistant being careful to keep hold of the eyelids during the operation. On the other hand, when the foreign body is actually lodged between the layers of the cornea, Beer considers that its extraction may be best accomplished with a lancet-pointed couching-needle. But, whatever instrument be used, its point must be passed with great caution closely and obliquely under the foreign body; and care must be taken not to introduce it too deeply, lest the anterior chamber be opened, which may readily happen in young subjects; and when it does, the aqueous humour flows out, and the cornea becomes so flaccid, that the removal of the extraneous substance is quite impracticable, before the puncture has healed, and the anterior chamber is again distended.

The removal of foreign bodies of the third class mostly demands very great caution, first, because, as Beer observes, no particles of them should be allowed to remain in the eye, which without the utmost vigilance is apt to be the case; and secondly, because the wound of the eye, already considerable, should not be made larger than can be avoided. The extraction of small bits of glass is particularly difficult, as they cannot be seen, but must be found out entirely by the feelings of the patient, or the *tactus eruditus* of the surgeon, assisted with a probe. When, in this way, a particle of glass is detected, Beer directs us to take hold of it with a pair of forceps, and cut it away with scissors. The place, from which it has been removed, must then be carefully probed, in order that no other fragment may be left in it.

According to the same author, pieces of iron and steel, which strike the eye so forcibly as to enter it, as well as all other fragments of metals, which are readily oxidated, should be as carefully removed as bits of glass; for the more easily they combine with oxygen, and the longer they remain, the more brittle they become, and the more apt are minute particles to be left in the eye, especially in the cornea. A speck on the part of this membrane where the splinter has lodged, is the least serious consequence of such an event. When fragments of steel, which have quite a black appearance, remain fixed in the cornea several hours, it is found, after their removal, that the whole circumference of the depression, from which they have been extracted, is of a reddish-brown colour, produced by the rust left behind, and firmly adhering to the cornea. Every particle of rust must be carefully removed with a couching-needle, or else a permanent speck will ensue; but caution must be used not to puncture the anterior chamber. The extraction of particles of lead and gunpowder is generally difficult, as they have mostly been projected with great force against the eyelids, so as to produce not only a great deal of spasm, but instantaneous swelling of those parts. Hence, Beer says that they should commonly be taken hold of with forceps, and cut away. Particles of cantharides are easily removed with a small silver spatula, or the end of an eye-probe; but their violent chemical effect must be obviated by frequently applying to the part a little fresh butter, touching it with a camel-hair pencil, dipped in diluted liquor ammoniæ, or dropping into the eye lukewarm mucilaginous collyria.

The attempt to wash particles of quicklime, mortar, &c. from the eye, Beer says, only has the effect of rendering their violent chemical operation more diffused, and he recommends them to be taken out by means of a fine hair-pencil, dipped in fresh butter, or oil. This is the only way of immediately counteracting their chemical effect, and, after their extraction, the application of unctuous substances to the part should still be continued.

The stings of small insects, when lodged in the sclerotic conjunctiva, are often very difficult of detection; but they are more readily seen on the skin of the eyelids. Beer directs us to remove them with a pair of forceps, or a couching-needle, and then to have recourse to means calculated to diminish inflammation, which, in these cases, always begins on the first occurrence of the accident. Small shots, lodged in the loose cellular texture of the conjunctiva, must be cut out. In general, says Beer, it is necessary to divide the conjunctiva, as they are mostly situated some distance from the place of their entrance, and of course are quite covered by that membrane.

As soon as a foreign body has been extracted from the eye, all precursors of ophthalmia diminish, as, for instance, the redness, intolerance of light, and the increased secretion and effusion of tears. Even the inflammation itself, when already developed, subsides; but this affection is slight, if the eye has not itself been injured by the extraneous body. On the other hand, when the eye has suffered more or less irritation from the nature of the substance itself, and the treatment requisite for its complete extraction, the inflammation may become more severe, unless the surgeon pay immediate attention to the degree of injury remaining. (*Beer.*)

According to the principles laid down in the foregoing columns, the first indication in the treatment of wounds of the eye in general is *to remove every kind of extraneous substance, which may impede the cure.* Hence, the necessity of observing whether the instrument with which the wound has been inflicted, or any part of it, is lodged in the eye. When this is the case, the foreign body should be quickly extracted, or else no recovery can take place. Beer relates a case, to which he was called, where a piece of tobacco-pipe had been driven so forcibly and deeply at the external canthus between the eyeball and orbit of a young student, aged 19, and of delicate make, that the eye was immediately pushed out of its socket, and on Beer's arrival, it lay with the cornea quite against the nose. Its very position led Beer to suspect that some extraneous body was lodged in the orbit, and notwithstanding the assurances of all the bystanders to the contrary, and the patient's being affected with violent spasms, the part was examined with a fine flexible whalebone probe, by which means, a piece of the pipe, nearly an inch in length, was felt and immediately extracted with a pair of forceps. Scarcely had this substance been removed, when the eyeball was spontaneously drawn back into the orbit, though with the cornea still turned towards the nose, and the twitchings of the muscles also instantly ceased; but the eye was blind, and had but a very faint perception of light. By careful treatment, the eyesight was restored in five weeks; but the eye could not turn towards the temple, owing to the considerable injury which the external straight muscle had sustained. With the aid of electricity, the power of rotating the eye about half its natural extent outwards was in the end regained, and the remaining infirmity resisted every method deemed worthy of trial. (*Beer*, b. i. p. 146.) See EXOPHTHALMIA.

Fragments of broken instruments are not the only kind of extraneous substances which may lodge in the wounded eye; for, as Beer observes, when the injury is extensive, contused and lacerated, there may be splinters of bone, or pieces of membrane, cellular substance, muscle, &c. so detached as to be quite incapable of reunion, on which account this author sets them down as foreign bodies requiring to be taken away. However, I conceive that with respect to the soft parts, the advice here delivered should be received with much limitation.

Wounds of the eye, like those of most other parts of the body, may be healed either by direct union, or a slower process, in which suppuration, the filling up of the chasm by granulations, and the gradual, but not complete, approximation of its edges to each other, are the most conspicuous effects. Clean incised wounds may be cured in the first way (see CATARACT); and lacerated, contused wounds, or such as are attended with loss of substance, in the second. But, whichever plan be attempted, the eye must be kept quiet, and excluded from the air and light.

In healthy individuals, small punctures of the eye, made with instruments like needles, and perforating only the conjunctiva, or cornea, but not reaching the deeper textures of the organ, are generally followed by no serious consequences, even when all the aqueous humor is voided. It is only necessary to keep the eye quiet, and the air and light excluded from it by means of a light compress, suspended over it from the forehead. Under this treatment, such punctures are so firmly closed in twenty-four hours, without any opacity, that the chambers are nearly filled again with aqueous humor, and the intolerance of light, which was only the effect of the loss of that fluid, is entirely removed.

In large clean cut wounds of the eye, whether accidental or made in the extraction of cataract, the prognosis must be very cautious, and the treatment conducted with the utmost care; for, says Beer, it too readily happens, that, though the wound is not important in itself, its effects become from the least mismanagement, highly dangerous to the eye. Hence, when the patient is known to be either an individual not likely to take proper care of himself, or one too much alarmed about the fate of his eye, the prognosis should be very guarded, even where the constitution is of the best description, because a violent and dangerous attack of ophthalmia is apt to ensue and destroy the eye, sooner than effectual succour can be administered. On the other hand, when the patient is steady and intelligent, and the case is properly treated, the prognosis is favourable.

In considerable cuts of the eye, it is only possible to promote their union with a suitable bandage, and by effectually preventing all motion of the eye and eyelids, which is best accomplished, when the sound, as well as the injured eye, is covered, and the patient kept quiet in bed until the sides of the wound have grown together. (*Beer*, b. i. p. 164.)

As cases of deeply penetrating wounds of the eyeball itself, Beer enumerates the punctures made in the depression and reclination of cataract, and in every mode of forming artificial pupils; lacerations of the conjunctiva with ears of corn, pointed pieces of iron, splinters of wood, &c. In these cases the prognosis, he says, is always favourable, when the patient can put himself under all the conditions which the treatment requires, and his constitution is good. The first thing here to be carefully fulfilled, is the removal of any fragments of the instrument or body with which the injury has been inflicted, and it should be recollected that, in these cases, minute splinters, which are scarcely discernible, frequently lodge in the conjunctiva, and, if not immediately traced and removed, produce the worst consequences.

With respect to lacerated wounds of the cornea, they either penetrate the anterior chamber, or not.

They are all of them attended with more or less concussion, laceration, stretching, and partial contusion, of the delicate anterior textures of the eyeball; a consideration, as Beer observes, materially affecting the prognosis. When in such injuries of the cornea, inflammation and suppuration cannot be prevented, or the discharge is protracted, an obvious scar is always the consequence, which, when situated in the centre of the cornea, is a serious impediment to vision. Every endeavour should therefore be made to unite the wound by the first intention; and the best chance will be afforded by treating the eye precisely in the same manner as after the extraction of a cataract. (See CATARACT.) And when the plan fortunately succeeds, the flow of the aqueous humour out of the eye ceases in about 36 or 48 hours, and the anterior chamber becomes distended again; but the site of the injury continues visible for some time afterwards. The speck, however, ultimately disappears, though much sooner in young, healthy subjects than in the aged and feeble. When the opacity does not go off of itself, Beer finds a collyrium, containing some of the lapis divinus (see LACHRYMAL ORGANS) and the vinous tincture of opium the most effectual means of dispersing it. Through large wounds penetrating the cornea near its edge a fold of the iris is apt to protrude, and when it does it should be replaced, which can only be effected without mischief to the eye by gently rubbing the upper eyelid, and then letting a strong light suddenly strike the organ. In this case, the employment of instruments is considered by Beer highly objectionable. When the iris is not immediately reduced, it, as well as the cornea, is attacked with inflammation, and soon becomes firmly adherent to the edges of the wound. (See IRIS, *Prolapsus of the.*)

Large wounds penetrating the eyeball, and reaching the iris, are always of a very serious nature, even though the latter part may have received only a prick, or cut, because, as the injury has been produced by accident, and not by art, the wound of the iris cannot be free from all laceration and contusion. It is incredible, says Beer, what extensive injuries the iris will bear in healthy individuals at its pupillary and ciliary edges, especially when produced by very sharp instruments; nay, rents may happen at both its edges, without any ill consequences, if the constitution be favourable; a proof of which fact is seen in the two common methods of forming an artificial pupil, viz. the extension of a piece of the iris and the detachment of the iris from the ciliary ligament, as practised both by Schmidt and Scarpa. But, according to Beer, all violent pressure, or actual contusion, particularly when it affects the portion of this organ between its two circles, cannot be borne even in the best constitutions, and the least grievous consequence is inflammation, soon followed by a partial, or complete closure of the pupil, or suppuration in the eyeball. When the instrument causing such injury passes to the iris through the cornea, as is mostly the case, and the wound in the latter tunic is extensive, the torn iris is frequently pulled between the edges of the wound, at the moment when the weapon is withdrawn, and protrudes in a lacerated state. In this case, Beer recommends the torn projecting piece of the iris to be cut away with scissors close to the wound in the cornea, when the rest, he says, is generally retracted within the eye. Thus an adhesion of the iris to the cornea, termed *synechia anterior*, may often be prevented, which, when the lacerated iris is suffered to hang out of the cornea, is inevitable, surrounded by a large opaque cicatrix.

Some violent blows on the eye, though they cause no wound, are attended with such a concussion of the anterior hemisphere of the organ, that more or less of the iris is instantaneously separated from the part of the ciliary ligament, where the force is most vehement. The consequence of this accident is either a double pupil, or the natural pupil closes, and the artificial one remains open. Such injuries may be produced by the lash of a whip, or a horse's tail (a common accident in the narrow streets of Vienna), or the thrust of any bluntish weapon against the outer part of the cornea; and they are purposely inflicted in the method of forming an artificial pupil, recommended both by Schmidt and Scarpa.

Wounds, which enter the eye through the sclerotic near the cornea, usually produce a considerable effusion of blood in the chambers of the aqueous humor; but, Beer thinks, that there is never any necessity for making an opening for its discharge at the lower part of the cornea, except when it is so considerable as completely to hide the iris; and at the same time that the eyeball is affected with very painful tension and hardness.

Wounds of the eyeball, affecting the corpus ciliare, are set down by Beer as extremely dangerous, independently of the inflammation which quickly follows. However, such injuries are most serious when they consist in a real contusion, or laceration of the corpus ciliare, which can hardly take place without a severe concussion, or actual disorganisation of the retina, and laceration of the principal ciliary nerves and vessels. Hence, besides an effusion of blood in the chambers of the aqueous humour, a partial or complete amaurotic blindness is instantly produced, and the iris, in the vicinity of the place where the instrument entered, is so retracted towards the margin of the cornea, that neither of its circles can be seen. In cases of this description, it also frequently happens, says Beer, that the patient, or the person who inflicted the wound, suddenly and roughly pulls the weapon out of the eye again, and together with it a part of the corpus ciliare, which is then to be regarded as an extraneous substance, and to be immediately cut off. With respect to the prognosis and treatment, the observations already made on these topics, in reference to wounds of the iris, are here quite applicable; excepting that the effused blood is less copious than in the latter cases, and therefore there can never be any necessity for letting it out by a depending opening in the cornea.

Wounds of the eye, affecting the crystalline lens, are not unfrequently followed by the formation of a cataract, and so are blows on the eye, which may be supposed to produce this effect by destroying some of the minute nutrient vessels naturally connecting the capsule with the lens. (*Beer*, b. i. p. 218.) The treatment of these accidents resembles that of injuries of the iris, except that the surgeon has rarely any extravasation of blood to deal with. However, when the lens has slipped into the anterior chamber, Beer recommends its immediate extraction through an incision in the cornea, in order to prevent the eye from being destroyed by a violent attack of traumatic inflammation and suppuration.

Nor, when inflammation has come on, should this measure be postponed, as Beer has constantly found the disorder lessen after the lens has been taken out.

Considerable wounds of the eye, attended with loss of the vitreous humor, are described by Beer as of a very serious nature; but, they rarely take place accidentally, being almost always the consequence of a surgical operation. Accidental injuries of this kind are generally combined with so large or complete a discharge of the vitreous humor, and with such mischief to the organisation of the eye, that the consequence is a loss of the eyeball, or such a dwindling of it, that the fissure of the eyelids becomes nearly closed. According to Beer's experience, injuries of the foregoing kind, arising from accident, are mostly produced by the horns of cows. On the contrary, the effusion of the vitreous humor in operations upon the eye, he observes, is seldom followed by the loss of vision. See CATARACT.

Considerable injuries of the eyeball, complicated with a concussion, bruise, or actual wound of the retina, produce, either gradually or immediately, an amaurosis, which is almost always incurable. When the concussion of the retina is less violent, and does not affect every part of this texture, it may occasion only an amaurotic weakness of sight. In worse cases, the surgeon may think himself very successful if he can prevent the figure of the eye from being destroyed by the subsequent inflammation, all idea of the recovery of the eyesight being out of the question. The treatment is the same as that commonly adopted after operations for the removal of an opaque lens (see CATARACT); but there is one particular circumstance, sometimes attending injuries of the retina and ciliary nerves, claiming notice, viz. violent vomiting; a symptom which Beer says may even attend contusions of the sclerotica and of the ciliary nerves and retina, without any wound. Injuries of the ciliary nerves, he observes, are denoted by a very peculiar appearance; for, near the injured part, the iris is drawn up so close to the edge of the cornea, that its colour can scarcely be seen. When the surgeon is consulted in a case of this kind, though some inflammation may have commenced, the prognosis is yet favourable in regard to the preservation of the eye; for a gentle opiate will relieve the vomiting when merely a nervous effect, not depending upon the loaded state of the gastric organs; but, if the case be of this last description, the primæ viæ should first be emptied. However, when a traumatic inflammation is completely established before the treatment is begun, the eye is generally destroyed, as the repeated and violent vomitings cause a great determination of blood to the head and eyes, and increase of the inflammation; an effect, which the opiates, given for the relief of the vomiting, also tend to produce.

Beer has seen two cases, in which the eye was pricked with a needle near the insertion of the external straight muscle into the sclerotica: in both instances, the punctures were so small, that they would scarcely have been found, had not the patients known their situations exactly by the pain, and they were then only perceptible with a magnifying glass. The punctures were soon followed by a convulsive rolling of the eyeball, and afterwards by trismus, which continued severe in one patient a day and a half, and in another two days, but yielded to large doses of musk and opium given at short intervals, the warm bath, and the application of warm poultices containing hyoscyamus.

As chemical injuries of the eye produce an actual loss of substance, they are even more serious than common mechanical lesions. However, chemical injuries of little extent are generally repaired with tolerable facility and expedition. Quietude of the organ, and moderating the outward noxious effects by lukewarm mucilaginous applications, either in the form of fomentations, or eye-waters, are the only requisite measures. If the cornea itself be hurt, as frequently happens, when boiling hot fluids strike the eye, a kind of vesicle appears on the injured part, which becomes more and more white. The vesicle either bursts of itself, or subsides without breaking. In both cases, the production of the conjunctiva, of which the cyst of the vesicle is composed, shrivels up, and peels off, a new membrane of a similar nature being regenerated underneath. An opaque speck is frequently apprehended; but, says Beer, if the surgeon will merely avoid being too much in a hurry to open the vesicle, and not disturb the work of nature by applying various remedies to the eye, there will be no danger of such an occurrence.

More extensive chemical injuries of the eye, which at first are not in themselves very severe, frequently become dangerous, in consequence of care not being taken to prevent the influence of external stimuli. To this class of cases belongs the accidental sprinkling of the eye with boiling fluids or strongish mineral acids. And even in these examples, says Beer, the prognosis is not unfavourable, and a complete recovery may be effected when the treatment is conducted according to the directions already given with respect to such accidents in general. While this author approves of cutting away any substance which is dead and partially detached, he strongly cautions surgeons not to remove the thin layer of the conjunctiva, nor to puncture any vesicle which may form.

When the burning, or corrosion, is not limited to the conjunctiva of the eyeball, but extends to the lining of one or both eyelids, Beer recommends covering the injured parts with mucilaginous applications and mildly astringent ointments containing putty or the white oxide of lead. In these cases, keeping the eye perfectly motionless must be hurtful, as it tends to promote the formation of adhesions, either between the eye and eyelids (Symblepharon), or between the eyelids themselves (Ankyloblepharon).

Extensive, deeply penetrating, chemical injuries of the eyeball, are almost always followed by impairment of the functions of the organ, or of some of its particular textures, because such accidents never happen without a loss of substance. Thus a part, or the whole, of the cornea, may be entirely destroyed, as in injuries caused by quicklime; and frequently adhesions between the eye and eyelids, or between the two latter parts, cannot be prevented by any kind of skill. (*Beer.*) These serious degrees of mischief, as the same author observes, are mostly occasioned by slaked, or unslaked lime, concentrated mineral acids, fire, &c. Unslaked lime, especially when extensively diffused over the eye by the immediate application of water, not unfrequently produces a sudden destruction of the whole of the cornea, which is changed into a greyish pappy substance, capable of being removed from the subjacent iris with a camel-hair pencil. Such an annihilation of texture, however, is generally restricted to particular points, or the surface of the cornea. Wherever this membrane has been so much decomposed that a manifest depression is directly preceptible in it when inspected sideways, a snow-white shining speck must be expected to be the consequence. Slaked lime never operates upon the cornea with so much violence, usually causing (as Beer states) only a superficial corrosion, or a coagulation of the lymph between the layers of the cornea. Nor are mineral acids, even when concentrated, generally so destructive to the cornea as quicklime: first, because, as fluids, they do not long remain in contact with the eye, and secondly, because the immediate mixture of the tears with them weakens their operation, whereas it only increases that of unslaked lime. The local treatment here consists in carefully removing every particle of the hurtful substance, afterwards dropping frequently into the eye lukewarm mucilaginous decoctions or collyria, or covering the injured place with a mild cerate, and excluding the air and light from the eye. Every endeavour must also be made to prevent the formation of adhesions between the injured surfaces.

In severe burns of the eyeball, of course all idea of restoring its functions is out of the question. The violence of the injury is the greater, the more numerous the vesicles are upon the conjunctiva, and the more the eyeball and the iris are incapable of motion. Here the only indication is to moderate the inflammation, and avert such additional mischief, as might otherwise be produced by it. With this view, the eye should be kept at rest, and excluded from the light and air. According to Beer, the most common injuries of the eye, partaking both of a mechanical and chemical nature, are those caused by mortar, or the accidental touching of the eye with hot irons. When the mortar contains no particles of quicklime, it often occasions, at particular points of the cornea, very white specks, which Beer describes as being composed of coagulated lymph, and admitting of dispersion. He even declares, that when the whole of the cornea is in this state, its transparency may be restored by proper treatment, as has been frequently exemplified to the gentlemen attending his clinical lectures. (B. i. p. 234) The pricking of the eyeball with a red-hot needle, and the stinging of it by bees, wasps, and other insects, are also both chemical and mechanical injuries. Whether the sting be left in the skin of the eyelid, or in the conjunctiva, or not, a considerable inflammatory swelling immediately takes place; and if the sting be lodged, and not now taken away, the inflammation spreads, and the eye itself is endangered. In two cases where the stings of bees were left in the skin of the upper eyelid, Beer knew gangrene arise, and the patients were saved with great difficulty. The treatment of such cases consists in immediately extracting the sting, if lodged, and applying folds of linen over the eye, wet with cold water.

After noticing the destructive effects of burning substances, the explosion of gunpowder, and fulminating silver, on the eye (cases in which, when the functions of the organ are annihilated, the only indication is to diminish the subsequent inflammation and its consequences), Beer inquires, what is the reason why the slightest mechanical, or chemical, injuries of the eye, in an apparently healthy subject, are sometimes followed by an immoderate degree of inflammation, and even the loss of the organ from suppuration? It is, says he, an observation made by Schmidt, that there are some eyes which the greatest bunglers may abuse for hours at a time without being spoiled, their powerful organisation defying all such unskilful disturbance; while other eyes are met with, which the most skilful operators can hardly touch without inducing a destructive degree of inflammation and suppuration. It was to this peculiar idiosyncrasy that Schmidt applied the term *vulnerability.* (*Verwundbarkeit.*) Patients of this habit are said to possess an exceedingly fine soft skin, with a reddish polish upon it; and their cheeks are not only red, but exhibit a network of very minute vessels, which seem as if injected. Such individuals appear as if they were in the bloom of health: and, says Beer, in some respects they are really so. When their spirits are raised by the slightest causes their complexion is universally reddened; but the least fear turns them pale as a corpse. Their skin is uncommonly irritable, sensible of every impression, and attacked with an erysipelatous redness, whenever any fatty substance touches it. In such habits the utmost caution is necessary whenever the eyes have been injured, and the prognosis should be reserved.

[Consult the books mentioned under article Conjunctiva, and also *Desmarres,* Traité Théorique et Pratique des Maladies des Yeux; 2nd ed. 1855, and numerous articles on this subject by *White Cooper*, Annales d'Oculistique, tom. xxxi. A. xl. Années, 1854—1858, and on Injuries of the Eye. London, 1860.]

[EYELIDS, INFLAMMATION OF THE. The eyelids are of course subject to œdema, erysipelas, abscesses, and the various forms of inflammation which attack the other parts of the common integument, and are to be treated accordingly.

Tumors of the eyelids (see article of).
Hordeolum (see article Hordeolum).
Entropium
Ectropium
Encanthis
Trichiasis (see articles on).
Ptosis
Phtheiriasis

Spasmodic twitching of the eyelids.— This is commonly the effect of intestinal irritation, especially that produced by ascarides; and a purge, followed by a little tonic medicine, quinine, or iron, suffices to put an end to the annoyance.

Injuries of the eyelids. Ecchymosis.—The best mode of treatment consists in the application of a poultice formed of the scraped root of black bryony mixed with linseed meal or bread crumbs. This produces a stinging sensation in the skin, and effects a very speedy disappearance of the effused blood.

Emphysema of the lids arises from blows; blowing the nose puffs the eyelid up. The swelling is unattended with any redness of the skin, and, on pressing the part with the fingers, the surgeon at once perceives the peculiar crackling of air effused into areolar tissue. The cause of this emphysema is rupture of the lining membrane of the nose, with fracture of the lachrymal, or perhaps of the ethmoid bone; and until the fissure has closed, the emphysema is apt to recur if the patient blows his nose. If he abstains from this the effused air soon becomes absorbed without any especial treatment. (*Dixon*, *A Guide to the practical Study of Diseases of the Eye, &c.* 1855, p. 288.)]

[On the anomalies of size, number, &c. and on Coloboma, consult *Himly*, Kkhten. und Missbildungen, &c. i. Bd. 1843, s. 181, and s. 536—538. *Himly*, l. c. Bd. s. 100. *Desmarres*, Traité, &c. 1847, p. 37. *Ammon*, Zeitschrift für Ophthalmologie i. Bd. s. 533. *Carron de Villardo*, Guide pratique, &c. vol. i. 1838, p. 388. *Desmarres*, Annal. d'Ocul. vol. vi. p. 236. *Bernard*, Ann. d'Ocul, vol. ix. p. 40; Ann. d'Ocul, vol. xxix. p. 211. *St. Ives*, Tractat, von den Kkhten. des Auges; translated by *Herschel*, 1730, cap. 10, s. 112. *Beer*, das auge oder Versuch, &c. 1813, s. 53. *Heyfelder*, Zeitschrft f. Ophthl. 1 Bd. s. 480. *Cuvier*, Ann. d'Ocul. vol. vii. p. 10. *Ammon*, Zeitschrift für Ophth. 3 Bd. s. 244, und 5 Bd. s. 83. *Prokaska*, *Himly*, l. c. 1 Bd. s. 538. *Ruete*, Lehrb. der Ophth. 1854, 2 Bd. s. 636. *Himly*, l. c. 1 Bd. s. 96 und 536. *St. Ives*, l. c. s. 128. *Cherillon*, Ann. d'Ocul. vol. xxix. p. 283.

On Inflammation of the Eyelids consult *Himly*, Kkhten. und Missbildungen, &c. 1 The. s. 201—207. *Dr. Stellwag*, v. l. Ophthalm. s. 1009. *Carron de Villars*, Ann. d'Ocul. vol. xxxiii. p. 245. *Stellwag*, l. c. p. 1010.]

FEVER. [In this Dictionary we are not called upon to treat of the various kinds of fever which custom has assigned to the care of the physician; such as the agues, and the malarious and remittent fevers, which are believed to arise from marsh emanations; the continued fevers, including the typhoid, typhus, gaol fever, plague, and others, which are believed to arise from mismanagement of the conditions under which human beings live; nor yet of those mysterious epidemics, or influenzas, which are believed to be brought by the wind; nor yet of the exanthematous class, as the small-pox and scarlet fever, which, as a rule, attain their full development but once in the lifetime of any individual, and which are supposed to be produced by some specific contagion.

In this place we propose to treat generally of those fevers, or feverish conditions, which may accompany such local inflammations, wounds, and injuries, as the surgeon is accustomed to consider his special objects of study.

Using the word fever in this sense, we mean by it a general disturbance of the whole faculties and functions of the body, beginning usually with shivering followed by increased heat and dryness of skin, lightness or pain or confusion of the head, aching and lassitude of back and limbs, weakness and incapacity of mental and bodily exertion, disturbed action of the heart and arteries and lungs, and interruption or disorder of the secretions of the tongue, intestinal tube, kidneys, and skin.

These disturbances are capable of a truly infinite variety in kind, in degree, and in mode of combination; sometimes so violent as to extinguish life rapidly, sometimes so slight as to be scarcely noticed, and sometimes almost indefinitely prolonged.

The climax of severity is found in that febrile condition which may be called intense surgical or traumatic or hospital fever, which is identical with acute pyæmia, and with the worst members of the erysipelatous alliance. The slightest grades of surgical fever, vary from the condition called *hectic* to that commonly called *cachexia*. In the one extreme of the series the fever may be a foudroyant attack that prostrates the body like a cannon ball, and destroys life in a few hours; in the other, a slight chilliness and languor, which may go on for months or years.

Fevers, or feverish maladies, such as those which we have to do with, have a twofold, sometimes a threefold, relation to local disease.

In the first place, the starting point may be local. Some change in the tissues of an injured part, some irritation of the nerves of sensation, or some change undergone by the fluids at one point, possibly by the imbibition of a poison, serves as the first step in the chain of morbid phenomena, and seems to change the composition of the whole blood, and so irritate the whole system. This is the case in the symptomatic or sympathetic fever which accompanies an irritated or ill-treated wound.

Secondly, the changes in the blood and nervous system instead of being secondary may be primary, and may be the originating cause of idiopathic local inflammation. Instances of this are so common as to require no illustration; yet we may refer to the well-known cases of the exanthemata, of idiopathic erysipelas arising from infection, or from bilious disorder, of boils, and the like.

Thirdly, a febrile condition having been excited by local change, may be the parent of secondary (*consecutive* or *metastatic*) inflammations in other remote parts. Pyæmia and glanders are examples.

These relations of *general febrile* with *local inflammatory* changes are, besides, often combined in different ways in different cases of the same disease. Thus, erysipelas may begin by local contamination of a wound; so notoriously may hospital gangrene; so does the small-pox when inoculated; so may some cases of farcy, of puerperal fever, and of the diffuse inflammation; whilst, in other cases of these same diseases, the first step is no local change, but a general malaise and shivering, which perhaps precede any local changes by some hours or days. In other cases, again, as in snake bites, the first local change, and the general blood infection, come at one *coup* from one and the same cause, and it were idle to talk of either preceding or being the cause of the other.

The general law appears to be, that the local changes are, as the Germans say, *the localisation of the blood crasis;* or, in plain English, that whereas the entire mass of blood and serum is one fluid, every part of which is miscible with every other part, so any perverted portion of blood or serum may be absorbed into and taint the whole, and so any morbid matter in the whole may be exuded into any particular part.

We do not pretend to give any thorough or satisfactory explanation of the phenomena of fever, or of the changes which take place in the course of it; still less will we wander into the region of *final causes* or purposes, which seems to have such a dreamy charm for the idolators of John Hunter. But, regarding as we do an hypothesis to be an allowable mode of giving the best explanation of any given set of phenomena, compatible with the present state of knowledge, we may give the following as our hypothesis of fever, whether in the general sense, or in that more limited sense in which it interests the surgeon:—

"*A process of decomposition set up in the blood, and producing increased oxidation, or local deposit, or increased secretion, or all three.*" (*Surgeon's Vade Mecum*, 8th ed. Lond. 1859, p. 27.)

This definition, or quasi definition, purposely includes the feverishness produced by a debauch, by over-fatigue, or by inhaling putrid vapours, or any specific poison; and it includes most of the cases which come under the term cachexia, which really seem to differ from fever solely in the slowness, or, we might almost say, the perpetuity, of some of them. That the causes of cachexia may be hereditary, or derived from remote disorders of assimilation, is no sign of difference in the processes, all of which may be included in our formula.

Before proceeding further, we may remark upon the strange controversy which occupied the attention of our forefathers, when they disputed whether there could be such a thing as *essential* or idiopathic fever (*i.e.* fever dependent on blood disease or other general disorder), or whether all fever was not dependent upon local disease, being itself an "irritation" of the constitution consequent thereupon. The kind of argument was this: Local inflammation excites general fever; therefore, all general fever is excited by local inflammation. In accordance with this doctrine, some believed typhoid fever to be an inflammation of the brain, or lungs, or intestines; some believed the cold stage of ague to be caused by congestion of the heart, &c. This false doctrine was supported, moreover, by the results of post-mortem examination, for the local congestions discovered after yellow fever, for instance, were assumed to be the cause of the general symptoms. Pathologists of this school resembled the Brahmin philosopher, who put the earth on an elephant, the elephant on a tortoise, and so on, without reflecting that the putting off a difficulty is no solution of it.

The more liberal and comprehensive pathology of the present day enables us to escape the difficulty of having to choose between two seemingly opposite theories by accepting them both, because each is true under certain circumstances. There are cases in which, by allaying local irritation, feverishness disappears like magic. There are, again, other cases in which local medication is absurd, or impossible, or injurious, and in which "attention to the general state of health" will remove the local symptoms without difficulty. There are others in which both sets of treatment are required; but be this as it may, the local and the general symptoms are parts of one and the same thing, and cannot be dissociated in practice. To treat the feverishness which accompanies erysipelas, apart from the erysipelas, is impossible. Let us now briefly consider the varieties of febrile disorder which accompany local disease, whether as cause or effect. They are—

1. The Common Symptomatic, Sympathetic, Traumatic or Inflammatory fever.
2. The Irritative or Pyæmic.
3. The Acute Hectic, and the Common Hectic or fever of exhaustion, and Cachexia.
4. The Putrid Typhoid type, arising from the absorption of putrescent matter.]

[I. Symptomatic Fever. This will be minutely described, according to modern ideas, in the Art. Inflammation, to which it properly belongs. Here we shall content ourselves with reproducing, as part of the history of medicine, some of the older doctrines found in the works of Hunter, and recorded in former editions of this Dictionary.]

Every local complaint of any consequence, says Hunter, or which has considerable and quick action within itself, although not of considerable magnitude, affects more or less the constitution, and gives rise to what has been called the symptomatic fever. These symptoms are the sympathies of the constitution with a local disease or injury, and will vary according to many circumstances, such as the age, the quantity and manner of the mischief done. Such fever, Hunter believed, if an injury were considerable, to be a natural result, and a much better sign of health than when no fever takes place. Nature, he says, requires to feel the injury, for where after a considerable operation there is rather a quiet, weak pulse, often with a nervous oppression, with a seeming difficulty of breathing, and a loathing of food, the patient is in a dangerous way. Fever shows power of resistance; the other symptoms show weakness and sinking under the injury.

In spontaneous inflammations, says Hunter, it is not easy always to know whether the constitution or the part is first affected; the priority of symptoms is a guide, although the constitutional symptoms are often so slight as not to be taken notice of.

Sympathetic inflammatory fever, he continues, is the sympathy of the constitution with the first stages of a local disease, which excites an alarm in the constitution, thereby rousing up its powers to produce succeeding actions.

[So far as Hunter writes from observation of disease, his sagacity is marked. But his reasonings are obscure and self-contradictory; his attempts at finding motives for morbid phenomena usually unhappy, and the conclusions derived therefrom erroneous. He spoke of *action* and *sympathy*, where we speak of chemical decomposition of the blood; he always tended to lose sight of plain facts in the search for final causes; and so spoke of fever as a necessary and beneficial process, whereas it is unnecessary, intrusive, and mischievous. We now consider fever, like inflammation, to be a disease and a complication of injuries, and not a beneficial process, although we still continue to speak of a *healthy* inflammatory fever, by way of contrast with other cases which are more unfavourable, and more unhealthy.

The following extract from Mr. Travers will serve to show the doctrines entertained by our forefathers on the subject of fever, as arising from irritation:—]

"It is scarcely necessary to illustrate the influence of an irritable temperament upon the consequences of casual injury or disease. Practically, we all know it well. We say, *such a person would be a bad subject for a compound fracture*; and whoever has had opportunities of watching several subjects of compound fracture under treatment at one and the same time, well knows the import of this phrase, and that the greatest degree of mischief is often accompanied by the least constitutional disturbance, and, for this reason, is soonest and most perfectly restored. The first few hours will enable an experienced observer to determine whether the subject of a serious injury or operation will do well or otherwise. How vastly different in different individuals is the inconvenience attending such minor derangements as a boil, an enlarged gland, a whitlow, or a simple ophthalmia. In some, the constitution seems ignorant of the affair, and the individual pursues his ordinary occupations. In others, the whole system sympathises; the spirits are ruffled; the nights are restless; the appetite fails, the pulse acquires an undue bound; and the white tongue, the creeping chilliness, and slight erratic pains of symptomatic fever are present." (*Travers on Constitutional Irritation*, p. 15.)

We may set down the ordinary symptoms of inflammatory fever, occurring in consequence of local inflammation in common parts, and in a healthy habit, as follows:—The pulse is frequent, full, and strong; all the secretions are diminished; the patient is vigilant and restless; the perspiration is obstructed, and the skin is hot and dry; the urine is high-coloured, and in small quantity; the mouth is parched, and the tongue furred; an oppressive thirst is experienced; with disturbance of the nervous system; loss of appetite and sleep; and, in some cases, delirium.

As Dr. Thomson has remarked, "the inflammatory fever, succeeding to external injuries, or to chirurgical operations, undergoes a kind of natural crisis, by the appearance of suppuration. In these instances, therefore, unless when the patient is strong and in full health, when the disease is seated in an organ of much importance to life, or is in danger of spreading, as is the case in all inflammations of the membranes lining the three great cavities of the body, the lancet ought to be used with caution. For we may, by too free a detraction of blood, produce a sudden sinking of the powers of life, and convert the existing constitutional symptoms into fever of a different type or character. But, in all cases of inflammation, in which any doubt arises with regard to the farther general detraction of blood, it may, I believe, be laid down as a general rule, that it is safer to employ local than general blood-letting." (*Lectures on Inflammation*, p. 170.)

Here we leave the subject, referring our readers to Art. INFLAMMATION for the modern views.]

[II. IRRITATIVE OR PYÆMIC FEVER. Under this designation we include the sum of the constitutional symptoms which accompany the class of local inflammations of which erysipelas and diffuse inflammation are types. It corresponds strictly with the irritative fever of Butter, and the constitutional irritation of Travers.

It was evidently considered by Travers, and the other writers of that generation, that fever, *i.e.* symptomatic fever, was a normal consequence of injuries in healthy persons; but that, under certain depressing circumstances, the symptoms displayed were not those of fever, but of acute constitutional irritation, arising from the action of an injury or poison on the nervous system. At that day, humoral pathology was in abeyance, and solidism reigned undisturbed. *Direct* irritation was the term used to signify the primary effect of the injury or poison; *reflected* irritation, the effects of the changes which it subsequently set up in the blood.

The symptoms of irritative fever, using the word to signify the constitutional symptoms of pyæmia and diffuse inflammation, are thus summed up by Mr. Travers: — "Rigors, nausea, and retching, abdominal tension, restlessness, and depression of spirits, with a rapid and feeble pulse, coated tongue, pinched countenance, partial perspirations, and, at length, delirium, followed by stupor and laborious breathing." (*Constitutional Irritation*, p. 276.) The presence of inflammation, continues Mr. Travers, is an indication of power, and implies that the nervous system is unexhausted. Pain and fever are incompatible with the state of high prostration. The pulse of real fever does not exceed a certain limit, and that consists with the property of distinctness; when it is innumerable, and from that cause indistinct, it ceases to be fever.

Rigors followed by increased heat, sometimes by profuse and fetid perspirations; action of the heart more rapid, tumultuous, and oppressed, than in common symptomatic fever; pulse jerking and soft, and from 120 to 160 or more; breathing rapid, that is from 30 to 40 or more per minute; nervous system variously affected: sometimes the mind quite clear; some sleep, if there be no local pain; sometimes delirium; later, stupor or coma, with twitchings or jerkings of the limbs: in some cases great irascibility and snappishness; hiccough, oppression at the region of the heart, and faintness; the bowels sometimes the seat of eliminative efforts; putrid, or bilious, or offensive motions, or redness of tongue, with aphthæ; in most cases tongue coated, dry, and white, or moist and yellow; at a later stage dry and black; nausea, retching, and vomiting very frequent; urine variable. Such are the symptoms.

These symptoms admit of classification in various sets of cases, and the best is that proposed by Dr. Ferguson, in his work on puerperal fever, with which this malady, as seen in the surgical records of hospitals, is perfectly homologous, if a wound or injury be substituted for a recently emptied womb. The first form is that in which local symptoms at the seat of injury preponderate, as in the peritoneal form of puerperal fever, or in cases of Irritative Fever, related Art. ERYSIPELAS, or in the following description of phlebitis after venesection, from Mr. Travers: —

"Moderate swelling, but great tension of the limb, and cordy hardness of the vein, traceable towards the axilla; insupportable pain, sense of weight and immobility, with a festered or oozing state of the orifice, are local symptoms; but the extreme constitutional excitement, morbid vigilance, mental irritability and despondency, partaking more of the nervous than of the simple inflammatory type, is peculiar. The blood drawn is strongly cupped and buffy. The pulse, rapid and stringy, becomes more full and soft after copious depletion, but the pain is only partially relieved." Surgically speaking, the safety of a patient in such a state will depend on free incisions. (See ERYSIPELAS AND DIFFUSE INFLAMMATION.) Besides the danger arising from enormous suppuration in loco, affecting probably the veins and lymphatics, there is that of secondary abscesses into the joints or viscera.

The second form, says Dr. Ferguson, assumes the character of mild typhus, with intestinal irritation. After a rigor and hot fit, there is marked irritation of the mucous membrane of the intestinal canal, either vomiting, nausea, or diarrhœa, in which the evacuations display every shade and degree of colour and consistence. The tongue, at first loaded and white, soon becomes preternaturally red. The skin is dry, hot, and dusky yellow; the mind is unsettled, without being absolutely delirious, and the impressions on the eyes are unwontedly vivid; the debility extreme, and the limbs tremulous. This form, if it terminates fatally, probably does so by purulent deposits, as the former does.

The third form is marked by anomalous nervous symptoms; extreme terror and depression; sudden and death-like faintings; sighing, tremors, and cramps—as in the case of Mr. Elcock, who died in forty hours after the receipt of a puncture in dissection, with *no local symptoms*, but with all the violent and alarming excitation of the nervous system peculiar to hydrophobia. (*Travers*, op. cit.)

The fourth form is the ataxic, or that in which local deposit in various organs defies all calculation, and, too often, all remedy. Extreme prostration: a rapid pulse; a skin dry, or offensively perspiring; a dusky red patch on the cheek; "a dull, glassy eye, encircled in leaden lids;" oppressed and sighing respiration; mind calm, and often wonderfully unconscious of danger. Such are the general symptoms which attend those pyæmic states, of which rapid effusion into, and disorganisation of, the eye, brain, joints or viscera, are the usual and fatal consequences. (See ERYSIPELAS, ABSCESS, PYÆMIA, POISONED WOUNDS.)

The treatment will be found under the articles just quoted.]

[III. HECTIC. *Acute hectic* is a constitutional condition for which the surgeon may be consulted, and in which he may have to rely on his own sagacity for the detection of the local cause.

As we observed in the article ABSCESS, *shivering* is an accompaniment of most blood changes. It occurs at the beginning of fever and inflammation, for instance. But there is another kind of shivering, which may occur in the *course of* an inflammatory attack, and which indicates that pus is being absorbed from the seat of disease.

It is often stated in surgical books that rigors are a sign of suppuration. This is not true in a general sense; on the contrary, suppuration may occur without rigors; but they occur when the pus under certain circumstances, not having vent, is absorbed into the blood; and they constitute the first state of acute hectic.

We define, then, the acute hectic, to be a fever having daily paroxysms, and depending on the absorption of decomposing pus.

The symptoms are usually these. A patient, who has some concealed abscess, or who has an abscess which is not opened, or which if opened does not thoroughly discharge itself, is seized with violent shivering, exactly resembling, and probably quite as severe as the cold stage of an ague. The most remarkable case which the writer ever saw is that of a lady with ovarian disease of thirty years' duration, who was suddenly seized with shivering, the commencement of a fatal illness; so severe was it that she was quite unable to move from her chair to the other side of the room to ring for assistance. It is attended with blueness of the nails, shrinking of the fingers and all the other signs of ague. To this follows a hot fit, with flushing, headache, and thirst: and to this, a sweating fit; the hair and skin and bedclothes being soaked in a clammy, offensive perspiration, which goes off, leaving symptoms of extreme debility.

The time at which the writer has observed these symptoms to come on, has been from four to six P.M.; and they last from eight to ten hours in well marked cases. During the day, paleness, and quickness of the pulse and languor remain. If the case goes on, the next symptom is a cleaning of the tongue, the epithelium of which becomes thin, so that it looks like a dog's tongue, or even redder. To this follows a tendency to diarrhœa; and frequently very decided attacks of that malady, with mucous and bloody evacuations. Meanwhile the appetite fails: sleep is lost: the hair falls off, emaciation increases, and unless the local cause be removed, the patient either passes into the state we call the *Typhoid-like* or *Sulphide-of-Ammonium-in-the-blood-stage*, or else sinks exhausted.

That these symptoms arise from the absorption of deleterious matter from abscesses and the like, is evident, partly from the facts of the case and from analogy; partly from the instant relief afforded when the abscess is opened, or other means taken to remove the cause. (See *Case*, *Art.* ABSCESS, p. 8.)

Whenever such symptoms present themselves, therefore, the surgeon is bound to make the most diligent scrutiny for some local cause which can give rise to them.

Nevertheless, Hunter and his followers denied that the absorption of pus gave rise to hectic; because, said they, much pus is absorbed without hectic. "If," he says, "the absorption of matter always produced the symptoms above described, how could any patient who has a large sore possibly escape hectic? for there is no reason to suppose that one sore can absorb more readily than another. If absorbed matter occasioned such violent effects as have been commonly ascribed to it, why does not venereal matter do the same? We often know that absorption is going on, by the progress of buboes. A large one, just on the point of bursting, has been known to be absorbed, in consequence of a few days' sea-sickness. The person continued at sea for four-and-twenty days afterwards; yet no hectic symptoms followed, but only the specific constitutional effects, which were of a very different description."

To this the reply is simple. It is not pretended that the absorption of pus *simpliciter* will cause hectic; but of pus, and of other substances in certain states of decay. This is well illustrated by a case put by Hunter himself. He says that in large chronic abscesses the hectic seldom comes on until after they have been opened, although they may have been forming matter for months. But in such cases the disposition often comes on soon after opening.

The fact is, that after the opening of a large and incurable abscess absorption of matter may take place, which has been partially decomposed by exposure; and which may produce hectic now, though not in its undecomposed state.

The Hunterian theory was that hectic depends on the parts being stimulated to produce an effect which is beyond their powers; that this stimulus is sooner or later in taking effect, in different cases, and that the constitution becomes affected by it: "The universal sympathy with a disease which gives the irritation of being incurable;" "the constitution irritated with an incurable disease;" or "harassed with a disease where the parts have no power, or, what is more probable, have no disposition to produce a salutary inflammation and suppuration." These are various explications, in which the solidism of Hunter appears conspicuously.

Common or Chronic Hectic. Under this term we are obliged to include almost all the constitutional symptoms of all the diseases that wear out life by a process of slow exhaustion, and which are attended with chilliness and accessions of fever.

In the first place, there are the cases in which incurable local disease is the main cause of the hectic: such as disease of joints, necrosed bone, and the like. In these cases there may be some absorption of pus; or it may be merely the continued influence of pain and sleeplessness; of bad appetite, and bad digestion; of want of air and exercise, which bring the patient to the extremity of weakness.

In the next place, hectic may arise from some blood changes, which are the result of bygone morbific influences, and are the parents of local disease. Thus in the early stage of phthisis, in disease of the kidney, in secondary syphilis, in subacute periostitis, in various forms of dyspepsia, reiterated attacks of febricula occur, consisting of evening chills, followed by flushes, hot skin, quick pulse, and night perspirations. There is no doubt whatever but that these hectic symptoms may exist, either in incipient cachectic disease, or in prolonged disease, without being caused by absorption of pus.

Nevertheless, the writer believes that in cases in which the hectic character is the most strongly marked, in which the paroxysms are most regular, the pulse quickest, the tongue red, and the bowels most irritable, that there an absorption of pus is most probable.

For example: The writer is at this moment attending a gentleman in the early stage of phthisis. There is some morbid deposit in the upper lobe of each lung, some cough, and some muco-purulent expectoration; but judging by analogy, no ground for assuming absorption of pus more than there would be in every case of catarrh. Moreover, the pus is not offensive. This patient has had several attacks of febricula, *i.e.* evening chills and profuse night perspirations, but they come irregularly, and although attended with diarrhœa, it is not severe.

On the other hand, the writer was lately attending an aged lady with epithelial cancer of the womb. As the disease advanced, the discharge became more offensive and profuse, and the ulcerated surface larger. On a sudden, one day her bowels became irritable, and her tongue, from being of the ordinary colour, was observed to have lost its epithelium, and to be red as a dog's tongue. This condition, with evening paroxysms of restlessness, lasted till her death.

In the former of these cases, we assume that the hectic arose from malassimilation or tuberculosis, and indicated deposit: in the latter, that it indicated absorption of decaying pus.

The *symptoms* of common hectic are evening chills, followed by heat, thirst, and restlessness, and by profuse perspiration. The perspiration generally begins soon after the patient has dropped asleep, and wakes him up. It is profuse, often offensive. The urine loaded with red sediment.

To these are added many signs of wasting and debility. The hair falls, the finger nails chip, the teeth decay; (although the theory has been broached that caries of the teeth is a preservative against phthisis); the skin is harsh and withered, and there is a general air of languor. The state of the appetite depends upon circumstances. In some cases, in which the digestive organs are not primarily or secondarily involved, the desire for food is immense, and digestion amazingly rapid. In others, in which diarrhœa prevails, all food may be loathed. The state of the bowels too is usually loose, but not unfrequently scrofulous ulceration of the mucous membrane comes on, and then there are attacks of the severest pain, with bleeding, and that intolerable fœtor of the motions which ensues when blood is mixed with fœcal matter and has time to decompose. Death, in these cases, usually occurs by asthenia; the patient faints away, and never recovers.]

[IV. The Putrid or Typhoid Type of traumatic fever, is that which is caused by the absorption of truly putrescent matter, probably of the sulphide of ammonium.

John Hunter, who may always be depended upon when he describes what he has seen, devotes a section of his work on the Blood and Inflammation to what he calls *dissolution*, or the manner in which death occurs after external injuries. He says that it may occur at any stage after an injury; sometimes appearing to be a continuation of the sympathetic fever, sometimes following a protracted suppuration and hectic. A man, he says, shall lose his leg, or suffer a bad compound fracture, and the earliest symptoms shall have subsided, and all seem to be going on well, "when suddenly he shall be attacked with a shivering fit, which shall not perform all its actions, viz. shall not produce the hot fit and sweat, but shall continue a kind of irregular hot fit, attended with loss of appetite, quick low pulse, and sunken eyes, and the person shall die in a few days." "Or, if the local disease does not or cannot heal, and is such as to affect the constitution, it then brings on the hectic, and sooner or later dissolution takes place."

The symptoms, according to Hunter, are shivering and vomiting, oppression, anxiety, and expectation of death; quick small pulse, perhaps bleeding from the whole surface of the sore; often mortification, with every sign of dissolution in the countenance.

This disease also, he says, has been supposed to arise from the absorption of matter. It is apt to follow violent and long-continued inflammations and suppurations, particularly of the lower extremity; it takes place more readily in hospitals than in private houses, and in cities than in the country. It is liable to follow amputation of the leg, and cutting for the stone in fat men who have lived well; and appears, according to Hunter, to be a thorough failure and abandonment of vital power. Hectic and "dissolution," he adds, are by no means the same disease; and that hectic may generally be relieved if its cause be removed; whereas "dissolution seems more to be connected with the past than the present;" that is, to be the result of foregone and irremediable exhaustion.

It is easy to recognise in Hunter's description some cases of pyæmia, perhaps some of hospital gangrene; and above all, the condition which we now proceed to describe.

Suppose a large chronic abscess, which has been opened; the sac has bled, the pus has putrified. Now come shivering, a hot skin, dusky complexion, dry brown tongue, sordes on the teeth, and weak, fluttering pulse. The ulcer or sac ceases to suppurate, but oozes a scanty bloody serum. The bowels are probably loose; the nervous system is profoundly disturbed ; low muttering delirium, twitching, and the other well-known symptoms which usher in death.

That these symptoms arise, not from exhaustion, as Hunter thought, but from poison, was distinctly believed long before Hunter, but was proved experimentally by M. Bonnet of Lyons, in a paper published in the *Gazette Médicale*, and translated in the London Medical Gazette for 1837, (vol. xxi. p. 490, *On the absorption of pus which has been in contact with the atmosphere.*)

M. Bonnet shows that the fœtor of putrid pus depends on the presence of sulphide of ammonium, which cannot be detected *in it* by ordinary tests, because the presence of albumen sets at nought all the ordinary metallic reactions. The same with the blood and urine. But if test papers be exposed to the *vapour of the pus*, raised if necessary by heat, all the reactions are exhibited perfectly. He gives the following case:—

A man received a severe bruise of the ankle. Gangrene of the skin and subcutaneous tissues followed. The pus had an indescribable fœtor, and gave off vapours which restored reddened litmus and blacked lead paper. So soon as the sores were bathed with this fetid pus, on the 10th day "he was seized with rigors, which having lasted an hour, were followed by fever, with extreme acceleration of the pulse, and abundant sweats. The febrile attacks were repeated until the 14th day, sometimes in the morning and sometimes in the evening. At a later period they were no longer preceded by a sensation of cold, and were merely characterised by fever and sweating. These fits were accompanied by a very fetid diarrhœa, the loss of strength became extreme, and the face of a paleness slightly tinged with yellow."

On the 16th day a large quantity of sulphide of ammonium was detected in the pus. On the 17th a small quantity of blood was taken, more fluid than usual, and of the colour of wine lees when slightly wetted. It gave off vapours of ammonia, as discovered by a glass rod dipped in hydrochloric acid ; and of sulphuretted hydrogen likewise. The urine was clear, pale, with no sediment, and alkaline ; its vapour gave the same reactions as that of the blood.

In another week, the fœtor of the pus abated, and the urine recovered its acidity.

Dr. T. Herbert Barker's experiments on the inhalation of cesspool vapours, and of sulphide of ammonium, give precisely similar results—excited circulation and thirst, twitching of the limbs, and dry dark tongue : after death the blood was found dark and ill coagulated ; the corpuscles dissolved, and congestion of fluid blood in the vascular organs. (*On Influence of Sewer Emanations, Sanitary Review*, 1858. *Extract from Fothergillian Prize Essay.*)

Dr. Richardson, who obtained the Astley-Cooper prize for his essay on the Coagulation of the Blood, and whose zealous prosecution of experimental research is well known, has the following observations on this subject:—

"In cases where putrid matter is imbedded in the system, as when deep seated abscesses, open by fistulous canals to the air, exist in the organism, and contain pus in a state of partial decomposition, ammonia is fully generated by decomposition of the putrid material, and is sometimes, I have reason to suspect, when the exit for the purulent matter is not free, absorbed by the surrounding tissues, and taken up into the blood. Here received, the toxical effect is not slow in being developed, and the 'typhoid' which succeeds is the result, not of so-called irritation, not of exhaustion from the drain, but of poison generated in the cavity and conveyed from it to the body at large." (*On the Coagulation of the Blood, Lond.* 1858, p. 353.)

The effect of a too alkaline state of the blood is shown in these cases by the corpuscles, which become crenate, many-sided, collapsed, or even dissolved.

To sum up our observations on the varieties of hectic fever: we have shown that there is one division of so-called hectic in which the symptoms depend upon intrinsic blood changes, which are caused by mal-assimilation, and which often accompany the beginning of tubercular and other deposits. Such feverish symptoms are very irregular, and may be so slight as to merge into mere cachexia.

But there is another set of cases of hectic, dependent upon absorption of decaying or putrid pus. Probably, if such pus finds its way bodily into the blood-vessels, we shall have pyæmia. If its vapour or serum, then, according to the quantity and intensity of the matter absorbed, we may have the acute hectic, the milder common hectic, or the putrid variety. (*See also* ABSCESS, p. 9.)]

[TREATMENT OF THE VARIETIES OF HECTIC. We cannot undertake to detail the treatment of that sort which accompanies broken health in general, otherwise we should be here repeating matters which will be found under the head of chronic inflammation and scrofula ; or which would embrace the whole treatment of disorders of mal-assimilation.

But as regards the varieties of true hectic from absorption, the indications are palpably these two: first, to remove the local cause if possible, and whether or no to strengthen the system as much as possible.

The first indication will be fulfilled if there be a deep abscess in the breast or perineum, or elsewhere, by giving free vent to the matter. "If," says Hunter, "the hectic arises from local disease in such parts as the constitution can bear the removal of, then the diseased part should be removed by amputation." "I have known a hectic pulse at 120 sink to 90 in a few hours upon the removal of the hectic cause. I have known persons sleep sound the first night without an opiate, who had not slept tolerably for weeks before. I have known cold sweats stop immediately, as well as those called colliquative. I have known purging immediately stop upon the removal of the hectic cause, and the urine drop its sediment."

Every sort of local treatment capable of relieving the particular local condition present is to be put into force. But in a condition of poisoning by sulphide of ammonium, surgeons will do well to remove or neutralise the matter whose decomposition furnishes that substance. Abscesses, therefore, should be drained by M. Chassaignac's drain tubes, if they seem appropriate. Matter should not be allowed to bag or lodge, and *adequate* chemical means should be adopted to deodorise any that remains.

The writer lays stress on the word *adequate*. Vexatious is it to see a man rotting with a putrid abscess, and having perhaps a tray of charcoal by his bed-side and a little chloride of lime on a rag outside the wound. Surely there are chemical means at hand, including watery solutions of creosote, of nitrate of lead, chloride of zinc, Condy's permanganates, and the chloride of lime; which, if effectually applied, will neutralise putrescent matter.

In the general treatment, the first point is to supply a most abundant and varied nutriment, so that the blood, filled with new and healthy matter, may better bear the exhaustion consequent upon the elimination of the old. The ingenuity of the practitioner will often be taxed to suggest fresh articles to stimulate an enfeebled stomach, for it is most true that novelty and change are most essential. First, we may mention the preparations of meat; essence of beef and gravy soups; turtle, mock-turtle, calves' tail, and other gelatinous soups; milk flavoured with rum, with orange peel, or vanilla; isinglass; fish soup, fish pudding with cream; custards thickened with pounded meat; potted beef or tongue; the starches in their turn, arrowroot, sago, tapioca, tous les mois and salep; Indian meal, chocolate and cocoa; the oily fishes, cod-liver oil, eels, American oysters; gum-arabic and tragacanth; lastly, the various wines and beers, especially Guinness's genuine Dublin porter.

Next to nourishment, the means of sharpening the appetite are to be cultivated. For most cases an acid tonic with quina in small doses, or some other light bitter, answers best; or perhaps the nitromuriatic or sulphuric acid.

For sleeplessness and pain, adequate doses of morphine should be given. When the paroxysms of shivering are diurnal and regular, the writer has sometimes succeeded in postponing or averting them by large doses of quinine, or by opiates, or ether, given before the fit, as in ague. But this plan does not answer many times in succession.

The perspirations may be mitigated by the dilute mineral acids, Griffiths' iron mixture, or, as Dr. R. Dickson suggests, by the oxyde of zinc.

Diarrhœa may be mitigated likewise by the mineral acids; or, if the tongue be red and aphthous, by bismuth, chalk, gum, and small doses of opium.

Vegetable bitters and astringents have their uses, provided they promote and do not interfere with the appetite and digestion. Pure tannin in grain doses; or still better, the decoction of oak-bark, or tincture of galls, is a very efficient and agreeable tonic; the pure bitter quassia or hop is also palatable; and the decoction of bark with nitric acid requires no praise. (*R. Druitt.*)

FINGERS, ABSCESSES OF, see Whitlow; Amputation of, see Amputation; Dislocations of, see Dislocation; Fractures of, see Fracture.

[The fingers may be more or less numerous than ordinary, and when perfectly formed, require no surgical treatment. Of this abnormal development the former is of more frequent occurrence than the latter. The supernumerary digit is generally situated on the ulnar side of the hand: when on the radial side, which is much more rare, two thumbs are present. These irregularities are hereditary, and usually occur on both hands; they do not interfere with the usefulness of the hand or the remaining fingers. M. Nelaton mentions a case of four fingers only, or rather of three fingers and a thumb; the deficiency occurred on the left hand. Similar cases are on record affecting one or both hands. Imperfectly formed supernumerary fingers are occasionally found articulated with the ulnar side of the metacarpal bone or first phalanx of the little finger, or with the radial side of the analogous bones of the thumb.]

Fingers Supernumerary.

Since allowing the redundant number of fingers to remain would keep up deformity, and create future inconvenience, the surgeon is called upon to amputate them. The redundant fingers may be with, or without, a nail; seldom more numerous than one upon each hand; generally situated just on the outside of the little fingers; and, so far as my observation extends, incapable of motion in consequence of not being furnished, like the rest of the fingers, with muscles. For the most part, the phalanges are also imperfectly formed, or deficient. The best plan is to cut off supernumerary fingers with a scalpel, at the place where they are united to the other part of the hand. The operation should be performed while the patient is an infant, that is to say, before the superfluous parts have acquired much size.

Fingers, Permanent Contraction of.

Baron Dupuytren has made some interesting observations on this affection, to which each of the fingers, but especially the ring-finger, is liable. Most of the individuals who have this infirmity have been accustomed to make efforts with the palm of the hand, and to handle bodies of great hardness. When a tendency to the complaint begins, some difficulty is experienced in extending the fingers; and the affected one, usually the ring-finger, soon becomes contracted; the metacarpal phalanx being first implicated, and the others afterwards inclining in the same direction. In this stage the flexion of the two adjacent fingers becomes more marked, but no knottiness is yet perceptible in front of, and around the cord on the palmar side of the ring-finger. Its second and third phalanges are straight and movable; the first is bent more or less to a right angle, and is movable on the metacarpal bone; but it cannot be put into the straight position by the most violent efforts. Dupuytren refers to a case in which a trial was made to cure the patient by means of the application of different weights, which were increased up to 150 lbs., without the flexion being removed.

When the ring-finger has become very much bent, the skin is thrown into curved folds, the concavities of which are towards the fingers, and the convexities towards the radio-carpal articulation. On first inspection one might suppose the skin to be diseased; but this is not the case. A tense cord is felt on the palmar side of the finger; it extends towards the first phalanx, and may be traced to the upper part of the palm. When the finger is bent, it disappears almost entirely. If attempts be made to extend the fingers, the tendon of the palmaris muscle is felt to move, and the motion is propagated to the upper part of the palmar fascia. The patient is unable to grasp largish bodies; and, if he try to take hold of them more forcibly, or an endeavour be made to extend the fingers, he experiences acute pain. The causes of this disease were formerly referred either to thickening and contraction of the skin, spasm of the muscles, disease of the flexor tendons, or that of their fibrous sheaths, or some change in the articular surfaces and lateral ligaments. All was uncertainty, when Dupuytren had an opportunity of dissecting a hand in which this infirmity existed. A drawing having been first made of it, the integuments were removed from the palm and palmar aspect of the finger, after which the folds and wrinkles had entirely disappeared. From this it was clear that the disorder did not depend upon the state of the skin. As soon as the palmar fascia had been exposed, it was found to be tense, contracted, and shortened, and that from its inferior part cords or bands proceeded to the sides of the affected finger. On attempts being made to straighten the finger, M. Dupuytren observed that the fascia became tense. He then divided the prolongations of it extending to the sides of the finger. The contraction ceased immediately, and the fingers assumed a very slightly bent position. In fact the disease was ascertained to be owing to the extreme tension of the palmar fascia, brought on by a contusion of the palm, or the long continued pressure of hard substances upon it. The plan of cure adopted by M. Dupuytren consisted in making a transverse incision, about ten lines in length, over the metacarpo-phalangeal joint of the ring-finger. The skin was first divided, and then the palmar fascia. As soon as this had been done, the finger became straight, and could be extended almost as readily as in the natural state. After the operation the hand was fixed with a bandage upon a piece of pasteboard for a few weeks, and the fingers kept extended. In one case M. Dupuytren made semicircular incisions; one at the base of the ring-finger in order to divide the two digital and lateral prolongations of the palmar fascia, sent to this finger; the other, an inch and a quarter from the first, in the palm of the hand, for the purpose of dividing the digital prolongation at its root, and thus detaching it from the palmar fascia. (See *Dupuytren Clin. Chir.* t. i. art. 1.)

In a lecture, delivered subsequently to the preceding observations, M. Dupuytren adverts to flexions of the fingers arising from other causes; as a previous wound of the palm, known by the scar; alteration in the formation of the phalanges, by disease, and unattended with the kind of cord observed when the palmar fascia is implicated; and a division of the extensor tendons with a cutting instrument, which, not being united again, leave the flexors without any antagonists. A contused wound, producing sloughing of the skin of the palm, may have the same result if its edges be suffered to be drawn together, instead of cicatrisation being completed by the formation of a new cutaneous texture. (See *Clin. Chir.* t. i. p. 521.) Burns of the palm are frequently followed by this deformity when the preceding indication is neglected. Amongst other causes of permanent flexion, M. Dupuytren notices deformity of the articular surfaces of the phalanges, produced by the long continued position of the fingers in certain employments, as in lacemakers, tailors, &c.; by wounds of the flexor tendons, or their displacement, in consequence of having been extensively laid open for the cure of whitlow. The wound of a joint may be another cause of contraction of the finger; and a gunshot-injury of the flexor muscles may lead to the same consequence. M. Dupuytren's observations on this subject seem to me equally original and valuable. The toes are also liable to a contraction, dependent upon a state of the plantar fascia, corresponding to that of the palmar.

Dupuytren's view of the cause of contraction of the fingers above alluded to, viz. that the bands hindering the extension of the finger were produced by a permanent contraction of portions of the palmar fascia, was also held by the late Mr. Henry Cline, and, as would appear from an extract taken from his lectures, and published in one of the volumes of the *London Medical Gazette*, even prior to the period when Dupuytren taught the corresponding doctrine. The former had also anticipated the latter in the practice naturally dictated by such contemplation of the cause of the deformity. MM. Goyrand and Velpeau, however, object to the explanation of the subject given by Dupuytren, because the digital slips of the palmar fascia terminate in, and are fixed to the base and sides of the root of each finger, whilst the diseased band is situated in the middle of the finger, and is often prolonged to the third phalanx. They both concur, therefore, in ascribing this contraction to the transformation of a part of the subcutaneous cellular tissue in front of the phalanges into a fibrous band. M. Sanson also believes that this is the ordinary case, and that the contraction of the palmar fascia is an exception. The treatment recommended by M. Goyrand, is to make a longitudinal incision through the skin, over each band, when extended; to separate the lips of the wound; to detach the fibrous cords by dissection, and to cut across them when thus detached from their connections. (See *Gaz. Méd.* No. xxxi. and xxxii. Août, 1835.) Sir Astley Cooper passes a narrow knife under the cord, which is cut through without dividing the skin.

[The fingers are subject to a congenital deformity resembling the web-foot of aquatic birds or animals, in which the skin passes from one finger to another, connecting their lateral surfaces for a greater or less extent. These deformities vary greatly, both as to the width and length of the connecting web; sometimes it extends only to the first phalanx, at others it implicates the whole length of the fingers; in one instance the intervening web may be an inch wide or more: in another, the adhesion between the fingers may be close and intimate. In the most extreme cases, the fingers are enveloped in one cutaneous covering without intervals between the fingers, the phalanges of which may, however, be distinctly felt. Various modes of operative procedure have been devised for the removal of these deformities. No one plan is applicable to all the cases; the surgeon must in each individual instance select the operation most suitable to its peculiarities. The most simple plan is to divide the web longitudinally into two lateral halves from its free edge to the cleft between the fingers, then to adjust by means of sutures the edges of each lateral half, so as to facilitate their union by the first intention. Unfortunately the web is always narrow exactly at the cleft between the fingers, and when it is divided the edges of each lateral half become widely separated; the consequence is that they can only be brought in contact by force, and union is rarely effected. The granulating surfaces resulting after the failure of union on either side, cannot be prevented from coalescing, new skin will not form over them, and in spite of all modes of dressing the deformity in many cases will recur. To obviate this frequent cause of failure it has been proposed, in the first instance, to make a triangular flap from the posterior fold of the web; this flap is to be left attached at its base, and is to correspond in shape and size to the space between the knuckles; its apex should be directed towards the free edge of the web; the flap being dissected back is to be applied to the cleft between the fingers, and must be cut of sufficient length for this purpose. The remainder of the web is now to be divided longitudinally into lateral halves ; the edges of each lateral half are to be adjusted by sutures, and the triangular flap fitted into the cleft, and there maintained by the same means. It has also been suggested to make an anterior and posterior triangular flap from the web, to truncate their apices, and unite them by sutures between the fingers before making the longitudinal section of the web. A very ingenious operation is described by M. Nélaton, which must effectually prevent the growing together of the contiguous surfaces of the fingers. It consists in dividing the web into a posterior and an anterior flap ; the posterior flap being intended to cover the raw surface of one finger, and the anterior that of the other. Each flap is formed by one longitudinal and two transverse incisions, each is the counterpart of the other, and has three raw unattached edges, and one attached. They are cut in the following manner. A longitudinal incision is made in the centre of the phalanx of one finger, on its dorsal aspect for the posterior flap, on the palmar aspect of the other for the anterior flap ; the length of the incision must correspond with the depth of the web; from either extremity of the longitudinal incision, a smaller transverse one is to be made towards the phalanx of the connected finger. The lower transverse incision will correspond to the free edge of the web ; the upper will cross the cleft between the fingers. Each flap is now to be dissected back towards the contiguous finger ; in doing this the two folds of the web will be separated from each other, one entering into the formation of the posterior flap, the other into the formation of the anterior. Each flap will now be found to be attached by one edge only, and is to be wrapped round the denuded surface of the finger to which it is attached. The flaps are to be adjusted by strips of adhesive plaster and by sutures.]

FISSURE (from *findo*, to cleave asunder). A fine crack in a bone is so called.

FISTULA, an opening, the consequence of a wound, abscess, or ulceration; it has no disposition to heal, and is connected with a channel, or canal, running more or less deeply and extensively in the soft parts. From the resemblance of this channel to the tube of a pipe, or reed, the term is derived. A fistula commonly leads to the situation of some disease keeping up suppuration ; and from which place the matter cannot readily escape. Thus, the presence of a dead piece of bone, or of a foreign body often keeps up suppuration, and the fistula continues for the discharge of the matter. When an abscess forms near the anus, the matter lodges, the part is disturbed by the action of the sphincter, and a *fistula in ano* is produced. Sometimes a fistula is produced by the continual discharge of some healthy secretion through a wound, or ulcer, as exemplified in salivary, lachrymal, and urinary fistulæ. The lining of old fistulæ may assume the appearance of certain mucous membranes, though follicles and villi, like those of the intestinal canal, have never been observed in it. As Andral remarks, when most perfectly organised, it can only be compared to the most simple mucous membranes, such as those of the ureters, or lesser branches of the hepatic ducts. The lining of fistulæ, like mucous membranes in general, when not irritated, is pale and of a greyish colour ; but, if affected with acute or chronic inflammation, it exhibits the same shades of injection and redness seen in a mucous texture. It is also liable to certain affections, which pertain almost exclusively to mucous membranes, as fungous growths, callosities, &c. The cellular tissue, connected with the lining of fistulæ, may become thickened and indurated, just like the submucous cellular tissue in general. Finally, just as adhesions never take place between the different points of a surface lined by a mucous membrane, unless a solution of continuity has taken place in it, so the sides of a fistula cannot adhere together, and its cavity be obliterated, unless incisions be made to bring the textures and the membrane-like investment of it into contact. (See *Andral*, *Précis d'Anat. Pathol.* t. i. p. 261.)

FISTULA IN ANO. See Anus.

FISTULÆ IN PERINÆO. Incisions in the urethra generally heal with great facility; a fact amply proved by the common result of lithotomy: but, when apertures are formed in the urethra, either from diseased states of the constitution and the part together, or of the latter alone, and when they are accompanied with any considerable destruction of the sides of the urethra, and of the corpus spongiosum, they are difficult of cure. (*Sir B. Brodie*, *in Med. Gaz.* Dec. 26. 1835. No. 13.)

When the methods recommended for the removal of strictures (See Urethra, Strictures of) have not been attempted, or not succeeded, nature endeavours to relieve herself by making a new passage for the urine, which, although it often prevents immediate death, yet, if not remedied, is productive of much inconvenience and misery to the patient through life. The mode in which nature endeavours to procure relief is by ulceration on the inside of that part of the urethra which is enlarged, and situated between the stricture and the bladder. Thus the urine becomes applied to a new surface; irritating the part, and occasioning the formation of an abscess, to which the urine has access; and when the matter is discharged, be it by nature or by art, the urine passes through the aperture, and generally continues to do so, whilst the stricture remains. (*Sir A. Cooper*, *Surgical Essays*, part ii. p. 212.)

In rare cases a fistula in perinæo occurs as a consequence of severe gonorrhœa. The urine comes away in a very small stream, because the urethra is inflamed, swollen, and contracted. At last, a pain is felt in the perinæum, a tumor is felt there; and this state is frequently attended with complete retention of urine, or with great difficulty of making water. At length the tumor bursts, or is opened with a lancet, pus is discharged, then the difficulty of making water subsides, and, a day or two afterwards, the patient finds that, whenever he voids his urine, a portion of it comes through the opening in the perinæum. (*Sir B. Brodie*, *in London Med. Gaz.* vol. for 1835—36, p. 486.)

The ulceration, which is usually on the side of the urethra next the external surface, commonly begins near, or close to the stricture, although the stricture may be at a considerable distance from the bladder. The stricture is sometimes included in the ulceration, by which means it is removed; but this does not frequently happen.

[If the urethra gives way rapidly, the urine readily gets into the loose cellular textures of the scrotum and penis, and it may diffuse itself throughout them, producing violent and destructive inflammation; a condition known as EXTRAVASATION OF URINE.] The presence of the urine prevents the adhesive inflammation from taking place; it becomes the cause of suppuration wherever it is diffused, and the irritation is often so great that it produces mortification, first in all the cellular tissue, and afterwards in several parts of the skin; all of which, if the patient live, slough away, making a free communication between the urethra and external surface, and producing what are termed *fistulæ in perinæo*, though it is plain enough to every surgeon who knows the correct meaning of the word *fistula*, that a recent opening, produced in the perinæum by ulceration or sloughing, ought not to be called a fistula immediately it is formed, and, at least, not until it has acquired some of the characters specified in my explanation of the term *fistula*.

A fistula in perinæo, then, is the result of an abscess in the perinæum, communicating with the urethra at one extremity, and opening externally at the other. "The whole or part of the urine flows through the fistula, whenever the patient makes water; the constant irritation of the urine causes the sides of the fistula to become hard and callous; and, at last, a sort of button-like projection, with the orifice of the fistula in the centre, is discovered in the perinæum. The fistula differs in length and size, and the opening into the urethra differs in size also. There is sometimes a single fistula, sometimes there are several; and, accordingly as the fistula is larger or smaller, accordingly as there are more or less sinuses, communicating with the urethra, so does a larger or smaller quantity of urine escape through this unnatural passage whenever the patient makes water. Sometimes the urine thus voided amounts to only a few drops, sometimes it comes away in a small stream, and sometimes it comes away in so large a quantity, that that which is voided by the perinæum is greater than what is voided in the natural way." (*Sir B. Brodie, in Lond. Med. Gaz.* vol. for 1835—36, p. 486.) I have seen a few examples in which all the urine was discharged through the fistula. In the King's Bench there was a man, about four years ago, who had been passing the whole of his urine through a fistula in the perinæum for fourteen years; and the anterior portion of the urethra seemed to be obliterated.

Although a fistula in perinæo is productive of much distress, inasmuch as the flow of urine in this direction wets the patient's dress, irritates the integuments, and sometimes the urine causes a good deal of pain as it is running out, the fistula, as Sir Benjamin Brodie has well observed, is not an evil unmixed with good. If a man has a stricture, it saves him from the ill consequences of a retention of urine. A spasm affects the stricture and he cannot make water through the natural passage; but the fistula being formed, the urine escapes from it, and thus the return of retention of urine, and the ill consequences of over-distension of the bladder, are prevented.

When the disease is the consequence of gonorrhœa, there is generally only a single abscess; but, when it is connected with a stricture, there may be many abscesses formed in succession. Thus, a patient, with a stricture of long standing, may have fistulæ produced in various directions, and terminating in the perinæum, the middle of the scrotum, or even in the groin, the nates, or the rectum. When the matter and urine have been freely discharged through one opening, a fresh abscess is not often formed; but, in the opposite case, several abscesses are liable to follow. (*Ib.*)

In many cases the matter is putrid and offensive, in consequence of the pernicious effects of the urine, and the admixture of it and dead cellular tissue with the pus which is produced. Sir Benjamin Brodie is of opinion that the matter may even act as a poison on the system; and, on this principle, he partly explains the repeated shiverings during the formation of the abscess, the dry brown tongue, hot skin, frequent pulse, and other typhoid symptoms.

According to Mr. Hunter, when ulceration takes place further back than the portion of the urethra between the glans penis and membranous part of the canal, the abscess is generally more circumscribed.

A fistula in perinæo, and extravasation of urine, producing gangrene, are both connected with ulceration of the urethra; but, as Sir Benjamin Brodie remarks, the ulceration occurs under different circumstances. "If the patient be making water in a small stream, and a little ulcer forms behind the stricture, the greater part of the urine flows out by the natural passage, and it is not probable that more than a few drops will dribble into the cellular membrane, through the ulcerated orifice. But if the patient has complete retention of urine, if the stricture be so contracted that not a drop of water can pass through it, and, if then the urethra ulcerates behind the stricture—the next time the patient tries to make water, he strains with the bladder and abdominal muscles, the urine cannot pass by the natural passage, and it is driven by the muscles, as by a syringe, into the cellular membrane of the perinæum first, and into that of the scrotum, penis, and nates afterwards, and a great deal of urine is extravasated. In the one case, it *dribbles* into the cellular membrane; in the other, it is *driven* into it; and hence sloughing under certain circumstances, and an abscess under others." (*Sir B. Brodie, in London Med. Gaz.* vol. for 1835—36, p. 487.)

[It is quite certain that abscess sometimes occurs without any primary lesion of the urethral walls, and this being opened in the perinæum, gives exit to no urine at first. After a few days, however, a communication forms between the cavity of the abscess and the urethra, and a fistula results. This is analogous to what takes place in ischio-rectal abscess bordering on the rectum, and gives rise to *fistula in ano.*]

Extravasated urine sometimes insinuates itself into the corpus spongiosum urethræ, and is immediately diffused through the whole, even to the glans penis, so as to produce a mortification of all those parts. A fatal instance of this kind is reported by Sir C. Bell. (*Surgical Obs.* vol. i. p. 96.)

Although the ulceration of the urethra be in the perinæum, the urine generally passes easily forwards into the scrotum, which contains the loosest cellular tissue in the body; and there is always a hardness, extending along the perinæum to the swelled scrotum, in the track of the pus. (*Hunter.*)

The direction which the extravasated urine takes is determined by the connection of the superficial with the deep perinæal fascia below the transverse muscle. This connection prevents the urine from extending towards the thigh or the buttock; and, if it become very widely extravasated it does not pass downwards or backwards, but forwards into the scrotum and penis, and then into the groins and cellular tissue of the parietes of the abdomen, and this nearly up to the ribs.

[When extravasation has taken place, free incisions should be made in the parts where swelling and tension are most evident, either in the perinæum, scrotum, or on the penis itself, in order to give abundant means of exit to the effused urine, and to the products of inflammation.]

Sir Astley Cooper is of opinion that, as soon as the abscesses, which are the forerunners of the fistula, can be plainly felt to contain a fluid, it is best to open them. They not unfrequently then heal up expeditiously without any fistulous orifice being left, and a tendency to those dangerous extravasations of urine is also prevented, which, if the abscesses are not opened early, often prove destructive to life. (*Surgical Essays*, part ii. p. 212.)

The occurrence of ulceration can only be prevented by overcoming the stricture; but when the urine is diffused in the cellular tissue, the removal of the stricture will generally be too late to prevent mischief, although it will be necessary for the complete cure. Therefore, an attempt may be made to pass a bougie, or rather a catheter, for perhaps the stricture may have been destroyed by the ulceration, so as to allow the instrument to be introduced. In these cases Sir A. Cooper expresses a preference to metallic bougies, the size of which is to be gradually increased, until their diameter exceeds the natural diameter of the passage. In some instances, however, he considers it advisable to introduce a metal catheter, of large size, and to allow it to remain in the bladder, so as at once to act upon the stricture, and hinder the urine from passing through the preternatural opening. In this manner a permanent cure may often be effected.

The experience of modern surgeons tends to prove, however, that particular cases form exceptions to the plan of employing bougies, or catheters, though a fistulous opening may have occurred; as when the apertures in the urethra are the consequences of ulceration and abscess, unaccompanied by stricture, and take place in a bad constitution, perhaps only preceded by a slight discharge from the urethra. Here bougies would increase the tendency to ulceration, and aggravate the local and constitutional irritation. (*Sir A. Cooper*, p. 216.) I believe that this is the right view of the latter point, because, when an abscess and fistulous opening form from gonorrhœa, they arise not so much from diminution of the canal of the urethra, but from the tendency in certain constitutions to have abscesses of this description produced by even slight degrees of irritation in the urethra. Hence, if a catheter be useful in such a case, it is not by dilating the urethra, but conducting the urine through it, without allowing it to enter the abscess. A bougie would serve no useful purpose.

[Furthermore, if, in a case of extravasation, free incisions have been made, and the urine flows off freely by them, which will be the case if they have been properly made, there is no occasion to pay much attention to the stricture at first; on the contrary, it is better to wait for a few days before applying any systematic treatment to it. The stricture will be more amenable to dilatation after rest, and the removal of the urine through the artificial openings which have been made.]

In fistulæ in perinæo from stricture, the cure mainly depends upon the diagnosis of the primary disease,—the obstruction in the urethra. In nineteen cases out of twenty, by the time that the stricture is fully dilated, the fistula has healed. It is more easy (as Sir Benjamin Brodie observes) for the urine to pass along the natural passage, if it be of its proper diameter, than it is for it to pass through the oblique passage of the fistula. The fistula has generally a kind of valvular opening into the urethra, which the urine does not readily enter; and when the stricture in front of the fistula has been dilated, and the urine has a free passage in that direction, it ceases to flow in the other.

Frequently the new passages for the urine do not heal, on account of the stricture not being removed; and even when this has been cured, they often will not heal, but become truly fistulous, and produce flesh inflammation and suppurations, which often burst by distinct openings. Such new abscesses and openings often form, in consequence of the former ones having become too small, before the obstruction in the urethra is removed.

Such diseases are sometimes accompanied by intermittent febrile symptoms, which do not yield to bark; but cease as soon as the fistulæ and disease of the urethra have been cured.

Cases occur where, from the communication of the fistula with the urethra being unusually large, or from there being several fistulæ, or from some other cause, the cure of the fistula, or fistulæ, does not immediately follow the removal of the stricture. Under these circumstances Sir Benjamin Brodie recommends an examination of the perinæum to be made, in order to ascertain whether there is any cavity in it in which the urine or pus lodges. If the orifice of the fistula is such that matter formed at the bottom of it does not readily escape, either the orifice should be dilated, or a fresh opening made elsewhere, according to the rules commonly recognised for the treatment of abscesses in general. But, if there is no impediment of this kind to the cure, and the stricture has been duly dilated, Sir Benjamin Brodie approves of the introduction of an elastic gum catheter into the bladder, and of its being continued there for the evacuation of the urine, under which treatment a cure of the fistula will often take place.

In some instances, the latter plan should not be continued beyond a certain stage of the case: at first, the catheter kept in the urethra frequently promotes the healing of the fistulæ; but, in the end, it may have the contrary effect, by acting at the bottom of the wound, as an extraneous body. This state of the case is particularly adverted to by Sir Benjamin Brodie:—"In many cases (says he) the permanent retention of a gum catheter in the bladder does not answer the intended purpose with respect to the cure of the fistula. It would do so if it altogether prevented the urine from flowing through it; but the fact is, that it does not in reality produce this effect; after three or four days a little urine always finds its way by the side of the gum catheter, and gets into the fistula, although the greater part is drawn off through the catheter. Another circumstance also takes place. The gum catheter acts like a seton, inducing inflammation and suppuration of the mucous membrane of the bladder; and some of the pus which is secreted passes through the fistula and keeps it open, as much as it would be kept open by the urine itself." (*Sir B. Brodie*, Op. et vol. cit. p. 488.)

If there be reason to suspect this to be the case, the best plan is to draw off the urine about every four hours and withdraw the catheter directly after each evacuation. The aim should be to let all the urine which is secreted be thus removed by the catheter, and no opportunity afforded for it to enter the fistula. But, as Sir Benjamin Brodie has explained, the urine sometimes cannot be comfortably retained the time required; and if the catheter be more frequently introduced it becomes a source of irritation, keeps up suppuration, and does as much harm as if it were continually retained. In a case which recently occurred, the permanent retention of catheters in the urethra, and the frequent introduction of them, were plans both tried unsuccessfully. One or two large deep cavities, filled with matter, and communicating with the fistulæ, were laid open, and this was followed by considerable improvement. But the use of catheters in any way always led to fresh abscesses, and could never be continued long and regularly enough without bringing on great local and constitutional disturbance. The constitution was indeed a truly irritable one. Abscesses at length formed successively in the testes, cord, and in the cellular tissue behind Poupart's ligament. An attack of diarrhœa came on, the appetite failed, and the gentleman died.

The opening of a fistula in the perinæum may sometimes be healed by touching it with the nitrate of silver, but the deeper part of it often continues unhealed, and abscesses form again. Hence, Sir Benjamin Brodie tried the plan of stimulating the bottom of the fistula, while he took measures to prevent the orifice from healing prematurely. A small quantity of nitrate of silver was melted in a platinum spoon, and the end of a probe, having been coated with it, was passed quite to the termination of the fistula, the orifice of which was then slightly touched with caustic potash. The method sometimes answered and sometimes failed.

If all these plans prove ineffectual, Sir Benjamin Brodie is in favour of trying what the daily introduction of a good-sized metallic instrument will accomplish.

When a perinæal fistula exists, communicating with the urethra, but having no external opening, a free incision is to be made into the abscess, and the rest of the treatment conducted on the principles applicable to common fistulæ in perinæo. Sometimes a small indurated lump, not bigger than a horse bean, may be felt in the perinæum. It may keep up for a long period a kind of gleet, in consequence of urine entering its cavity, and the matter oozing into the urethra. The cure consists in puncturing it, dilating the urethra with catheters, and, if necessary, touching the deeper part of the wound with caustic potash. (*Sir B. Brodie*, Op. cit.)

Some practitioners occasionally resort to the actual cautery for healing fistulæ in perinæo which resist milder plans.

The following method of laying open such fistulæ was more commonly followed a few years ago than at the present day.

As little as possible of the sound part of the urethra must be opened. Hence, the surgeon is guided to the inner orifice of the fistulæ by means of a staff, introduced (if possible) into the bladder, and a probe passed into one of the fistulous passages. The probe should be first bent, that it may more readily follow the turns of the fistula. When it can be made to meet the staff, so much the better, for then the operator can just cut only what is necessary. When the fistula is so straight as to admit of a director being introduced, this instrument is the best. When neither the probe nor the director can be made to pass into the staff, the sinuses are to be opened as far as the first instrument goes, and then the continuation of the passage sought and laid open. The difficulties of this dissection, however, through the thickened diseased state of the parts in the scrotum and perinæum when no staff can be passed, are only to be duly appreciated by a man who has either made the attempt himself, or seen it made by others. I have seen one of the first anatomists in London fail in two instances to trace the continuation of the urethra, and baffled in the endeavour to pass an instrument. The difficulty and confusion arising from the hardened enlarged state of the parts which are cut, have been well depicted by Sir C. Bell. (*Surgical Obs.* vol. i. p. 129.)

When fistulæ in perinæo have been laid open, the wounds are to be at first dressed down to the bottom, which will prevent a premature reunion of the parts near the surface, and make the granulations shoot from the bottom, so as to consolidate the whole by one bond of union. (*Hunter*, *On the Venereal Disease*, 2nd ed.; See also *Urinary Abscesses and Fistulæ*.)

[When from sloughing after extravasation, or from other causes, a large opening exists in the perinæum, or, as most commonly happens, just in front of the scrotum, and a portion of the urethra itself has been destroyed, some plastic procedure is necessary in order to restore and close in the canal. For an account of the various operations available in these circumstances, see URETHROPLASTY.] *Henry Thompson.*

FISTULA, SALIVARY. See PAROTID DUCT.

FLUCTUATION. The perceptible motion communicated to any collection of purulent matter, or other kind of fluid, by applying the hands to the surface of a tumor, and pressing with them alternately, in such a manner, that the fingers of one hand are employed in pressing, or rather in briskly tapping upon the part, while those of the other hand remain lightly placed on the opposite side of the swelling. When the ends of one set of fingers are thus delicately applied, and the surgeon taps, or makes repeated pressure with the fingers of the other hand, the impulse given to the fluid is immediately perceptible to him, and the sensation thus received is one of the principal symptoms by which practitioners are enabled to discover the presence of fluid in a great variety of cases. Great skill in ascertaining by the touch the presence of fluid in parts, or being endued with the *tactus eruditus*, as it is termed, distinguishes the man of experience as remarkably, perhaps, as any quality that can be specified.

When the collection of fluid is very deeply situated, the fluctuation is frequently obscure, and sometimes not at all distinguishable. In this circumstance the presence of the fluid is to be ascertained by the consideration of other symptoms. For example, in cases of hydrops pectoris and empyema, surgeons do not expect to feel the undulation of the fluid in the thorax with their fingers; they consider the patient's difficulty of breathing, the uneasiness attending his lying upon one particular side, the œdema of the parietes of the chest, the dropsical affection of other parts, the more raised and arched position of the ribs on the affected side, the preceding rigors, fever, and several other circumstances, capable of being learned with the aid of the stethoscope, from which a judgment is formed, both with regard to the presence and the peculiar nature of the fluid.

FOMENTATION. The application of flannel or cloths wet with warm water, or some medicinal decoction. Fomentations are chiefly of use in relieving pain and inflammation, and in promoting suppuration, when this is desirable. Some particular decoctions, however, are used for fomentations, with the view of affecting, by means of their medicinal qualities, scrofulous and other sores of a specific nature. I shall merely subjoin a few of the most useful fomentations in common use.

FOMENTUM AMMOMIÆ HYDROCHLORATIS. ℞. Fomenti communis ℔ ij. Ammon. Hydroch, ℥ j. Spirit. camph. ℥ ij. Just before using the hot decoction, add to it the hydrochlorate of ammonia and spirit.

FOMENTUM CHAMÆMELI. ℞ Lini contusi ℥j. Chamæmeli ℥ij. Aq. distillat. ℔ vj. Paulisper coque, et cola. A fomentation in very common use.

FOMENTUM CONII. ℞ Fol. conii recent. ℔ j. vel. Fol. conii exsiccat. ℥iij. Aq. comm. ℔ iij. Coque usque reman. ℔ j. et cola. Sometimes applied to scrofulous, cancerous, and phagedenic ulcers.

FOMENTUM GALLÆ. ℞ Gallæ contusæ, ℥ss. Aq. ferventis ℔ ij. Macera per horam et cola. Used in prolapsus ani, and sometimes employed as a cold application in hæmorrhoids.

FOMENTUM PAPAVERIS ALBI. ℞ Papav. Alb. exsiccati, ℥ iv. Aq. pur. ℔ vj. Bruise the poppies, put them in the water, and boil the liquor, till only two quarts remain, which are to be strained. Employed for the relief of pain, whether from inflammation, neuralgic affections, ulcers, &c.

FORCEPS, an instrument much employed in surgery for a variety of purposes, and having accordingly various constructions. The general design, however, of surgical forceps is to take hold of substances which cannot be conveniently grasped or reached with the fingers; and, of course, the instrument is always formed on the principle of a pair of pincers, having two blades, either with or without handles, according to circumstances. The smallest forceps is that which is employed in the operation of extracting cataract, and which is useful for removing any particles of opaque matter from the pupil, after the chief part of the crystalline lens has been taken away.

Another forceps, of larger size, is that used for taking up the mouths of the arteries, when these vessels require a ligature, in cases of hæmorrhage. This instrument is also frequently employed for taking dressings off sores, removing pieces of dead bone, foreign bodies from wounds, and particularly for raising the fibres which are about to be cut, in all operations where careful dissection is required. This forceps resembles that which is contained in every case of dissecting instruments, and is often called the *artery* or *dissecting* forceps, from its more important uses.

Neither of the foregoing forceps is made with handles; each opens by its own elasticity; and the ends of the blades only come into contact when pressed together by the surgeon.

The following kinds of forceps are constructed with handles, by means of which they are both opened and shut:—

1. The common dressing forceps, contained in every pocket-case of surgical instruments, and used for removing dressings from sores, extracting dead pieces of bone, foreign bodies, &c.
2. Larger forceps, employed for extracting polypi from the nostrils, or foreign bodies from the pharynx.
3. Forceps of different sizes and constructions, used in the operation of lithotomy, for taking the stone out of the bladder, or for breaking the calculus, when it is too large to be extracted in an entire state.
4. Cutting forceps, as the common bone-nippers, with transverse edges, and the sharp forceps, made with the edges in the same line with the handles, used by Mr. Liston, and others, for the division of bones.

FRACTURE. A solution of continuity of one or more bones, produced in general by external force; but occasionally, by the powerful action of muscles, as is often exemplified in the broken patella.

Fractures constitute so interesting a branch of surgery, and the accidents themselves are so frequent and important, that the more scientific and successful views now entertained of the whole subject, than those prevalent forty or fifty years ago, must be highly gratifying to every admirer of the incessant progress of surgery towards perfection. Nor is this branch of surgery simply mechanical, or restricted to the consideration of bandages, splints, and other apparatus; but comprises questions and investigations not surpassed, in respect to their scientific character, by any others in the whole range of surgery.

Let it not be any longer supposed, therefore, that the treatment of fractures is only a mechanical business. In fact, whoever pretends to be capable of conducting it efficiently, without a due acquaintance with anatomy and pathology, and the principles on which inflammation, abscesses, gangrene, wounds, ulcers, erysipelas, hæmorrhage, and various febrile disturbances of the constitution should be treated, must absolutely be a simpleton, or an impostor; for all these complications frequently accompany or follow fractures. Under such circumstances, what man of common sense would trust his limb and life to a mere bone-setter? But the sequel of this article will enable the reader to judge of the truth of these observations.

1. Differences of Fractures.

The differences of fractures depend upon what bone is broken; what portion of it is fractured; the direction of the fracture; the respective position of the fragments; and, lastly, upon circumstances accompanying the injury, and making it simple, compound, or variously complicated.

1. *In respect to the bone affected.* Sometimes it is one of the broad bones, as the scapula, the sternum, or the os ilium. Sometimes it is a short bone, like the os calcis; but far more commonly it is one of the long bones. The situation and functions of the broad bones render their fractures unfrequent. The bones of the skull are the only exception to this remark; but here the assistance of the surgeon is required less for the solution of continuity itself, than for the affection of the brain, and the extravasation of blood, with which the case is apt to be combined. Fractures of the short bones are still more unusual, because these bones, being nearly equal in their three dimensions, are capable of greater resistance, and are not much within the reach of external violence. Besides, most of them are but little exposed to the operation of outward force, by their situation, or functions. Hence, except when limbs are crushed, fractures of short bones are generally caused by muscular action, which frequently breaks the patella, and sometimes the olecranon, and os calcis. The long bones, which serve as pillars, or arches of support, or levers, are, from the very nature of their functions, particularly liable to fractures.

2. *In respect to the part of the bone broken.* The long bones may be fractured at different points. Very often their middle portion is broken, and, in this circumstance, they usually break like a stick, which has been bent beyond its extensibility by a force applied at each end of it. Sometimes the fracture occurs more or less near the extremities of the bone, which is always an unfavourable event. Lastly, the bone is sometimes broken in several places, and the injury may be produced by two different causes, which operate successively, or simultaneously, upon the broken parts of the bone; or it may be occasioned by one single cause, which acts at the same moment upon several points of it. These distinctions of fractures, deduced from their particular situation (says Boyer), are not mere scholastic refinements; they have a truly important influence over the prognosis and treatment.

3. *In respect to the direction in which the bone is broken.* Thus, fractures are distinguished into *transverse* and *oblique*. The obliquity renders the surface of the injury larger, and materially increases the difficulty of maintaining the ends of the bone in contact, after the fracture has been set. Oblique fractures are subject to considerable variety, which depends upon the degree of their obliquity, and whether they are partly oblique and partly transverse. When a bone is broken in different places at once, and divided into several fragments, or splinters, the fracture is termed *comminuted.*

Duverney admitted another class of fractures, viz. *longitudinal.* (See *Maladies des Os*, t. 1. p. 167.) Such cases were regarded by J. L. Petit as only imaginary, because he conceived that any blow, capable of breaking a bone longitudinally, would more readily cause a transverse fracture. For the same reason, Louis absolutely rejected the possibility of longitudinal fractures.

The following case, however, is related by Leveillé. An Austrian soldier was put under his care in the year 1800, in consequence of being struck by a ball in the lower third of the leg at the battle of Marengo. He had walked to Pavia, a distance of several miles, after receiving the injury. In the end, amputation became necessary, and Leveillé preserved the tibia, upon which the impression of the ball was distinguishable. From this point proceeded several longitudinal and oblique lines, which extended from the lower third, towards the upper end of the tibia, and passed through the whole thickness of the parietes of the medullary canal. They were acknowledged to be really longitudinal fractures, by Dubois, Chaufrier, Duméril, Deschamps, and Roux. (*Nouvelle Doctrine Chir.* t. ii. p. 158.)

In several cases of fractured thigh-bones from gunshot violence, which were under the care of Dr. Cole and myself in Holland, the bone was split longitudinally to the extent of seven or eight inches. The fact, however, that bullets and other balls do produce longitudinal fractures, is now universally admitted. Boyer, who formerly denied the possibility of longitudinal fractures, was latterly of a different opinion:—"*On trouve néanmoins, à la suite des plaies d'armes à feu, les os fendus suivant leur longueur, jusques dans leurs articulations,*"—but he is correct when he adds, that such instances afford no proof of the possibility of a simple longitudinal fracture. (See *Maladies Chir.* t. iii. p. 10.) M. J. Cloquet has recorded a case, in which the fall of a building buried a man in the ruins, and occasioned several longitudinal fractures. (See *Pathol. Chir.* 4to. Paris.)

[Some other instances of *purely* longitudinal fractures, or fissures, are referred to by M. Malgaigne. They appear to be commonly associated with such serious injury to the limb as either to necessitate its removal or to cause the death of the patient. (See *Traité des Fract. &c.* t. i. p. 36.) Such a fracture is attended with little or no displacement, and is therefore scarcely recognisable during life, unless it happen to be accompanied by a wound which exposes it to view. Longitudinal fractures, however, combined with transverse or oblique fractures, are by no means uncommon; thus, for instance, it often happens that the femur or the humerus is broken across in its lower third, and the inferior fragment is split longitudinally into the knee or elbow joint.]

4. *In regard to the respective position of the fragments.* These differences are highly important, because the treatment essentially consists in obviating, or preventing, the displacement of the fragments. It is not to be supposed, however, that such displacement is a constant effect of all fractures, for it seldom takes place where there are two bones, and only one of them is broken. Neither does it invariably happen in every fracture of the neck of a bone, as is exemplified in certain fractures of the neck of the thigh-bone, the fragments of which sometimes change their relative situation only when the limb is too freely moved about. Fractures of the leg are also observed, in which there is neither a displacement of the fragments, nor an alteration in the shape of the limb, espe-

cially when the tibia alone is fractured near its upper part, where it is very thick. When the ulna alone is broken at its upper part, there is hardly ever any displacement. The corresponding surfaces of the fragments having a large extent cannot be separated, or can only be so with difficulty. Fractures of the fibula are also frequently unattended with displacement. But when both bones of the leg or fore-arm are fractured together, there is generally more or less displacement; and such is also the case when a fracture occurs in the thigh, or upper arm, where there is only one bone. Here the little extent of the surfaces of the fracture, and the great number of muscles, facilitate displacement.

The displacement may happen in respect to the diameter, length, direction, or circumference of the bone.

In respect to the diameter. In transverse fractures, this kind of displacement is frequently exemplified. The two fragments may either be in contact at a part of their surfaces, or they may not be in contact at all. In the latter circumstance, the limb is shortened by the ends of the fracture slipping over each other.

In respect to length. The mode of displacement, in which the ends of the broken bone pass more or less over each other, is chiefly noticed in oblique fractures, but sometimes in transverse ones, when the displacement, in the direction of the diameter of the bone, has been such that the surfaces of the fracture are no longer in contact. When the limb is shortened, it is generally by displacement of the lower fragment.

To the species of displacement here spoken of, may be referred that which takes place in fractures of the patella, olecranon, and os calcis; but with this difference, that the fragments, instead of passing over each other, recede from each other in the direction of the length of the bone, and continue separated by a more or less considerable interspace.

In respect to the axis of the bone. In this kind of displacement, the two fragments where they meet form an angle, and the bone appears bent. This displacement is often termed the *angular deformity.* It may occur in the leg, when the limb does not lie upon a surface exactly horizontal, and the heel is lower than the rest of the limb. The angular projection is then anterior. On the contrary, it would be posterior if the heel were too much raised. In fracture of the shaft of the thigh, it will happen if the lower part of the limb be too much depressed, or elevated, or placed too much outwards or inwards.

In respect to the circumference of the bone. This displacement occurs when the lower fragment performs a rotatory movement, while the upper one continues motionless. Thus, in fractures of the neck of the femur, if the foot is badly supported by the apparatus, its weight, together with that of the limb, and the action of the muscles, inclines it outward, and turns the lower fragment in the same direction. This is called the rotatory displacement.

Besides these displacements, there are others of a more complicated nature, which happen in several directions at once. For example, such is the displacement observed in a fracture of the thigh-bone, when the lower fragment is drawn upward and inward, while the foot is turned outward.

With respect to the causes of displacement, I may remark, that as the bones are only passive instruments of locomotion, they possess not, in their own organisation, any power capable of causing the change of situation which takes place; but yield to the impulse of external bodies, the weight of the limb or part, and the action of muscles.

The displacement may be produced by an external force, either at the moment when the fracture happens, and by the action of the same cause as that which breaks the bone: or it may be caused by the weight of the body, when the fracture precedes the fall: or, lastly, it may be brought on by some other external force, acting on the fragments, sooner or later after the occurrence of the injury.

The outward violence operates sometimes directly on the situation of the fracture; sometimes on parts more or less distant from it. In both cases, the action of the force is not confined to the production of the fracture, but is partly spent in causing a displacement of the fragments.

Fractures are generally occasioned by falls. Sometimes, however, the fall does not happen till after the leg, or thigh, is actually broken. The weight of the body then produces the displacement, by pushing the upper fragment against the soft parts, which are more or less lacerated. This is what happened to Ambrose Paré, who, being kicked by a horse, endeavoured to get out of the way, but instantly fell down, and the two bones of his left leg, which had been fractured, being impelled by the weight of the body, not only passed through the skin, but even through his stocking and boot. Boyer saw a nearly similar case, in a young man who was struck on the middle of the thigh by the pole of a carriage, which fractured the femur. The patient fell down, and in the fall the upper fragment was not only driven through the muscles and integuments, but also through his breeches.

The weight of the limb itself may produce displacement according to the direction, or circumference of the bone, as already detailed.

But of all the causes of the displacement of fractures, the action of the muscles is the most common and most powerful. Amongst the muscles surrounding a fractured bone, some are attached to it throughout its whole length, and are equally connected with both the fragments. Some arise from the bone above, and are inserted either into that, which is articulated with the lower fragment, or into the lower fragment itself. Lastly, others come from a point more or less distant, and terminate in the upper fragment. The muscles around the thigh-bone furnish examples of these three arrangements. The adductor magnus is attached to the bone through the greater part of its length. The long portion of the biceps, the semimembranosus, and semi-tendinosus, come from the pelvis, and are inserted into the leg, a part with which the lower fragment is articulated, and all the motions of which it follows. The tendon of the adductor magnus is inserted into this fragment itself. Lastly, the iliacus, psoas, pectineus, &c. come from the loins and pelvis, and are attached to the femur, not far from its upper end.

The muscles attached to both fragments perhaps contribute but little to the displacement. They may, however, draw them to the side on which they are situated, and thus change the direction of the limb.

The displacement is principally owing to such muscles as are affixed to the lower fragment, or part with which this fragment is articulated. Suppose the humerus to be broken between its upper end and the insertion of the great pectoral. This muscle, aided by the latissimus dorsi and teres major, will draw the lower fragment inward, and displace it by drawing it to the inner side of the upper fragment, which remains motionless. In fractures of the neck of the thigh-bone, the upper fragment, included within the capsular ligament, affords attachment to no muscle; but all those which are affixed to the lower fragment tend to draw it upward and backward. In all cases, the lower fragment follows every movement made by the part of the limb with which it is articulated, and, consequently, the muscles attached to the bones of this last part of the limb become a powerful cause of displacement. Thus, in a fracture of the thigh-bone, the biceps, semi-tendinosus, and semi-membranosus, draw the leg, and with it the lower fragment, upward, inward, and backward, so as to make the lower end of the fracture ascend at the inside of, and rather behind, the upper one, the extremity of which then projects forward and outward. In a fracture of the leg, the gastrocnemius, soleus, and peronei muscles, acting upon the foot, draw the lower fragments of the tibia and fibula to the outer and posterior side of the upper fragments. For here, as well as everywhere else, the strongest muscles, in producing the displacement, draw towards their own side the end of the fracture on which they operate. And as the posterior muscles of the leg are far more numerous and powerful than the anterior, while those on its outside are not antagonised by any others, the displacement must happen in the direction backward and outward. Whenever, therefore, a bone is fractured at a given point, the knowledge of the muscles will enable a surgeon to determine *à priori* in what direction the displacement is disposed to happen.

Lastly, the muscles attached only to the upper fragment may contribute to the displacement. In a fracture of the thigh, situated immediately below the lesser trochanter, the psoas and iliacus muscles carry forward the extremity of the upper fragment, which elevates the integuments, and forms a more or less considerable projection near the fold of the groin. But the displacement of the upper fragment is generally less considerable and important than that of the lower.

The manner in which the displacement of fractures is effected by the action of muscles explains one circumstance which frequently attends these cases, especially fractures of the thigh, clavicle, and leg. This is a rising, a projection, of the upper fragment, or that which is nearest the trunk. One might believe, at first sight, that such projection is formed by the upper fragment quitting its natural situation, and rising over the lower one. But, on the least reflection, it becomes manifest that the upper end of the fracture projects only because the lower one is displaced, and drawn towards that side on which the strongest muscles are situated. Thus, in practice, in order to make the *rising end of the bone* (as it was termed) disappear, it is only necessary to reduce the lower fragment. If, instead of doing this, pressure be made on the projecting part, the design fails; and if the plan be still more forcibly pursued and continued, inflammation, ulceration, and sloughing, and the conversion of the case into a compound fracture, are likely to be the consequences.

5. *In respect to circumstances with which fractures are accompanied.* The most important division of fractures is into *simple* and *compound.* By *simple fracture,* surgeons mean a suddenly formed breach in the continuity of one, or more bones, without any external wound, communicating internally with the fracture. By a *compound fracture* they signify the same sort of injury of a bone, or bones, attended by a wound of the soft parts leading down to the fracture, which wound may be produced by the protrusion of one or both ends of the fracture through the skin, or by a ball, or other body, which enters, or otherwise wounds, the soft parts, at the same moment that it breaks the bone.

Fractures are said to be *complicated* when attended with diseases, or accidents, which render the indications in the treatment more numerous, and require the employment of different remedies, or the practice of sundry operations, for the accomplishment of the cure.

Thus, fractures may be *complicated* with severe degrees of contusion, wounds of the soft parts, injury of blood-vessels, a dislocation, or diseases and particular states of the constitution, as the scurvy, rickets, syphilis, cancer, pregnancy, &c.

The complication of fracture with dislocation is frequent in the ancle and vertebral column. In the first case, the dislocation usually precedes the fracture; but, in the second, the fracture of the body or bodies of the vertebræ, precedes the dislocation, which otherwise is exceedingly rare.

Under the head of differences in fractures may be fitly introduced that injury to the bones of children, which is denominated a *bending* of them from falls, blows, and external violence, since this injury requires the same treatment as fractures, although crepitus and separation of the fragments do not attend it. In 1821, Dr. J. R. Barton, of Philadelphia, published a valuable paper on the subject, including also remarks on another injury to the bones of children, which he calls a *partial* or *incomplete fracture* of a single bone, or both bones. These cases had been previously noticed by Underwood and Boyer, and perhaps by them alone. Dr. Barton has illustrated his paper by very accurate drawings of the deformity resulting from both of these accidents. (See *Amer. Med. Recorder for* 1821 and *Reese's Amer. ed. of this Dictionary.*) In the course of three years, Mr. Hart, of Dublin, met with five cases of partial fracture of long bones: one of the humerus; two of the radius; and two of the femur. "The diagnostic symptoms of this affection (he observes) are pain and a bent state of the bone injured, without absolute shortening of the limb. On the contrary, it is lengthened on the side to which the ends of the fractured bone project." (See *Dublin Journ. of Med. Science,* vol. i. art. i. 8vo. 1832.)

[A bending or partial fracture of the bones of children is now well known to be of not uncommon occurrence. It happens more frequently in the forearm than in any other part of the body, but it has been also observed in the humerus, femur, tibia, fibula, and clavicle. The fracture, of course, occupies the side of the bone which corresponds to the convexity of the bend, and extends to a variable distance through its substance. In the attempts made to straighten the bone, a complete fracture is sometimes produced. It is very doubtful whether a *bending* of bones, unaccompanied by fracture of some portion of their thickness, ever takes place.

Under the head of differences of fractures should also be noticed, the separation which occurs in children and young persons at the line of union of the epiphyses with the shafts of the long bones. These epiphysary disjunctions are not unfrequent in the humerus, and in the radius at its lower extremity, but they may occur also in other situations. They do not differ in their mode of production, in their symptoms, or in the treatment required, from ordinary fractures in corresponding situations, and they admit of union with at least equal facility, and without interfering in any way with the subsequent growth and development of the bone. The only point of difference worth mentioning is the indistinct character of the crepitus which is elicited, in consequence of the smoothness of the separated surfaces. Further notice will be taken of these cases in speaking of particular fractures.]

2. The Causes of Fractures

Are divided into *predisposing* and *remote*.

In the first class are comprehended the situations and functions of the bones, the age of the patients, and their diseases. Superficial bones are more easily fractured than those which are covered by a considerable quantity of soft parts. The functions of some bones render them more liable to be fractured than others; thus the radius, which supports the hand, is more liable to be fractured than the ulna. The clavicle, which serves to keep the shoulder in its proper position, and to support on its arched extremity all the motions of the upper limb, is particularly subject to be broken. The gradual increase of the quantity of the phosphate of lime, in the structure of the bones, makes them brittle, in proportion as we advance in years; and, in old age, the proportion of the inorganised to the organised part is so great, that the bones are fractured by the slightest causes. In childhood, the animal and organised part bears a greater proportion to the earth, and the bones being, consequently, more elastic and flexible, are not so easily broken as in old age.

Lues venerea, cancer, rickets, scurvy, and scrofula predispose to fractures. B. Bell mentions two venereal patients, of whom the hardest and largest bones were completely broken by the ordinary action of the muscles of the limb. Sir Benjamin Brodie had a patient, whose clavicle broke exactly in the situation of a venereal node. (See *Med. Gaz.*) In the museum of University College, London, are two thigh-bones, taken from a patient who was using mercury for the cure of syphilis: one has several nodes upon it; the other broke as he was turning himself in bed. Fabricius Hildanus quotes from Sarazin, a physician of Lyons, the case of a gouty patient, sixty years of age, who, in putting on his glove, broke his arm above the elbow. Desault used often to speak of a nun of Salpetrière, whose arm was broken as a person was handing her out of a carriage. Louis, who was vexed that no union took place, was not a little surprised to find her thigh-bone experience the same fate one day as she was changing her posture in bed. It was then learned that she had a cancer in her right breast. Leveillé observed similar cases in the Hôtel-Dieu; Sir Astley Cooper has met with others; and at this present time (March 1837), there is in University College Hospital a woman with cancer of the breast, whose humerus was broken about a fortnight ago by the ordinary action of the muscles. A few months ago she was in the same institution for a similar occurrence, and she had previously sustained the same kind of injury of other bones. A few years ago I attended a gentleman's coachman, who had a cancerous disease of the bladder, and whose thigh-bone broke at its upper third as he was turning himself in bed. Around the fractured part a scirrhous mass had been deposited between the periosteum and the bone; and one of the ribs was found in a similar condition, and also broken. The preparations are placed in the museum of University College. (See *Med. Chir. Trans.* vol. xvii.)

[In some of these cases, which have been now frequently noticed, the bones are found infiltrated with cancerous matter, which is first deposited so as to take the place of the natural medullary tissue, and afterwards causes a gradual absorption of the walls of the bone itself. Mr. Paget remarks that bones thus cancerous become liable to be broken with very slight forces; and to these conditions a certain number of the so-called spontaneous fractures in cancerous patients may be assigned. But he also thinks that others are independent of the specific deposition, and are due to the wasting and degenerative atrophy which the bones undergo, during the progress of cancer, even more than in other emaciating and cachectic diseases. (See *Lectures on Surg. Pathology*, vol. ii. p. 316.)]

According to Leveillé, the history of two girls is related by Buchner, one of whom died rickety at the age of sixteen, having broken the femur a short time before her death; and the other, after taking the breast very well for two years, and thriving for a time, became affected with rachitis, and met with the same accident as she was merely running along the street. (*Nouvelle Doctrine Chir.* t. ii. p. 163.)

Many extraordinary instances of fractures from the morbid softness and fragility of the bones are upon record. Suffice it here to refer to the Philosophical Transactions; Mém. de l'Acad. Royale des Sciences; Act. Hafniens.; Ephem. Nat. Cur. dec. I. ann. 3. obs. 112; Gooch's Chirurgical Works, vol. ii.; Saviard, Obs. Chir. p. 274; Gibson's Institutes of Surgery, vol. i. p. 370, &c. (See *Fragilitas* and *Mollities Ossium.*)

On the subject of fractures produced by scurvy, Marcellus Donatus; Saviard; Heyne de Morbis Ossium; Poupart's Works inserted in the Mém. de l'Acad. des Sciences, 1699; and the Treatise published at Verona, in 1761, by Jean de Bona, may be consulted. To these works I would add Lord Anson's Voyage, in which the effect of the scurvy in producing the absorption of the callus of old fractures, a disjunction of the fragments, and a renewal of ulcers which had been many years healed, is curiously exemplified.

Paré, Platner, Callisen, and several other writers, set down cold as a predisposing cause of fractures. This doctrine has originated from these injuries being more frequent in the winter time, but is erroneous, since, in cold countries, the greater number of falls which happen in winter from the slippery and very hard state of the roads, is a circumstance that fully explains why fractures are then more common than in summer.

The remote cause of fractures is external force variously applied, in falls, blows, &c. In particular instances, the bones are broken by the violent action of the muscles attached to them; this is almost always the case with the fractured patella. Occasionally the olecranon and os calcis have likewise been broken by the violent contraction of the muscles inserted into them. With respect to the heel, Petit records two instances, one of which was communicated to him by Poncelet, and the other seen by himself in Madame La Présidente de Boissire, who met with the accident in walking at a gentle pace in the court of the Hôtel de Soubise. When the injury happens in leaping, or in falls from a high situation, Leveillé thinks it more probable that a portion of the os calcis is torn off by the powerful action of the muscles of the calf, than that it is broken by any blow immediately on the part. He states that Desault used frequently to cite two examples of this kind, one of which is recorded in his Œuvres Chirurgicales.

Whether the long bones can be fractured by the mere action of the muscles, has been a disputed point. In the Philosophical Transactions, a fracture of the humerus is ascribed to this cause; and Botentuit knew of the same accident being produced as a person was striking a shuttlecock with a battledore. According to Debeaumarchef, as a man was descending a ladder at a quick rate, his heel got entangled in an opening, and he made a violent exertion to avoid falling. The consequence was a fracture of the lower third of the leg. Curet informs us that a cabin-boy, aged seventeen, made a considerable effort to keep himself from being thrown down by the rolling of the ship. The femur was fractured by the powerful action of the muscles of the thigh. The lad had no fall, and, with some difficulty, supported himself on the other limb till he received assistance.

We are told, says Leveillé, by Poupée Desportes, that a negro, about twelve or thirteen years old, was seized with such violent spasmodic contractions of the muscles of the lower extremities that the feet were turned backward, and the neck of each thigh-bone was fractured, the ends of the broken bones also protruding through the skin upon the outside of the thigh. A cure was effected after an exfoliation. We read also, in the Miscellanea Curiosa Acad. Naturæ Curiosorum, that during a fit of epilepsy, a child, ten years old, had its left humerus and tibia broken, and that, upon opening the body, other solutions of continuity were observed. Chamseru assisted in dressing a child, eleven or twelve years old, that had broken the humerus in throwing a stone a considerable distance. (*Nouvelle Doctrine Chir.* t. ii. p. 164. 166.)

It is the belief of Richerand, however, that a long bone, when healthy, can never be broken by the mere contraction of the muscles. (*Nosogr. Chir.* t. iii. p. 12. édit. 4.)

For my own part, making all due allowance for the inaccuracy of some of the reports, I think the possibility of the long bones being broken by the violent action of the muscles is sufficiently proved. I have never seen but one example; but it was an unequivocal one; I attended, for the late Mr. Ramsden, an exceedingly strong man, at Pentonville, who broke his os brachii in making a powerful blow, although he missed his aim, and struck nothing at all. The whole limb was afterwards affected with vast swelling and inflammation.

3. Symptoms of Fractures.

The symptoms of fractures are: the pain and inability of the patient to move the limb; the change in its form, the shortening of it; the separation and inequalities of the ends of the fracture when the bone is superficial; and especially the crepitus or grating which may be both heard and felt when the ends of the broken bone are made to rub against each other.

Most of these symptoms, however, taken by themselves, are equivocal; the pain and inability to move may arise from a mere bruise, a dislocation or other cause; and even the crepitus, one of the most important signs, is simulated in some cases of dislocation in consequence of synovial effusion. On this point Sir A. Cooper remarks, speaking of dislocations, that "some time after the accident, it frequently happens that a sensation of crepitus is produced by the effusion of adhesive matter into the joint and surrounding burse; the synovia in which becomes inspissated and crackles under motion. But every practitioner ought to be able to distinguish this *crackling* from the *grating* crepitus of fracture." —(*On Dislocations, &c.*; ed. by *Bransby Cooper*, p. 4.)

Indeed, the signs of fractures are so exceedingly various, according to the bones which are the subject of injury, that it cannot be said that there is any one, which is invariably present and characteristically confined to them. The writers of systems of surgery usually notice loss of motion in the injured limb, deformity, swelling, tension, pain, &c. as forming the general diagnosis of fractures. However, it is easily comprehensible by any one acquainted with anatomy, that numerous fractures cannot prevent the motion of the part, nor occasion outward deformity; and every surgeon must know, that though at first there may be pain in the situation of a fracture, no inflammation, swelling, and tension can take place till after a certain period. There may be, however, a swelling produced in the first instance by extravasation of blood, or by displacement of the ends of the bone.

When, therefore, a limb is broken, and the event is not manifest from the distortion of the part, it is proper to trace with the fingers the outlines of the suspected bone: if it be the tibia, let the surgeon examine with his fingers whether any inequality can be discovered along the anterior surface, and along the sharp front edge of that bone. If it be the clavicle, let him trace the superficial course of the bone in the same attentive manner. Wherever any unusual pain occurs, or any unnatural irregularity appears, let him try if a grating or crepitus cannot be felt, on endeavouring to make one end of the suspected fracture rub against the other.

[It must be borne in mind, however, that in cases where the ends of the fracture have been separated from each other by the action of muscles, or any other cause, it will be impossible to feel a crepitus unless the surgeon so manages the limb as to bring them into contact. This is especially true of fractures of the cervix femoris within the capsular ligament, where the two pieces may be separated from each other to the extent of an inch or more.]

When the humerus, or the os femoris, is the subject of inquiry, a crepitus is felt almost as soon as the limb is touched; and, in the case of the broken thigh, there is a considerable shortening of the extremity, except in a few cases of completely transverse fractures.

[Here again, in some cases of shortening, unless the fracture be very oblique, it may be necessary to draw down the limb to its proper length to render the crepitus distinct, as the sensation produced by the smooth periosteal surfaces of bones overlapping one another will not be by any means so evident as that occasioned by their fractured ends.]

When there are two bones, as in the leg and the fore-arm, and only one is broken, the other continues to prevent the limb from being shortened, and thrown out of its natural shape, so that a crepitus can only be felt by a very careful examination with the fingers. The difficulty of the diagnosis is increased when the surgeon is consulted late, and great swelling has come on. "Where is the surgeon," says Boyer, "that has not sometimes hesitated to deliver an opinion in certain cases of this description?" (*Malad. Chir.* t. iii. p. 27.)

When the injured limb is shortened, the surgeon, before pronouncing that such change proceeds from the passage of the fragments over each other, must be sure that the bones are not dislocated, and that the limb is not naturally shorter than the other, or is shortened in consequence of a previous fracture, that has been badly set.

In comparing the length of the lower extremities one should place the pelvis in a horizontal position, and put the two anterior superior spines of the ossa ilii in the same line: for, if these processes are not on a level, the limb, towards which the pelvis inclines, will seem longer than the opposite member.

The practitioner who is well acquainted with the anatomy of the limbs, and particularly with the mutual relations of the eminences of the bones to each other, will readily perceive the alterations produced by a fracture. Whenever, in consequence of a fall, or blow, a limb becomes concave at a part where it ought to be convex or straight, *et vice versâ*, the change of shape and direction must proceed from a fracture with displacement. The inner edge of the great toe, when the leg rests on a horizontal surface, should correspond with the inner edge of the knee-pan. If this natural relation be altered; if the inner edge of the great toe correspond with the outer edge of the knee-pan, there can be no doubt of the existence of a fracture of both bones of the leg. (*Boyer*, vol. cit. t. iii. p. 25.)

I am aware that considerable harm, and great unnecessary pain, have been occasioned by too much solicitude to feel the grating of fractured bones, and whenever the case is sufficiently evident to the eyes, the practitioner who gives way to this habit, at the expense of torture to the unfortunate patient, ought in my opinion to be severely censured. A fracture is an injury necessarily attended with a great deal of pain, and followed by more or less swelling and inflammation; and to increase these evils, by roughly or unnecessarily handling the part, is ignorant and cruel, and (if I may use the expression) unsurgical.

In some kinds of fractures the broken bone is so surrounded with thick fleshy parts that it is difficult to feel a crepitus, or ascertain the existence of the injury. Some fractures of the neck of the thigh-bone are cases illustrative of this observation. In very doubtful cases, the stethoscope has been proposed as a means of elucidating the diagnosis, and Lisfranc is said to have used it with success. (See *Edinb. Med. and Surg. Journ.* No. 78. p. 237.)

4. Prognosis of Fractures.

The prognosis of fractures varies, according to the kind of bone injured, what part of it is broken, the direction of the breach of continuity, and what other mischief complicates the case. Fractures of bones, which have many strong muscles inserted into them, are more difficult of cure than those of other bones, which have not so many powers attached to them capable of displacing the fragments.

A fracture of the middle part of a long bone is less dangerous than a similar injury near one of its joints, which may be followed by synovial inflammation and ankylosis. Thus, in a fracture of the thigh-bone, near the condyles, the inflammation and swelling extend to the knee-joint, which is affected with a degree of stiffness that continues for a long while, and sometimes cannot be entirely cured during life. The experiments of M. Cruveilhier prove that various forms of irritation will make the periosteum, ligaments, and cartilages ossify; and it has been ascertained, that in some cases of fracture near the joints the ligaments have sometimes been converted into bone. (See *Andral. Anat. Pathol.* t. i. p. 300.)

Inflammation of a joint, brought on by fracture, is attended with more severe symptoms, in proportion as the contusion has been more violent. In a fracture near an articulation, it is to be observed, also, that common splints have little command over the short fragment, so that it is often difficult with them to prevent displacement; and, with respect to transverse fractures of the neck of the thigh-bone *within the capsular ligament*, although the possibility of the reunion of such cases *by means of bony matter* is no longer a disputed point, the cure is more commonly effected only by means of a fibrous ligamentous substance.

When a bone is fractured in several places, the case is more serious, and the difficulty of cure greater. But the accident is still worse when a limb is fractured in two different places at once; as, for instance, in the thigh and leg. Here, without the assistance of a double oblique plane, or M'Intyre's excellent apparatus, it would be almost impossible to reduce the fracture of the thigh and maintain the reduction well, so as to preserve the natural length of the limb.

Oblique fractures are more troublesome and difficult of cure than transverse ones, because an oblique surface does not resist the retraction of the lower portion of the broken bone, and consequently the ends of the fracture are kept duly applied to each other with difficulty.

Fractures, complicated with violent contusion of the soft parts, or with a wound, rendering them *compound*, are much more dangerous than others free from such accidents. The bad symptoms, which render compound fractures so dangerous, are of many kinds: hæmorrhage; violent and extensive inflammation of the limb, either phlegmonous or eysipelatous ; delirium and fever ; large abscesses ; gangrene ; &c. Fractures of the leg are generally more serious than similar injuries of the upper extremity. The wound of a large artery may add considerably to the danger of a fracture.

In a debilitated old man, or an unhealthy subject, or a constitution predisposed to inflammation, particularly erysipelas, or to violent derangement of the nervous system, a fracture is less likely to end well than in a healthy child, or a strong young person, or one of good constitution. In extreme old age the cure of a fracture is always more difficult, and sometimes impossible. (*Boyer*, t. iii. p. 32.) Scurvy certainly retards the formation of callus, and, as I have already noticed, even produces its absorption again.

Fabricius Hildanus has cited two cases which tend to prove that the union of fractures is retarded by pregnancy. (*Cent.* 5. obs. 87. *Cent.* 6. obs. 68.) Alanson has also related a case in which the union, which had been delayed during pregnancy, took place after delivery (*Med. Obs. and Inq.* vol. iv. No. 37.) ; and Werner has published an account of a fracture of the radius in a pregnant woman, where the cure was apparently retarded for a long time by this circumstance, and though the union took place previously to delivery, the callus was not very firm till after that event. (*Richter*, *Bibl.* b. xi. p. 591.)

Other observations, however, have shown that though this may occasionally happen, yet that it is by no means invariably the case. Some years ago, I attended, for Mr. Ramsden, a woman in a court leading out of St. Paul's Churchyard, who broke both bones of her leg when she was several months gone with child. Her pregnancy, however, did not appear to be at all unfavourable to the cure, as it followed in the usual time. "It is not generally settled," says a modern writer, "whether pregnancy should be accounted a complication. I, as well as some other practitioners, have seen a pregnant woman get well of a simple fracture in the ordinary time." (*Leveillé*, *Nouvelle Doctrine Chir.* t. ii. p. 159. And in another place he says, "*Contre l'opinion de Fabrice Hildan, l'expérience m'a prouvé que, chez les femmes grosses, le cal était aussi prompt à se former, que chez toute autre personne.*" (Op. cit. t. ii. p. 172.) The experience of Boyer also tends to prove that pregnancy does not generally prevent the union of fractures. (See *Mal. Chir.* t. iii. p. 32.)

The cases in which fractures remain disunited will be considered in a future section.

5. TREATMENT OF FRACTURES IN GENERAL.

The treatment embraces three principal indications. The first is to reduce the pieces of bone into their natural situation. The second is to secure and keep them in this state. And the third is to prevent any unpleasant symptoms likely to arise, and relieve them if they come on.

The first indication is only applicable to cases attended with displacement ; for when the fragments are not out of their relative position, the surgeon must strictly refrain from all avoidable disturbance of the limb. His interference should then be limited to putting up the fracture, resisting the accession of unfavourable symptoms, and removing them, if possible, after they have taken place.

Reduction.—The means employed for the reduction of fractures in general are chiefly three, viz. *extension*, *counter-extension*, and *coaptation*, or *setting.* But, as Boyer remarks, these means should vary according to the species of displacement; and surgical writers have generalised too much in representing them all three as necessary for the reduction of every kind of fracture. In fact, there are several cases in which extension and counter-extension are positively useless ; of this nature are fractures of the patella and olecranon, where the displacement consists of a separation of the fragments. Here the reduction may be accomplished, by putting the limb in a position in which the muscles attached to the upper part of the bone are relaxed, and then pushing the upper fragment into contact with the lower.

Extension signifies the act of pulling the broken part in a direction from the trunk, with the view of bringing the ends of the fracture into their natural situation. By counter-extension, surgeons imply the act of making extension in the opposite direction, in order to hinder the limb, or even the whole body, from being drawn along by the extending power, which would then be unavailing.

It was formerly recommended to apply the extending force to the lower fragment, and the counter-extension to the upper one. Such practice, indeed, was advised by Mr. Pott, and is still generally preferred in this country; but upon the continent it has been abandoned. The objections made to it by Boyer are : first, that it is frequently difficult, and sometimes impossible, to take hold of the two fragments; as, for example, when the neck of the thigh-bone is broken. Secondly, that by applying the extension and counter-extension to the broken bone itself, most of the muscles which surround it are compressed, and such compression produces in these organs a spasmodic contraction which often renders the extension and counter-extension useless, and sometimes even hurtful. (*Mal. Chir.* t. iii. p. 34.) The French surgeons, therefore, apply the extending force to that part of the limb which is articulated with the lower fragment, and the counter-extension to that which is articulated with the upper. For instance, in a fracture of the leg, the extending means act upon the foot, and the counter-extending upon the thigh; and in a fracture of the thigh the extension is applied to the leg, while the counter-extending power fixes the pelvis.

One circumstance must here occur to the mind of the surgical reader. In this country it is properly inculcated that one of the first principles to be attended to in the reduction of fractures is to put the limb in such a position as will relax the most powerful muscles connected with the broken bone; because these muscles principally impede the reduction and disturb the ends of the fracture. But in the French mode of making the extension and counter-extension, how can this grand principle be conveniently fulfilled? If the extending and counter-extending means are not to be applied to the broken bone itself, but to others which are articulated with it, the limb must of necessity be kept in a straight posture at the time of reducing the fracture ; for were the limb placed in a half-bent state, the extension and counter-extension, as practised by the continental surgeons, would not be in the same line, and, therefore, less efficiently and readily accomplished. If it be advantageous to bend the limb at the time of reducing a fracture, the French mode of practising extension and counter-extension may not be the best. I am not, however, one of those surgeons who are entirely blinded with the idea of the possibility of relaxing the whole of the muscles connected with the broken bone by merely bending the limb. On the contrary, I am convinced with Desault, that in general what is gained by the relaxation of some muscles, is lost by the tension of others. But where it is possible to relax by a certain posture the set of muscles most capable of preventing the reduction and disturbing the coaptation of a fracture, that posture I would select. Thus in a fracture of the leg the strong muscles of the calf undeniably possess this power, and the bent position which relaxes them appears to me, therefore, generally the most judicious and advantageous, not only during the reduction, but during the whole treatment of the case.

It is difficult to lay down rules respecting the precise degree of force which should be used in making extension; for it must vary in different cases, according to the species of displacement, and the number and power of the muscles concerned in producing it. In transverse fractures, displaced only according to the diameter of the bone, a very moderate extension suffices, as it is merely practised with a view of lessening the friction and pressure of the surfaces of the fracture against one another. But whatever be the direction of the fracture, when the fragments pass over each other, the extension and counter-extension should be such as to remove the shortening of the limb, and overcome the force of those muscles which, after all attention has been paid to their relaxation, still oppose the reduction. Extension, however, ought never to be practised in a violent and sudden way; but in as gradual a manner as possible, the utmost care being taken not to shake, nor even move, the limb any more than can be avoided. When the practitioner extends a broken member all at once violently, he excites the muscles to strong spasmodic action, and there is some danger of lacerating them, because their fibres are not allowed the requisite time to yield to the force which elongates them. The extension is to begin in the direction of the lower fragment, and be continued in that which is natural to the body of the bone.

In every case of fracture with displacement, as soon as the necessary extension has been made, the surgeon is to endeavour to place the ends of the broken bone in their natural situation : this is termed *coaptation*, or *setting*. This operation is to be undertaken in different ways, according to the species of displacement, and the practitioner can almost always execute it by acting upon the lower fragment, without applying his fingers directly to the fracture itself, in order to regulate the contact of the extremities of the bone. When, however, it is judged necessary for this purpose to touch the broken part itself, it should be done with the utmost gentleness, so as to avoid pressing the soft parts against the points and splinters of bone.

Although the reduction of fractures may in general be accomplished with tolerable facility, it sometimes happens that the first attempts fail. This is occasionally ascribable to the employment of too much force and too little management, in making the extension, whereby the muscles are irritated, and act so powerfully that the design of the surgeon is completely frustrated. Here the grand means of success is putting the limb into such a position as will relax the most powerful muscles which oppose the reduction. Sometimes, however, the irritable and convulsive state of the muscles is not the effect of any wrong mode of proceeding on the part of the surgeon, but arises from the alarm, pain, and injury caused by the accident itself, the comminuted state of the bone, the irritation of spicula, or the very oblique direction of the fracture. Here relaxing the muscles is also the most likely method of removing the difficulty. In short, now that the utility of paying attention to this principle is universally known in the profession, a fracture is rarely met with which cannot be immediately reduced, particularly if opium be given. But supposing the bone cannot be made to lie well at first, it will easily be made to do so in the course of a few days, when the tendency to spasm has diminished, and the pain and first irritation have subsided. Only let the surgeon watch and regulate the position of the limb about this period, and the cure will be completed without any deformity.

Of the means for keeping Fractures reduced.— After the bones have been put into their natural situation, time alone would complete their cure, were there not in the muscles a continual propensity to displace the ends of the fracture again. In cases of fracture the muscles are often affected with involuntary spasmodic action, by which the broken part would certainly be displaced, were no measures taken to maintain the extremities of the broken bone in contact. Besides, the patient, in easing himself, coughing, sneezing, &c. must unavoidably subject the limb to a degree of motion, by which the coaptation would be altogether destroyed. Hence the necessity of employing means for fixing the broken limb so effectually that it may continue perfectly motionless during the whole time requisite for the union of the fracture. The means employed for the fulfilment of this indication are: an advantageous position, quietude, bandages, splints, and various kinds of apparatus.

In the treatment of all fractures, the position of the part, and indeed of the whole body, is a thing of material importance. Whenever the case is a fracture of the lower extremities, the patient should lie strictly in bed until the callus is completely formed and strong. It is likewise an advantage not to have the bed too wide, because the surgeon and assistants can then more conveniently get at any part of the limb. As featherbeds are too yielding, a horse-hair mattress is preferable. Boyer, indeed, is so impressed with the utility of letting the patient lie upon a surface which will not sink, that he recommends two mattresses to be used, and a board to be laid under the upper one, from the hip to beyond the patient's foot. (*Mal. Chir.* p. 39. vol. iii.)

Generally the most favourable position for a fractured limb is that in which all the muscles, passing over the fracture and extending either to the lower fragment, or to that part of the limb which is articulated with it, are equally relaxed. The injured limb should also have firm support at every point, and its position ought to be regulated, so that not only this object be carefully fulfilled, but at the same time the chance of displacement from the action of the muscles, or the weight of the body, or part itself, may be diminished as much as possible.

The natural, or rather the most easy, position of the limb, is that which is usually chosen by a person who reposes himself, or who is sleeping; for then all motion is suspended, and every part assumes that posture which is most congenial to it. In this condition the limbs are not extended, nor yet entirely bent; but only in a moderate state of flexion. Hence, Boyer remarks, that a half-bent position of the limbs is that which is most natural, and that in which all the muscles enjoy an equal degree of relaxation, and, consequently, that it is, generally speaking, the best for fractures. This posture, which was recommended by Hippocrates and Galen, has been highly extolled by Pott, who appears to have exaggerated its advantages. Considered in a general way, it is without contradiction preferable to every other position of the limb; but its employment should be liable to exceptions, as will be noticed in treating of particular fractures. (See *Traité des Mal. Chir.* t. viii. p. 40.)

In whatever position a broken limb is placed, it should bear, throughout its whole length, equally and perpendicularly upon the surface on which it lies, and not be only partially supported. When, for example, only the extremities of a fractured limb rest upon the bed, the weight of the limb itself will make it bend in the situation of the fracture. The limb will also be rendered crooked, if the broken part be supported, while the extremities of the limb (especially the inferior) sink lower by their own weight. The displacement of the fracture is not the only inconvenience arising from the limb being laid upon a surface where it is not everywhere equally well supported. The parts which bear on this surface, experience a painful degree of pressure, which, if long continued, may produce inflammation, and even sloughing of the integuments. Thus, in fractures of the leg, gangrene of the heel has sometimes arisen entirely from this cause. Such inconveniences may often be prevented by laying a fractured limb on a surface of corresponding form; that is to say, on a surface which is depressed where the limb has projections, and rises where it presents depressions. The surface should not be so hard as to annoy the patient; yet it ought to be sufficiently firm not to yield to the weight of the limb and apparatus.

In whatever position fractured limbs are placed, they ought to be kept perfectly quiet during the whole time requisite for the union. If the broken bone be moved while the callus is forming, the surfaces of the fracture rub against each other, and the process is disturbed and retarded; and, indeed, sometimes by repeatedly moving the limb, the consolidation of fractures is entirely prevented.

In order to maintain the limb in the right position, and in a state of quietude, and to preserve the fragments in proper contact with respect to each other, the surgeon is to caution the patient to avoid moving more than can be helped, and every cause likely to subject the limb to any kind of shock or concussion is to be removed. But, in particular, it will be necessary to apply a retentive apparatus, usually consisting of bandages, splints, tapes, straps and buckles, soft pads, &c.

With respect to bandages, the common roller answers for fractures of the humerus, radius, ulna, and fibula. Indeed, when M'Intyre's apparatus is made use of, or Desault's method of treating a broken thigh is followed, it is the most eligible bandage for all simple fractures of the lower extremity, and even for some compound ones. But if a broken thigh or leg is to be treated according to Pott's directions, then the eighteen, or many-tailed bandage is necessary. The advantages of it are that, by means of it, all necessity is avoided of lifting up, and disturbing the limb, every time it is dressed, or every time the bandage loosens. Indeed, with it the leg or thigh need never once be removed during the cure from the pillow or splint on which it has been deposited.

The same advantage, however, is obtained with common rollers, when M'Intyre's apparatus is used, which, as well as the limb itself, is to be encircled by them. (See *Description of a Splint invented for the Treatment of Fractured Limbs by James M'Intyre*, 8vo. Newcastle, 1825.) In University College Hospital we dispense with the sock, and fix the limb with three rollers; one surrounds the upper part of the leg and the knee; another binds the foot to the foot-piece and encircles the ankle; and the third is applied to the central part of the leg, including the situation of the fracture. This last roller admits of being taken off, and the fracture, simple or compound, examined, without meddling with the other rollers, which steady the upper and lower parts of the leg, and therefore it does not undergo the slightest disturbance. On the whole, I cannot fancy that any apparatus for broken legs will ever fulfil its purposes better than that of Mr. M'Intyre, which has also the recommendation of great simplicity. A very cheap form of this apparatus has lately been contrived by Mr. Liston, the peculiarities of which are the omission of most of the thigh part, and the placing of an aperture at the point where the heel lies, so that the painful pressure on this part is considerably lessened. However, those surgeons who prefer to treat fractured thighs in the flexed position, with the patient on his back, will find M'Intyre's apparatus, as arranged by himself, exceedingly convenient.

Another surgeon of Newcastle, Mr. T. M. Greenhow, is also the inventor of an exceedingly ingenious apparatus for fractures of the lower extremity. It enables the surgeon to bring the whole circumference of a broken leg into view, after the fracture has been set, without the least movement or disturbance of any part of the limb. This, as every man of experience knows, is a great advantage in the treatment of compound fractures, where the application of dressings to the wound sufficiently often, the prompt discharge of abscesses, the preservation of the parts in a cleanly state, and the opportunity of inspecting the position of the ends of the fracture in the early stages of the formation of the callus, are objects contributing very essentially to the favourable progress and termination of these accidents. With this apparatus permanent extension either of the leg or thigh, if judged advisable, may be adopted, there being a contrivance for this object. One chief principle of Mr. Greenhow's apparatus is, that the limb remains supported in an iron frame-work, after everything else has been removed. (See *T. M. Greenhow's Description of an Apparatus intended to* *facilitate the Treatment of Fractures, &c.* 8vo. Lond. 1833.)

In France, the preference is given to Scultetus's bandage in almost every instance where we employ the eighteen-tailed one, from which it principally differs in being composed of separate transverse pieces admitting of removal, so that when a part of the bandage is soiled it can be taken away, and a clean piece (first stitched to that which is about to be removed), drawn under the limb, without disturbing the whole of the dressings. Dupuytren was partial to this bandage, not only in cases of compound fracture, but others where a frequent change of parts of the bandage was rendered necessary by the discharge.

As a general remark, we may say, that some apparatus of the foregoing kinds, a double oblique plane, or else splints, are unquestionably the most efficient of all the applications made to a broken limb, with the view of keeping the ends of the fracture steady, and in a proper state of contact.

"Splints," says Pott, "are generally made of pasteboard, wood, or some resisting kind of stuff, and are ordered to be applied lengthways on the broken limb; in some cases three, in others four; for the more steady and quiet detention of the fracture.

"That splints, properly made and judiciously applied, are very serviceable, is beyond all doubt; but their utility depends much on their size, and the manner in which they are applied.

"The true and proper use of splints is to preserve steadiness in the whole limb, without compressing the fracture at all. By the former they become very assistant to the curative intention: by the latter they are very capable of causing pain and other inconveniences; at the same time that they cannot, in the nature of things, contribute to the steadiness of the limb.

"In order to be of any real use at all, splints should, in the case of a broken leg, reach above the knee, and below the ankle; should be only two in number, and should be so guarded with tow, rag, or cotton, that they should press only on the joints, and not at all on the fracture.

"By this they become really serviceable; but a short splint, which extends only a little above and a little below the fracture, and does not take in the two joints, is an absurdity, and what is worse, it is a mischievous absurdity.

"By pressing on both joints, they keep not only them, but the foot steady; by pressing on the fracture only, they cannot retain it in its place, if the foot be in the smallest degree displaced; but they may, and frequently do, occasion mischief, by rudely pressing the parts covering the fracture against the edges and inequalities of it." —(See *Pott's Chir. Works*, vol. i. p. 298, &c. edit. 1808.)

Splints, double oblique planes, and other kinds of support for broken limbs, must always be lined with pads of tow, oat-chaff, or other soft materials, for otherwise their pressure would cause severe pain, inflammation, ulceration, and even sloughing.

Assalini strongly disapproves of the employment of all tight bandages, and of covering the whole of a broken limb with splints. In a case of transverse fracture of the patella, he laid the limb upon a concave splint, the shape of which was adapted to the under surface of a part of the leg and thigh. No bandage was used, merely two leathern straps, which crossed upon the knee, and included the fractured bone. A perfect bony union was thus easily effected. Assalini afterwards extended the use of a concave splint, applied under the limb, to fractures of the leg and thigh. In the first of these cases, however, only the thigh is received in the hollow splint, and from this two lateral splints go along the leg. The apparatus has also a kind of sole for the support of the foot. As this simple contrivance is fastened with a very few straps, and no plasters or bandages are used, the surgeon has constantly a view of the whole front of the limb, and of the fractured part of it. In compound fractures, he covers the wound with linen compresses, wet with cold water. (*Manuale di Chirurgia*, *Parte prime*, 1812.) See SPLINT.

So convinced is Baron Larrey of the advantage of keeping broken limbs perfectly motionless, after they have been properly set, that he sometimes employs an apparatus which moulds itself to the shape of the limb, then hardens, and remains applied during the whole of the treatment, unless circumstances call for its earlier removal. The apparatus is made by wetting the pads, compresses, and bandages in a lotion, containing the acetate of lead and white of egg, which, when it has dried, leaves the apparatus sufficiently hard and stiff to afford full support and steadiness to the limb, with the advantage of being most perfectly accommodated to the exterior of it. This plan is followed, not merely in simple, but compound fractures, and when there is a necessity for removing the patient any distance, is found by Larrey highly expedient.

[An apparatus of this nature, "*appareil inamovible*," is now in very common use in the treatment of fractures. One of the most strenuous advocates of the method is M. Seutin of Brussels, and thick starch is the material which he employs to stiffen the apparatus. A dry roller is first applied round the fractured limb, underneath which layers of cotton-wool may be placed to protect the prominences of the limb from injurious pressure. The outer surface of the bandage is then smeared with the starch, and two splints of pasteboard, softened by soaking in water, are placed one on each side of the limb. The pasteboard should be torn rather than cut, in order that its edges, when it dries, may be less sharp and cutting. The pasteboard is to be retained in its place and moulded to the shape of the limb by another bandage, and this also is to be covered by layers of starch, laid on smoothly with the hand or with a brush. When the apparatus becomes dry a firm and solid case is obtained, and the patient may be allowed, in fractures of the lower extremity, to leave his bed and walk about on crutches, without danger of displacing the fracture. The drying is not complete for thirty-six or forty-eight hours, and during that time it is necessary to pay careful attention to the position of the limb, as the apparatus does not yet possess the requisite firmness to prevent displacement occurring. For this purpose temporary splints may be applied over the starched bandage, or, as M. Seutin prefers, a mould formed from an apparatus which has been already used in a similar case. When completely dry, M. Seutin divides it longitudinally with strong scissors or cutting pliers made for the purpose, and examines the limb to see whether any undue pressure is occasioned at any point, and if this is the case, the fault is remedied by moistening it at that part and moulding it to the required shape. If the bandage is too tight it may be enlarged by separating the cut edges, and a piece of moistened pasteboard may be laid over the interval; if, on the other hand, it is too large, as is frequently the case from the shrinking of the limb, the edges can be cut away or can be made to overlap. When, by these manœuvres, a perfectly-fitting case has been obtained, it can be again firmly fixed by another bandage, which is to be covered, like the former ones, with starch. Many surgeons do not follow M. Seutin's practice in dividing the bandage for the purpose of inspecting the limb and adjusting it more exactly, but unless pain or great discomfort is complained of, allow it to remain undisturbed. The pasteboard splints also are only necessary; when very firm support is required; in the upper extremity, especially, two or three layers of bandage stiffened with starch are usually sufficient. M. Velpeau uses a solution of dextrine in preference to starch; it does not, however, possess any special advantage, excepting perhaps that it produces a somewhat firmer and harder case. Greater solidity may be easily obtained, if required, by adding a little powdered chalk to the starch solution.

It is an important question whether the "*unremovable apparatus*" should be applied immediately after the occurrence of the fracture, or whether it should be delayed until the swelling and inflammatory disturbance have subsided. Many continental surgeons, and among others M. Velpeau, advocate its immediate employment, and allege that the compression which it exercises is advantageous in preventing the development of inflammation, and also in procuring its resolution, if it does take place. Mr. Erichsen also speaks of having followed this practice in a large number of fractures of all kinds, and with very satisfactory results. The majority of English surgeons, however, prefer not to lose sight of the limb until the inflammatory swelling has subsided, and the parts about the fracture are in a quiescent state. The proper period will arrive sooner of course in some cases than in others, often at the end of four or five days in the upper extremity, often not for ten days or a fortnight in the lower extremity, or a longer period if the soft parts have been much contused. Used in this manner, the starched bandage is a very valuable aid in the treatment of fractures, and is productive of great comfort to the patient.]

In oblique fractures of the thigh, and sometimes even in those of the leg, the difficulty of accomplishing by the ordinary means a cure free from deformity, and especially without a shortening of the limb, led to the idea of employing *permanent extension.* This is effected by the operation of a bandage, or machine, which continually draws the fragments of the broken bone in contrary directions, at the same time that it restrains them from gliding over each other, and maintains them in contact during the whole time necessary for their union. In England this practice appears to have been chased away by Pott's dazzling theory of relaxing every muscle in such manner as to render it incapable of displacing an oblique fracture. Desault saw, however, great inconsistency in the doctrine of the possibility of relaxing the muscles, so as to incapacitate the whole set of them connected with a broken thigh; and he never ceased to inculcate that a mechanical apparatus was the main thing by which the shortening of the limb was to be prevented. When we consider the treatment of fractured thighs, we shall find that the principle of permanent but moderate extension has had in France advocates of great talent and eminence, though it is a method to which many surgeons in this country for a long time entertained strong objections.

By means of permanent extension (observes Boyer), we not only succeed in uniting the fracture, while the limb preserves its natural length; but we afford the part a steadiness which is singularly favourable to the formation of the callus. In order to derive from permanent extension the utmost benefit, and render the method as little painful as possible, and supportable during the whole time of treatment, he recommended the machines and bandages to be constructed and applied conformably to the following rules.

We should avoid compressing the muscles which pass over the situation of the fracture, and the elongation of which organs is necessary to restore to the limb the length which it has lost by the gliding of the fragments over each other.

The extending and counter-extending force ought to be divided upon as large surfaces as possible.

The powers, making permanent extension, should act according to the direction of the axis of the broken bone.

The extension should be practised in as slow, gradual, and insensible a manner as possible.

Lastly: the parts, upon which the extending and counter-extending force acts, should be defended; and the compression, made by the tapes, or other pieces of the bandage and apparatus, ought to be equalised. (*Mal. Chir.* t. iii. p. 56, 59.)

If we consider the principles on which the mechanical means operate usefully in the treatment of different fractures, we shall find that they are various. For the most part, they have this effect by holding the ends of the fracture steadily in contact, maintaining the proper length of the limb, and hindering motion not only of the broken bone itself but of the joints connected with it, without which object being fulfilled, the fracture must always be liable to hurtful disturbance. In fractures of the shafts of the femur and humerus, and of the tibia, fibula and bones of the fore-arm, the apparatus acts beneficially in all or some of these ways; but, on certain occasions, it accomplishes its purpose, not by any direct action on the broken part of the limb itself, but by holding the limb in a particular position, and maintaining its due length. Thus, when the neck, or upper part of the thigh-bone is broken, the apparatus can have but an imperfect effect by its direct operation on the fracture, this portion of the bone being, as it were, not within its immediate grasp. But, by holding the limb in the right position, keeping it steady, and preventing its retraction, and the eversion or inversion of the foot, it accomplishes all which it is in the power of surgeons to do, especially if care be taken to let the pelvis and broken portion of the bone be so connected together by the apparatus, as to render them, as it were, one piece, only moveable together, in every movement of the patient, or change in the surface on which he is lying.

Frequently position does everything, without the slightest attempt to make any direct pressure on the fracture, or to act upon it immediately by any other means. This is exemplified in fractures of the clavicle, cases in which, as well as several others, we see no splints at all employed, the requisite position of the arm and shoulder being maintained with a sling roller and pad in the axilla. Even in some cases where a splint is employed, it only operates by fixing the limb in the desirable position, as illustrated in fractures of the olecranon. In these last cases we also use mechanical means to keep the upper fragment from ascending too far ; but, in other instances, position and quietude are the only principles in operation, as in the treatment of fractures of the coracoid and acromion processes of the scapula. Here the relaxation of the muscles by position, and quietude of the shoulder, are the only essential things to be attended to, and, whatever mechanical means are employed, are not designed to act directly on the broken parts of the bone.

Occasionally, the application of splints, bandages, and other mechanical means should be deferred. This is proper in fractures near joints, as of the olecranon, patella, &c. where the inflammation and swelling prohibit any compression of the part. Under such circumstances, the first indication is to subdue the inflammation by means of cold applications, bleeding, &c., care being taken, however, to lay the limb in a judicious position.

Means for preventing and removing the unfavourable symptoms liable to arise from fractures.— After having reduced the fracture, applied the apparatus for maintaining the reduction, and put the part in an advantageous position, the practitioner is to attend to another indication, viz. the prevention and removal of any unfavourable symptoms.

With the exception of a few simple fractures of the upper extremity, it is proper to allow for the first few days only very low diet. When the patient is young and strong, and the swelling and inflammation considerable, venesection may possibly in some cases be required. In other circumstances, it should be dispensed with, because it is well known that, for the quick formation of callus, by which the fracture is to be united, strength and a vigorous circulation are highly favourable. The patient may be permitted to drink as often, and as much as he likes, of any cooling acid beverage. The low diet is only to be continued the first few days, unless great inflammation arise ; for experience proves that the method, when too much prolonged, has bad effects, and tends, on the same principle as bleeding, to retard the union of the fracture.

Costiveness is to be obviated by the use of mild aperient medicines. It must be confessed, however, that in fractures of the lower extremity, the disturbance of the limb caused by the patient's being obliged to move himself, after taking a purgative, is seriously objectionable ; but perhaps in all, and certainly in some, habits, the neglect to open the bowels soon after the accident would have still more pernicious consequences. In order to lessen the disturbance, a bed-pan should be introduced under the patient. Here, also, I feel it my duty to recommend to the notice of the profession a very complete fracture-bed invented by my friend, Mr. Earle. One great convenience of this bed, the cost of which is moderate, is to enable the patient to void his fæces without the slightest change of position, or disturbance ; an object effected by the simple contrivance of a little kind of trap, opening under the bed, out of which a small portion of the mattress admits of being withdrawn, and a tin receptacle is placed for the reception of what is voided from the bowels and bladder. Some other advantages of this apparatus will be hereafter briefly mentioned.

With respect to external applications, we should carefully avoid using all such plasters and ointments as irritate the skin, or create a disagreeable itching ; for they sometimes bring on erysipelas. In some cases, and especially in summer, it is a good plan for the first few days to wet the bandages with cold water ; for in this way the tendency to inflammation and swelling may be considerably lessened. The surgeon, however, should recollect, that the bandage shrinks when wet, and may become so tight as to do harm, if not attended to. Solutions of the acetate of lead make the bandages stiff and hard ; and as they are perhaps not more efficacious than cold water alone, the latter should be preferred.

When a fracture is well set, the position of the part right, and the bandage and splints neither too tight nor too slack, the less the broken bone is moved, and the less the apparatus and dressings are disturbed, the better. Sometimes, however, the practitioner is obliged to take off the splints, and undo the bandage, in order to ascertain that the ends of the fracture lie in even contact. Were he to leave the splints on the part too long, without ever being sure of this important point, he might find, when too late for alteration, that the fracture was in a state of displacement, and the limb seriously deformed. Hence, one reason for employing the eighteen-tailed bandage, or an apparatus like that of M'Intyre's, which admits of being opened without disturbing the limb, or even without lifting it from the surface upon which it has been deposited.

In fractures of the lower extremities, particularly of the legs, it sometimes happens, the first two or three nights after the reduction, that the limb is affected with spasms, which displace the ends of the bone. Here, if the patient be young and strong, let blood be taken from the arm, the bowels be emptied, and opium or morphia prescribed ; strict attention being also paid to restore the ends of the fracture to a right position again. If they cannot be kept in exactly a good posture at first, they will admit of being so, after a few days, when the tendency to spasm has diminished.

When the callus has acquired some firmness, the patient should still keep the part or limb quiet, until the union is perfectly consolidated. And, in fractures of the lower extremity, even after the union has proceeded so far that the splints admit of being left off, the patient ought not to venture to get out of bed, or bear upon the limb, till several more days have elapsed.

All fractures, however simple and well treated they may be, are constantly followed by weakness and stiffness of the limb. These unpleasant consequences are the greater, the more violently the limb has been contused, the nearer the fracture is to a joint, and the longer the part has remained motionless, and without exercise. The stiffness always affects the inferior joint of the broken bone, much more than the superior. For the relief of these effects of fractures, it is customary to employ friction, liniments, emollient applications, cold washes and bathing ; but sometimes, notwithstanding such remedies, the member does not quickly recover its strength, but continues stiff and weak for a year, or even a longer time. The most effectual plans for the prevention of this state should therefore be resorted to early. These consist in making the joints nearest the fracture execute slight motions, as soon as the union is sufficiently advanced not to be in danger of interruption from this practice. A great deal of caution, however, is necessary in moving the part, and it is safer for the surgeon to superintend the business himself, than leave it to the patient, or others. One of the best proceedings also for the hindrance of much weakness and stiffness in the limb after a fracture, is to discontinue the splints and tight bandages immediately the state of the callus will allow. The manner in which their pressure retards the circulation, and prevents the action of the muscles, is one of the principal causes of the stiffness which sometimes ensues, and consequently, the sooner they can be safely left off, the sooner will the patient regain the free use of the limb.

In France, the chief division of fractures is into *simple* and *complicated*, which last includes, amongst many varieties, the cases which we name *compound.* We shall here briefly notice a few of the complications, and the particular treatment which they require.

Fractures (says Boyer) are always attended with a certain degree of contusion, which is constantly more severe in cases where the violence has acted directly on the situation of the fracture. But such contusion can only be regarded as a complication of the accident, when it exists in so violent a degree as to demand a different treatment from that which is employed in simple fractures.

In this circumstance, the splints and bandage should be applied rather slackly, and the latter ought to be wet with cold water, or some resolvent lotion. The patient is to be bled more or less freely, according to his age, the state of his constitution, and violence of the contusion. The next day, the splints and bandage should be opened; a thing highly necessary to be observed; for where it has been neglected, the limb has been known to mortify, in consequence of the swelling having rendered the bandage too tight. (*Boyer*, *Mal. Chir.* t. iii. p. 63, 64.)

In simple fractures it does not often happen that a large artery is wounded; but when the injury does occur, and a diffused aneurism takes place, the surgeon is to expose the vessel by an incision, and apply a ligature above and below the opening. We are to be careful, however, before resorting to the operation, that the tumor is not a venous extravasation, which may almost always be dissipated by resolvent applications.

Fractures are sometimes complicated with a dislocation. Here, if possible, the luxation should invariably be reduced before the fracture is set. The possibility of reducing the dislocation (says Boyer) depends upon the species of articulation, the situation of the fracture, and other circumstances of the case. When it is a ginglymoid joint, when the ligaments are lacerated, and the swelling is not considerable, the luxation may be reduced easily enough; but when it is an orbicular joint, surrounded by numerous muscles, and when the fracture is near the articulation, and situated below the dislocation, the reduction of the latter is impossible. The attempt, indeed, would be injurious, because the necessary extension could not act upon the upper fragment; and were it to operate upon the lower, it could only have the effect of painfully stretching the muscles, and perhaps lacerating them. The fracture, therefore, should be at first attended to, and after its firm union an endeavour may be made to rectify the dislocation. Boyer conceives that there will be more probability of success when care is taken to move the limb gently, as soon as the state of the callus will permit it. He also recommends the employment of emollient relaxing applications. He confesses, however, that the attempt rarely succeeds after the perfect union of the fracture. There are, it is true, examples, in which old dislocations may be reduced; but these are cases which are not complicated with a fracture; an accident which always renders the muscles and ligaments so stiff that they cannot yield to the extension requisite for the reduction. "I do not know (says Boyer) that a luxation, complicated with fracture, has ever been reduced, when the nature of the joint, and the circumstances of the case, prevented the treatment from beginning with the reduction of dislocation." (*Mal. Chir.* t. iii. p. 79.) See DISLOCATIONS.

COMPOUND FRACTURES.

Here the first question is, whether an attempt should be made to save the limb? If the first opportunity of amputating be lost, there may *never* be another. *Inflammation* comes on, and the constitutional disturbance may prove fatal, and no second opportunity may present itself. In some cases, traumatic gangrene will invade the limb, and hardly leave time for the surgeon to amputate. Indeed, after it has once begun, so rapid is its progress that unless the operation be immediately performed, the patient's doom is sealed. Hence, in this kind of mortification, it is now a maxim not to wait for the red line of demarcation, but to remove the limb without the least delay, even though the mortification may be in a spreading state. With the exception of this case, if the first opportunity of amputating has been lost, the surgeon must wait until the constitutional disturbance has partly subsided before the knife can be used. This period may occur on the establishment of suppuration. But whether he ought now to amputate or not, will depend upon the extent and nature of the local injury; whether the soft parts are severely contused and lacerated—the bones crushed and comminuted—the degree of suppuration—the state of the pulse, &c. Under doubtful circumstances, the surgeon may yet be disposed to persevere in his endeavour to save the limb, and sometimes ultimately succeed in bringing the patient through all dangers; in extricating him from the weakening effects of repeated abscesses, profuse suppuration, &c. But in other instances, the long continuance of the suppuration—the presence and irritation of dead bone—the diseased state of all the cellular tissue—the implication, perhaps, of a neighbouring joint in the mischief, and the urgency of the hectic disturbance of the system, will compel the surgeon to amputate.

Supposing an attempt is to be made to save the limb, then the first indication is to reduce the fracture. For this purpose, lay the limb on the splint or apparatus, with pad, &c. and attend to the relaxation of muscles. When the protruding end of the bone cannot be returned, it is to be sawn off, or the wound enlarged.

When the fracture is *comminuted*, such fragments as are perfectly detached, quite exposed, and near the surface, are to be extracted.

The second indication is to bring the sides of the wound together, with an adhesive plaster, and after its edges have been approximated, the wound may be covered with wet lint; and if it unite, the compound fracture is at once converted into a simple one. With the view of keeping off inflammation, the bandages may be wetted with cold water.

In all leading points, the treatment of compound fractures is like that of simple, with the exception of measures called for by the wound itself; the higher degree of inflammation; the abscesses; the detached pieces of bone; the splinters, or sequestra; and the more severe constitutional disturbance. The same attention to keeping the ends of the bone in their proper position, and completely at rest, is even more urgently necessary.

As the presence of a suppurating wound, and the frequent formation of matter, render it indispensable to undo the bandage more frequently than in simple fractures, it should always be a maxim *to employ* such *splints, bandage*, or *apparatus* as will admit of this being done, as often as necessary, without any disturbance of the fracture.

An apparatus which will allow the surgeon to get at almost any part of the circumference of the limb, is particularly advantageous. Hence the superiority of M'Intyre's and Greenhow's apparatus, and the use of fracture-boxes.

While inflammation prevails in a high degree in the early stage of the case, the splints should not be tightly applied, and cold evaporating lotions and leeches may be of great service. Venesection may occasionally be beneficial when the patient is strong and full of blood; and saline purgatives and opium should be given.

One rule is to make early openings for the discharge of abscesses, and to let them be free and depending. Another maxim is to take away *sequestra* as soon as exfoliation is sufficiently advanced.

In tedious severe cases, patients sometimes fall victims to sloughing over the sacrum or trochanters. In the suppurative stage, attended with hectic symptoms, there is an obvious necessity for supporting the constitution, by means of tonics, sulphate of quinine especially, and light nutritious food and wine. In this stage, opium, pure air, and cleanliness will be of vast importance.

OF HÆMORRHAGE IN COMPOUND FRACTURES.

Profuse arterial bleeding is chiefly seen in compound fractures of the leg; but it may happen in those of the thigh or arm. If a wound of the anterior or posterior tibial artery be conjoined with a violent contusion and extensive *laceration of soft parts*, comminution of bone, or long fissures of it extending into or near the joint, amputation will generally be most prudent. In the opposite circumstances, the wound of the artery is not an adequate ground for removing the limb. In the treatment of such an accident, *pressure* and *cold* applications are insufficient, and it is indispensable to employ the ligature. Then the question is, whether the wounded part of the artery should be exposed and tied, or the *femoral* artery itself taken up.

Dupuytren and Delpech, instead of adding to the mechanical injury of textures already existing in the fractured part of the limb, advocated and practised the latter measure with decided success. In this way the bleeding was commanded without any additional disturbance of the broken part of the limb. If we look over the particulars of cases where operations were practised to secure the anterior or posterior tibial artery, in compound fractures, we shall find that the result has commonly been mortification of the limb, and the patient's death. However, if the anterior tibial artery were wounded in the lower third of the leg, where its place is superficial, I think that the plan of securing it here would then be preferable to that of taking up the femoral artery.

OF THE FORMATION OF CALLUS, AND THE CONSOLIDATION OF FRACTURES.

In the treatment of fractures the whole business of the surgeon consists in putting the displaced extremities of the bone into their natural situation again; in keeping them in this position by means of a suitable apparatus; in endeavouring to avert unfavourable symptoms, and in adopting measures for their removal when they have actually occurred. The consolidation of a broken bone is the work of nature, and is effected by a process to which a good constitution, with as little disturbance of it as possible, is above all things propitious.

The process alluded to is that by which the new bony deposition, or the *callus*, as it is termed, which forms the uniting medium, is produced.

Surgical writers have been absurdly anxious to specify a determinate space of time which should be allowed for the completion of this process, as if it always went on in different cases with the same uninterrupted regularity. Forty days were often fixed upon as necessary for the purpose. This doctrine is not only false, but dangerous, inasmuch as patients have been thereby induced to suppose themselves cured before they were so in reality, and have consequently moved about too boldly, and thus run the risk of occasioning deformity, or a new fracture. It is impossible to determine precisely, and in a general way, the period requisite for the cure, because it differs according to a variety of circumstances.

1. *Age.* Fractures are consolidated, *cæteris paribus*, with more ease and quickness in young subjects than in adults or old persons. In general, also, the callus forms more speedily in proportion as the individual approaches to infancy. In two children whose arms had been broken in difficult labours, De la Motte found the humerus united in twelve days, by a very simple apparatus. In fact, at this period of life every part has a tendency to grow and develope itself, and the vitality of the bones is more active, their vascularity greater, their animal matter more abundant. On the contrary, in advanced age the parts have lost all disposition to development, and (to use the expression of Boyer) their vitality is nearly annihilated under the mass of phosphate of lime which accumulates in them.

2. *Constitution.* A fracture is united much sooner in a strong healthy person than a weak unhealthy subject. Sometimes the consolidation is prevented by some inexplicable unknown cause, nothing wrong being remarkable either in the constitution or the part.

3. *State of Health.* Fractures unite with more quickness and facility when the patient enjoys good health. Scurvy has a manifest and powerful effect in retarding the consolidation of fractures,

and even in causing the absorption of the callus several years after its formation, so that a bone becomes flexible again at the point where it was formerly broken. In Lord Anson's Voyage this phenomenon is particularly recorded. (See p. 142, edit. 15, in 8vo.) Langenbeck is acquainted with several cases in which the provisional callus, at the end of eight weeks, became again soft, and the bone flexible, in consequence of the patients being attacked with fevers or erysipelas. (*Neue Bibl.* b. i. p. 90.) Cancer, lues venerea, and rickets are also stated by surgical writers to obstruct, and sometimes hinder altogether, the formation of callus.

Pregnancy, as I have remarked in a preceding part of this article, has been sometimes found to retard the union of a fracture.

4. *Thickness of the Bone, and Weight which it has to support.* The bones are thicker and larger in proportion as they have a greater weight to bear, and as the muscles inserted into them are more powerful. It is observed, *cæteris paribus*, that the larger the bones are, the longer is the time requisite for their union. Thus, a broken thigh-bone is longer in growing together again than a fractured tibia; the tibia longer than the humerus, the bones of the fore-arm, clavicle, ribs, &c.

Besides the remarks made here, and in a preceding page, on the causes preventing the union of fractures, a few additional observations on the same subject will be introduced in the sequel of this article, when I speak of the modes of attempting the cure of old disunited fractures.

Three local circumstances were insisted upon by Boyer as necessary to obtain a firm callus, without deformity. 1. The two fragments must be possessed of sufficient vascularity. 2. The surfaces of the fracture must correspond. 3. They must be kept in a completely motionless state.

The two fragments must be sufficiently vascular. If one of them should be too scantily supplied with blood, the fracture would be incapable of union. This is what may happen in certain fractures of the neck of the femur, where the head of this bone is entirely detached, and the ligamentous substance which is reflected over its neck, and serves as its periosteum, is totally lacerated, as well as the vessels which ramify upon it. Hence, the upper fragment, lodged in the cotyloid cavity, may no longer receive from the vessels sent to it through the ligamentum teres a sufficiency of blood for the formation of callus with any degree of certainty. This is especially likely to be the case when the patient is far advanced in years, and the vessels considerably lessened in diameter. An adequate circulation must exist in both portions of bone; for without it the attempt at union will fail.

The surfaces of the fracture must correspond. This circumstance is not absolutely necessary for the consolidation of the fracture; but without it the formation of the callus will be slow and irregular. For instance, in a transverse fracture of the thigh-bone, the fragments, after being displaced according to the thickness of the bone, may undergo a second displacement, according to its length, by passing beyond each other. The surfaces of the fracture are then not at all in contact, and the portions of bone only touch each other by their sides. Here, at the end of the second month, the union will frequently have made but little progress; nor can the cure be accomplished without deformity and shortening of the limb.

The fragments must be retained in a motionless state. This condition is so essential to the formation of callus, that, if the ends of a fracture were daily moved, they could not unite. The two extremities of the bone would then heal separately, just like the sides of a wound which have not been put in contact.

Perhaps no subject has excited more discussion than the formation of callus. The ancients ascribed it to the extravasation of a gelatinous fluid, which was called the osseous juice, and which, becoming hard, served to unite the ends of the broken bone, just as glue serves to unite two pieces of wood. Hence, in order to favour the production of callus, they were in the habit of recommending their patients to eat abundantly of every sort of viscid farinaceous aliment, the glutinous parts of animals, and especially osteocolla, of which Fabricius Hildanus relates miracles.

According to Duhamel, callus is formed by the periosteum, which he regards as the organ of ossification. When a bone is fractured (says this naturalist), the periosteum of the two fragments first grows together, and then swells, and forms a circular rising round the fracture. The thickened membrane is converted into a gelatinous substance, which soon becomes cartilaginous. In this vessels are developed, and different points of ossification commence, which multiply and unite. Thus, when every part of the periosteum near the fracture is hardened and ossified, *this membrane is changed, as it were, into a sort of clasp, which extends over the two fragments, and holds them together.*

It was objected to Duhamel's theory, that, if a bone be slit longitudinally in the situation of a former fracture, the fragments are observed to have their substances blended completely together, and not simply to lie in contact in the manner of two pieces of wood placed end to end, and kept in contact by means of a clasp. Duhamel, with the view of obviating this difficulty, supposed that the periosteum elongated itself from the circumference towards the centre of the bone, and that such continuation of this membrane underwent the same changes as that portion which was contiguous to the fracture, and thus served to unite the ends of the fragments between which it was interposed. He admits also in some cases that the *internal periosteum*, or *medullary membrane, may furnish productions extending between the ends of the fracture*, like the continuation of the external periosteum with which they become connected. Lastly, he supposed that in young subjects, whose bones had not acquired their full degree of hardness, the cartilaginous part was capable of extension, and that, in cases of fracture, it contributed to the more perfect union of the fragments.

Boyer thought that Duhamel imputed too much to the periosteum; but that Haller and Dethleef were also wrong, when they supposed that an unorganised lymph could produce an organised substance by inspissation. (See *Le second Mémoire sur les Os, par M. Bordenave, recueilli et publié par M. Fougeroux*, p. 124.) It appeared to Boyer much more natural to believe that the gelatinous lymph already contains the rudiments of organisation, which become visible as they are developed; just as it is usually believed that the rudiments of all our organs are contained in the transparent mucilage of which the embryo seems to consist.

The experiments of Duhamel and Dethleef were carefully repeated by Bordenave, who ascertained several new and interesting facts. The result was the same in regard to the phenomena observed; but the explanation of them was different.

Instead of attributing the formation of callus to the periosteum, like Duhamel; or to the extravasation of lymph, or fibrine, like Dethleef; Bordenave conceived that broken bones unite again by a process analogous to that which nature employs for the union of the divided soft parts. His inference is principally founded on two facts generally admitted. 1st, That there is in the bones a vascular texture, designed to maintain the circulation in them. 2nd, That such texture dilates when fractures are uniting, as appears from the swelling in the situation of the fracture, without which swelling there could be no union. Bordenave further remarks, with Haller and Dethleef; 1st, That callus, at the commencement of its formation, appears to consist of a glutinous fluid effused from the ruptured vessels. 2nd, That this substance afterwards assumes the form of cartilage, to which certain vessels are distributed, which deposit the bony matter, and thus begin the generation of callus. 3rd, That the particles of bone, being all joined together, the callus changes into a porous substance, which in time becomes solid and compact, like the substance of bones.

John Hunter explained the formation of callus by the organisation of the extravasated blood, and its subsequent ossification. He noticed also the inflammation of the extremities of the bone, the softening and rounding of them, and the partial absorption of their earthy particles.

According to Mr. Howship, the first effect of fracture is the extravasation of blood between the fragments into the medullary cavity, and also into the periosteum, which is thus thickened. The blood coagulates, loses its colouring matter, becomes organised, assumes the appearance of cartilage, and is at length converted into bone. This latter change is first effected external to the fragments, and in the medullary canal, so that an osseous case is formed before the complete reunion of the fracture. (See *Med. Chir. Trans.* vols. vi. vii. and viii. and *G. Gulliver*, in *Edinb. Med. and Surg. Jour. for July* 1835. p. 44.) Mr. Howship's observations are interesting, as coinciding very much with those previously made by Duhamel, Villermé, Breschet, and Dupuytren.

The observations made by Baron Larrey lead him to reject as erroneous the doctrine which refers the production of callus to the periosteum, and he adopts the opinion that the union and reparation of bones are the work of their own vessels. He adverts to examples in which, after the use of the trephine in young subjects, the perforation becomes more or less closed by new bone, thrown out from the circumference towards the centre. Here, says he, the ossification assuredly can neither be referred to the pericranium, nor the dura mater. The first of these membranes has been extensively destroyed, and if the second were concerned, a vertical substance, shutting up the opening, would be apparent. In further support of his opinions, Baron Larrey cites the well-known celerity with which fractures of the lower jaw unite, on account of the great vascularity of that bone; and he believes, with Sir Astley Cooper, that if the ends of a fracture do not touch, in consequence of loss of substance, the intervening space remains unfilled up by new bone; a position which seems rather repugnant to what he has said concerning the mode of reparation after the use of the trephine.

With respect to the alleged impossibility of union, when fractures are attended with loss of substance, Mr. Gulliver observes that the union of bone, under such circumstances, is common in the lower animals, and has been repeatedly observed in the human subject, of which a remarkable instance is recorded by M. Contevoz. (*Mem. de l'Acad. de Chir.*) "Professor Syme showed me a case in the Royal Infirmary of Edinburgh, in which he had removed from the tibia of an adult male about an inch of the entire diameter of the bone, which had been completely reproduced; and I saw in the practice of Dr. Bushe of New York, a similar example in the femur of a young man, which was not followed by a shortening of the limb equal to the length of that portion of the shaft of the bone removed by Dr. Bushe." (*Gulliver, in Edinb. Med. Journ.* No. 124, p. 46.) If any doubt could exist on this point, it would cease on our remembering the occasional cures of disunited fractures effected by sawing off the ends of the bone.

For the most complete account of the process by which broken bones unite, we are indebted principally to MM. Villermé, Breschet, Sanson, Cruveilhier, and Dupuytren, all of whom, however, owe a great deal to their predecessors in the same field of inquiry, more especially to Duhamel. In 1808 Baron Dupuytren instituted certain experiments to determine the truth of the statements made on this subject by Bordenave and Bichat, but was surprised to find nothing to justify their accounts, and he was led to adopt other views, partly founded, however, on those of Duhamel. The process is far more complicated than represented by Bordenave and Hunter. Many years ago Sir Benjamin Brodie also made experiments upon animals with the view of elucidating this subject, and the preparations are still preserved. At that time he thought of publishing a paper on the union of fractures; but, before his investigations were completed, he found the whole matter so satisfactorily made out by Baron Dupuytren, that he was induced to relinquish the design. (See *London Med. Gaz. for* 1833-34, p. 54.) The results of Mr. Bransby Cooper's experiments seem also to agree very much with those arrived at by Dupuytren, due allowance being made for the greater celerity of the process in the bones of rabbits than in those of the adult human subject. (See *Guy's Hospital Reports*, part 4.) The researches of MM. Villermé, Dupuytren, and Breschet prove that all the old descriptions of the process were too limited and exclusive. When a bone is broken, the soft parts near it are torn and contused, and the vessels of these, as well as of the periosteum and medullary membrane, assist in the reparation. It has long been familiarly known that callus is not formed suddenly; that it requires more or less time for its production; and that the broken part of the bone only obtains solidity by degrees. Now, before the work of repair is complete, several changes happen, one after another, or in succession. Hence, the process is now usually divided by pathologists into four stages.

In the *first*, comprising a period of about ten days from the time when the accident took place, if the injured parts are examined, blood is found to be extravasted around the ends of the fracture, between them, and even in the medullary canal. The ecchymosis may extend to parts far from the fracture. Considerable inflammation and swelling ensue at the irritated points. The muscular fibres are confounded with the inflamed cellular tissue, and very soon cannot be distinguished from other parts. The periosteum becomes red, swollen, and softened, and a reddish serous fluid is effused between it and the portions of the bone which it covers. The fibrous appearance of the ends of the bone disappears. The medullary membrane itself swells, inflames, and gradually obliterates the tube in the centre of the bone. The medulla acquires a greater consistence, and the portion of it in one fragment is conjoined with that of the other. If we look at what is passing between the ends of the fracture, we find that the coagulated blood between them is absorbed in a few days, and replaced by a gelatinous fluid ; and between the fourth and the sixth day the surfaces of the fracture are sometimes, but not always, covered by a reddish, fleecy substance. (See *Dupuytren*, *Clinique. Chir.* t. iv. p. 132.)

In the *second stage*, extending from the tenth to the twenty-fifth day, the swelling of the soft parts becomes firmer, and every day more intimately adherent to the substance between the ends of the fracture; and the muscles resume their usual appearance. This *tumor of the callus*, as it is termed by Baron Dupuytren, now diminishes in extent, and becomes more distinct from the surrounding parts. Its texture is homogeneous, very like fibrocartilage, and divided with difficulty. Its fibres are parallel to the axis of the bone. The swollen medullary membrane, transformed into a fibrocartilaginous texture, progressively lessens the central cavity of the bone, and at length fills it up. The internal production, or peg (*cheville*) resulting from these organic changes, becomes blended on the level of the fracture with the substance interposed between the fragments. (See *Dupuytren*, op. et t. cit. p. 133.)

As the formation of the callus advances, other particularities are noticed, and these occur in what may be considered as the *third stage*, which begins about the twenty-fifth day, and is prolonged to the fortieth, or even the sixtieth. In weak constitutions the process is not finished till the end of the third month. The firm, homogeneous, fibrous mass, constituting what Dupuytren names the *tumor of the callus*, acquires by degrees a cartilaginous, and rather an osseous consistence. About the end of this period the fragments are placed in the centre of a solid ferule, which adheres to every point of their circumference. This kind of ferule, or clasp, the very same thing which was accurately described by Duhamel, is covered by thickened periosteum, which is united to that which invests the sound portions of the bone, and no external traces remain of the solution of continuity. The surrounding cellular tissue is yet stiff and indurated. The soft substance between the fragments has become denser and more adherent to the extremities of the bone; but it is still far from uniting them with any degree of perfection. The central peg, continuing to extend itself towards the ends of the fracture, rapidly assumes a greater consistence, and soon forms a very solid osseous cylinder. It is commonly at this period that surgeons discontinue the apparatus; but the callus, now existing, is not to remain, and consequently Baron Dupuytren terms it the *provisional callus.*

Fourth stage. Between the third and the fifth, or sixth month, the tumor of the callus becomes gradually more compact ; and the central ossification, or peg (*cheville*) undergoes the same transformation. The substance interposed between the fragments acquires all the organic characters and the consistence of the firm substance of bone, from which it is only distinguishable by its particular colour. It is this intervening substance, transformed into an osseous tissue, which makes what Baron Dupuytren has named the *definitive callus.*

Finally, the central ossification (*cheville*) assumes a lighter texture, cells are produced within it, and, after having been converted into a reticular texture, it disappears, leaving the central canal of the bone perfectly free again. After the restoration of the medullary canal, a medullary membrane, which invested the cells, becomes continuous with the membrane that lines it and secretes the medulla. Lastly, the external portion of the provisional callus (for the central ossification may be looked upon as another part of it) disappears.

As Dupuytren further explains, the differences of fractures must occasion slight varieties in the formation of the callus. Thus, when the two ends of the fracture pass over one another, the internal cylindrical ossification, or peg, is not formed ; and the case is the same when the bone does not present a medullary canal.

This history of the process by which fractures unite must at once let us understand that the period of forty days, sometimes specified as the time requisite for the consolidation, is far from being sufficient, and that it should be much longer in oblique fractures, and those where the ends of the bone ride over one another.

The same history would lead us to expect what certain facts prove, that, down to a certain period, when a fracture has united with much deformity of the limb, the surgeon may safely make the callus yield, so as to bring the limb into a better shape. Dupuytren has recorded cases in which he accomplished this purpose in the leg, after the twenty-ninth and even the fifty-ninth day, and in which a deviation of the hand towards the radial side of the fore-arm was rectified as late as the twenty-fifth day. The advantage now spoken of may be obtained without breaking the callus, which is a substance endued with a certain degree of suppleness and elasticity. The fragments having been brought into a better position by the observance of the principles recommended to be attended to in the reduction of fractures generally, the improved situation of the fragments is to be secured by mechanical means. Thus, as Dupuytren remarks, supposing there is a projection made by the end of one, or those of both fragments, the limb is to be placed between two inflexible planes, which compress it in two diametrically opposite directions. As the projecting points receive the greatest pressure, they tend to return to the level of the rest of the bone. If, by means of pads, the projection is increased, while a vacancy is left at the opposite point, then the effects produced will be still more marked, and even carried so far as to cause deformity in the other direction. The same improvement may be brought about even without acting directly on the seat of the fracture, by employing the lower fragment as a lever, and applying an apparatus, calculated to incline it in the direction that will bring it into a better position with respect to the upper fragment. (*Dupuytren, Clin. Chir.* t. iv. p. 147.) The apparatus should be put on more tightly than in a recent stage of fracture; but the manner in which the limb bears the pressure must be vigilantly attended to. So long as the deformity is not entirely corrected, the apparatus should be opened every third or fourth day, and fresh but gentle attempts at reduction made. Every little improvement made by each manual interference is then to be secured by means of the bandage and apparatus. In this way the natural shape of the limb will be gradually restored. The plan is not, however, to be continued too long, as it would altogether prevent union of the bone. Another maxim laid down by Dupuytren is, that, when the deformity has been considerable, the treatment after its removal should be continued as long as if the case were a recent fracture. (*Clin. Chir.* t. iv. p. 146—151.)

The *provisional callus*, then, differs from the definitive, not only in point of situation and time of its formation, and continuance, but in its inferior consistence and solidity. When completed, it only possesses the strength necessary to resist the moderate action of the muscles, and to support a certain weight. Nay, after the removal of the splints, it will sometimes yield to these forces, especially in oblique fractures.

The support of the provisional callus is frequently overcome by a blow or rough use of the limb. Sometimes it is weakened or destroyed by the influence of constitutional diseases, fever, &c.

The *definitive* callus, though less bulky, is harder, stronger, and more compact than the *provisional.* Hence, after the definitive callus has been completed, bones rarely or never break in the exact situation of the former fracture. Excepting in very aggravated forms of scurvy, I believe that the definitive callus is hardly ever disorganised and destroyed by the effects of constitutional diseases.

When the two ends of a fracture are in contact only at a point, it is here alone that the definitive callus can be produced; but, as a compensation, the external or provisional callus is then never entirely absorbed.

In fracture of the neck of the thigh-bone, entirely within the capsular ligament, the provisional callus cannot reach the fracture, and, if bony union follow, it is effected by a process within the bone itself. "The instances (says Mr. Mayo) in which union is effected through a process originating in the bone itself, are fractures of the cranium, and of the neck of the thigh-bone, within the capsular ligament. In the first of these cases no provisional callus is formed: in the second, the provisional callus has no means of reaching the fracture. It is difficult to explain why a provisional callus does not form about fractures of the cranial bones. The physical cause of this negative phenomenon is not known. The final cause, however, is evident. If a hard swelling, such as a provisional callus, were stretched as a ridge along the inner aspect of a cranial fracture, it would encroach upon the cranial cavity; and hemiplegia, epilepsy, or some other form of cerebral disorder would attend the cure of every fracture of the skull. No callus therefore is formed. But the fracture, after a time, shows a disposition to unite through forces inherent in the bone itself, &c. In a fissure of the skull, examined some months after the injury, the only change apparent is the rounding of the edges externally. After a year or two the fissure is united at its internal or cerebral aspect. After the lapse of many years the narrowest part of the fissure is entirely filled up. In persons who have lived ten, twenty, or fifty years, after loss of portions of the cranium, the slow restoration of the bone appears to have been progressive for the whole period. In fifty years, a trephine hole is nearly closed by the shelving growth of bone from the margin towards the centre." (See *Mayo's Outlines of Human Pathology,* p. 8.) The causes of the difficulty of bringing about osseous union in such fractures of the neck of the femur as are entirely within the capsular ligament, will be hereafter considered.

When the ends of a fracture only touch laterally, as I have stated, there is strictly no provisional callus. The vessels of the adjoining cellular tissue, muscles and other textures, here greatly assist in the work of reparation. The side of one fragment becomes soldered to that of the other, and here the callus is permanent, or never removed. In such a case there is no internal cylindrical ossification; no *cheville,* as the French term it; because it would evidently be of no service.

In compound fractures, followed by suppuration, the bones remain disunited for many weeks. Here also no provisional callus is formed. The ends of the bones soften and granulate, and, in proportion as the secretion of pus subsides, the granulations begin to deposit the osseous matter, which is to constitute the uniting medium. This part of the subject was explained many years ago by John Hunter and the late Mr. Wilson. (*On the Skeleton, Diseases of Bones, &c.* p. 233, 8vo. also *Dict. des Sciences Med.* t. xxxviii. p. 486.)

Fractures of the patella, olecranon, condyles of femur, coronoid process of the ulna, acromion, and coronoid process of the jaw, are generally united by a ligamentous substance.

Broken cartilages, the cartilages of the ribs especially, and in some instances the thyroid or cricoid cartilages, do not unite by cartilage, but by means of osseous matter, deposited around the solution of continuity, in the manner of a provisional callus, which, however, is here permanent.

As the provisional callus in adults never begins to ossify before the tenth day, we know that, if great inflammation or other causes forbid the application of mechanical means during this period, no permanent deformity will be the result of deferring the employment of splints, bandages, &c. On this principle, and with the view of letting the limb get into a more favourable state to bear the pressure of mechanical means, some surgeons do not usually apply any apparatus during this stage. In infancy, however, where the callus is completed with surprising quickness, it is desirable always to set the fracture without delay.

[The more recent investigations of Mr. Stanley and Mr. Paget have led them to form conclusions on the subject of the union of fractured bones somewhat different from those of Dupuytren, and especially as regards the formation of provisional callus in the human subject. Mr. Stanley, while admitting and confirming the views above expressed as to the union of fractured bones in animals, thinks that in man, where the ends of a fracture are kept perfectly at rest, there is no provisional deposition of callus, as in animals, which is afterwards to be absorbed, but that the union takes place by direct ossification of the substance effused between the ends of the fractured bone. He admits, however, that a provisional callus is formed in the human subject after fractures of the ribs, and also that in cases where the bone cannot be kept at rest, the irritation may occasion the deposition of an ensheathing osseous substance answering all the purposes of a provisional callus, as in animals, but not, like it, previously cartilaginous or deposited between the periosteum and bone, but infiltrated more indiscriminately into all the surrounding tissues in consequence of the irritation produced by the movements of the fracture. Mr. Stanley thus states his conclusions: "The undisturbed ends of a fractured bone in man unite by the medium deposited between its fractured surfaces; that the amount of adventitious osseous deposit accompanying the reparation of a fracture is proportionate to the degree of irritation which, from the unquietness of the ends of the bone, is excited in the surrounding parts; that the seat of this deposit is the periosteum and cellular tissue adjacent to it; but that the characters of this deposit are wholly distinct from those of the provisional callus in animals. Such will be the explanation of the seemingly irregular osseous deposits around fractured bones. The interpretation of other osseous productions of well-defined shape and texture, found upon this or that side of a fractured bone, or filling up the hollows between its displaced portions, must be sought for by observing in what directions such additions of support and strength were required." (See *Illustrations of the Diseases and Injuries of the Bones*, p. 29, 1849.)

Mr. Paget coincides with the views of Mr. Stanley on this point, and considers that "the normal mode of repair in the fractures of human bones is that which is accomplished by 'intermediate callus.' The principal features of difference between it and union by provisional callus are, (1.) that the reparative material or callus is placed chiefly or only between the fragments, not around them. (2.) That when ossified, it is not a provisional, but a permanent bond of union for them. (3.) That the part of it which is external to the wall of bone is not exclusively, or even as if with preference, placed between the bone and the periosteum, but rather in the tissue of the periosteum, or indifferently either in it, beneath it, or external to it." Mr. Paget thinks it *possible* that when the fragments are placed in close apposition and correspondence, that they may be joined by immediate union (that is, that they may be united without any new material being formed for their connection; a continuity of tissue and blood-vessels being restored, as in the cases of healing by immediate union of soft parts), but if this do not happen, a thin layer of reparative material is deposited between them; it does not in any direction exceed the extent of the fracture; neither does it, in more than a trivial degree, occupy the medullary canal; but, being inlaid between the fragments, and there ossifying, it restores their continuity. The process may be compared with that of union by primary adhesion. If, however, as more commonly happens, the fragments at certain parts project more or less one beyond the other, the reparative material is, as in the former case, inlaid between them, but is also in larger quantities placed in the angles at which the fragments overhang one another, but never to the extent of forming a complete ensheathing callus, excepting in the ribs, and more rarely the clavicle. "It is deposited where it is most wanted for the strengthening of the bone, and in quantity as well as position, is adapted to the exigencies of the case, so as to restore, as much as may be, the original condition and capacities of the bone." If it be inquired why this difference should exist in the corresponding processes in man and in other animals, Mr. Paget thinks it must be ascribed principally to two causes, namely, the quietude in which fractures in our bones are maintained, and the naturally greater tendency to the formation of new bone which animals always manifest. In answer to the statement that an ensheathing callus can often be felt during life, he says, "The deception is produced either by thickening and induration of the soft parts around the fracture, or by the two overlapping ends of the fragments being grasped at once, or much more rarely, by new bone accumulated about the fragments in consequence of inflammation." (See *Lectures on Surgical Pathology*, vol. i. p. 251.)

Mr. Paget has examined the changes which the effused reparative substance undergoes previous to its conversion into perfect bone, and has found that those changes are by no means the same in all cases, but that the lymph, previous to its ossification, may form itself into perfect cartilage, into fibro cartilage, into pure fibrous tissue, or into the rudimental forms of the latter tissue, viz. nucleated cells or nucleated blastema. In animals, perfect cartilage with cells, intercellular substances, and all the characters of pure fœtal cartilage may be produced. Mr. Paget has not found the same process in the human subject, but thinks it might occur in favourable instances of simple fracture in children. In youths and adults he has met only with varieties of fibrous cartilage, presenting numerous gradations from the fibrous towards the perfect cartilaginous structure.

The new bone, through whichever mode it is formed, quickly acquires its proper microscopic characters. Its corpuscles or lacunæ, being first of simple round or oval shape, and then becoming jagged at their edges, subsequently acquire their canals, which appear to be gradually hollowed out in the preformed bone, as minute channels communicating with one or more of the lacunæ. The laminated canals for the blood vessels are of later formation. (*Paget*, op. cit. p. 246.)]

OF THE CONDUCT TO BE ADOPTED AT THE ORDINARY PERIOD OF THE CONSOLIDATION OF FRACTURES; AND OF UNUNITED FRACTURES, AND FALSE JOINTS.

When the requisite time for a broken bone to become firmly united has elapsed, it is proper to examine carefully and cautiously the place of the fracture, in order to learn whether the callus has acquired a suitable degree of strength. If the bone should be found to bend in the least at the injured part, the callus is not sufficiently strong, and the limb should be immediately put up in the apparatus again, with the view of preventing a new fracture, or, at all events, deformity.

For the same reason the patient should not be allowed to make free use of his limb as soon as the fracture has united. In fractures of the lower extremity he ought to use crutches, and only let the weight of the trunk by degrees bear upon the injured limb. From neglect of this precaution the callus has been known to be absorbed, the limb to be shortened, and the patient become a cripple. An accidental slip may also produce the fracture again; for the provisional callus, so far from being firmer than the rest of the bone, is at first considerably weaker.

That the state of the constitution has vast influence over the process by which broken bones are reunited, is unquestionable. Schmucker found the formation of callus, even in the most simple fractures, sometimes delayed eight months, and in one example, more than a year; but all the patients were unhealthy. (*Vermischte Chir. Schriften*, b. i. p. 26.)

There are certain indescribable constitutions, in which bones, particularly the humerus, will not unite again after being broken. These temperaments are also exceedingly various; at least, I infer so from two subjects, to whom I paid particular attention. One was a strong robust man, whose chief peculiarity seemed to be his indifference to pain: the ends of his broken humerus were cut down to, turned out, and sawn off by Mr. Long, in St. Bartholomew's Hospital, and the limb was afterwards put in splints, and taken the greatest care of; but no union followed. The other case was a broken tibia and fibula, which remained disunited for about four months, but afterwards grew together. The latter subject was a complete instance of hypochondriasis. I afterwards saw a woman, under Sir James Earle, in the above hospital, whose humerus did not unite, though it had been broken several months. Every attempt to move the bone occasioned excruciating torture. The woman died of some illness in the hospital, and on dissecting the arm, the cause of the fracture not having united was found to arise from the upper sharp-pointed extremity of the lower portion of the broken bone having been forcibly drawn up by the muscles, and penetrated the substance of the biceps, in which it still remained. I am indebted to Mr. Earle for the description of the appearance in the dissection, and I do not know that this kind of impediment to the union of a fracture has been noticed by any earlier writer than Mr. Charles White, who appears to have conceived the possibility of the occurrence. (*Cases in Surgery*, p. 70, edit. 1770.)

Sir Benjamin Brodie attributes the want of union mostly to the state of the constitution. "A gentleman (says he), was growing fat, and not liking to do so, he placed himself on a very spare diet, though accustomed to good living previously. After six months of starvation, he broke his arm, and the bone would not unite. I saw him many months afterwards, and there was scarcely any union even by soft substance. Another patient, about whom I was consulted, a lady, was growing fat, and thought she would also prevent it by pursuing a similar system of diet. Some months afterwards she broke her arm, and union did not take place." A man broke his thigh and remained ten days without any action of the bowels: no union of the fracture ensued. The same distinguished surgeon adverts to other facts, which tend to prove, that tight bandaging and other circumstances, unfavourable to a free circulation in the limb, may prevent union. (See *Lond. Med. Gaz.* for 1833-34, p. 57.)

It is observed by Larrey that the gunshot wounds of the extremities, complicated with fracture, especially with that of the humerus, received by the soldiers of the French army in Syria, were almost all followed by the formation of accidental joints. The two fragments of the broken bone continued moveable, their asperities and projecting angles having been destroyed by friction, and their ends being rounded and covered with a cartilaginous substance, so as to facilitate the motions which the patients executed in various directions, in an imperfect manner and without pain. Larrey acquaints us that many invalids were sent back to France with such infirmity.

"I ascribe," he says, "the causes of these accidental articulations:

"1. To the continual motion, to which the wounded soldiers were exposed after their departure from Syria till their arrival in Egypt, in consequence of their having been obliged either to walk this journey on foot, or to be carried on beasts.

"2. To the bad quality of the food, and the brackish water, which the men were under the necessity of drinking in this painful journey.

"3. To the state of the atmosphere of Syria, almost entirely destitute of vital air, and impregnated with pernicious gases, issuing from the numerous marshes, near which we were a long while stationed.

"All these causes may have prevented the formation of callus, either by diminishing the quantity of the phosphate of lime, or moving the bones out of that state of coaptation in which they should constantly lie in order to unite.

"Bandages, embrocations, rest, and regimen proved quite ineffectual." (*Larrey*, *Mém. de Chir. Mil.* t. ii. p. 131, 132. *Langenbeck, N. Bibl.* b. i. p. 81.)

The presence of an ulcer, a sinus, loose splinters of bone, a necrosis, or other suppurating disease, near a fracture, is a circumstance that often seriously retards or completely prevents the formation of callus. How frequently have I noticed in compound fractures, that, while the wound suppurates largely, and while there are spicula and dead portions of bone unextracted, no solid union takes place; but that as soon as the wound, ulcer, or sinus admits of being healed and the suppuration ceases, ossification goes on in the most favourable manner.

With respect to the union of broken bones being prevented by disease, Sir Benjamin Brodie believes that this *may* be the case where there is an abscess in the bone, a necrosis, or some other conditions. "I know, however," he observes, "that the rule is not *absolute*; for, in a great many instances, where the bone is diseased, it will unite perfectly. I had a patient, who had disease of the bones, whether it arose from syphilis, mercury, or a cachectic state of the constitution, I cannot say; however, some of the bones had nodes upon them, and were very much enlarged. The principal enlargement was in one of the clavicles. There was a portion of this bone enlarged, and much diseased besides. This man, in using his arm, broke the collar-bone, the fracture going through the diseased part. I bound up his arm, and concluded, that there would be no union; but to my surprise, it united quite as soon as ordinary fractures. Women, labouring under cancer of the breast, are very liable to a similar disease of different bones in the body. Sometimes this disease, which is indicated by pains, like those of rheumatism, will affect nearly the whole of the bones, which then become brittle, and very liable to break. I first observed this fact, many years ago, in the case of an old woman, who was dying of cancer, and who, in turning one day in bed, broke the thigh-bone. I concluded that the broken bone would not unite; but union took place as well as under ordinary circumstances. I attended a lady, two years ago, who had cancer of the breast, and pains in the limbs, indicating cancerous disease of the bones. There was a scirrhous affection of the collar-bone; and one day, in moving her arm, the collar-bone was broken; but it united, just as if it had been a healthy bone." (*Sir B. Brodie, in Lond. Med. Gaz.* for 1833-34, p. 56.) The truth of the latter statement has been proved in the case of a woman with a cancerous breast who has been a patient in University College Hospital more than once under Mr. Liston, for spontaneous fractures, which have always united again tolerably well. I was once called to see a coachman for a retention of urine, dependent on a cancerous disease of the bladder. A few days afterwards his thigh-bone broke as he was turning in bed; and in the course of another week he died. The *post-mortem* examination detected a scirrhous tumor under the periosteum, surrounding the fractured part of the bone; and one of the ribs, which had given way, was similarly encompassed. The history of the case is recorded in the Med. Chir. Trans. vol. xvii. and the specimens are preserved in University College Museum.

According to Boyer, the ends of the fracture, which are sometimes rounded, and sometimes pointed, are connected together by a cellular and ligamentous substance. But their surfaces are not covered by a smooth cartilaginous matter, nor is there constantly a capsular ligament. "I am convinced of this fact, by the dissection of several ununited fractures, the fragments of which are preserved in my museum." (*Boyer*, t. iii. p. 94.) And, in another place, the same Professor, speaking of these false joints, remarks: "I repeat that I have never found, in their structure, anything which could be compared with an articulation; neither capsular ligament, nor smooth cartilaginous surfaces. On the contrary, I have invariably found, in the false joints of the thigh-bone and humerus, which I have had opportunities of dissecting, a fibrous ligamentous substance, extending from one fragment to the other, and it is very probable, that, with some modifications, it is the same with all the other cases, which I have not seen.

On this subject, Langenbeck observes, "When the parts are incessantly moved, the end of one fragment becomes excavated, in the form of an articular cavity. I have in my possession (says he) a lower jaw, and an olecranon, the fractures of which are not united. For the connecting medium, nature has provided a white substance, resembling ligament. I have also seen an articular connection established in the body of the thigh-bone subsequently to a fracture." (*Neue Bibl.* b. i. p. 93.)

In the Hunterian Collection may be seen a false joint in the bones of the fore-arm, where the resemblance to a natural articulation was greater than what Boyer has seen in other situations.

According to Professor Sharpey, the connection is mostly by means of a tough, fibrous, ligamentous-looking mass; and the nearest approximation to a new articulation which occurs, consists in the existence of cavities, more or less extensive, between the fibres of this connecting substance. (See *Syme's Principles*, ed. ii. p. 161.) The bond of union is stated to differ from ordinary ligament in presenting no fibrous appearance. Sir Benjamin Brodie, who has made this remark, coincides with Boyer, with regard to the ordinary mode of connection; admitting, however, the occasional formation of a new, or false joint, where "the rounded ends of the bones are covered by a thin ligamentous substance, and the inner surface of the capsule is lined by a smooth membrane, like the synovial membrane, and capable of secreting synovia." (See *Lond. Med. Gaz.* for 1833-34, p. 57.)

A valuable dissertation on false joints was published by Reisseisen, entitled "*De Articulationibus analogis, quæ Fracturis Ossium superveniunt.*"

[Rokitansky, who has more recently investigated this subject, describes these unnatural joints resulting from fracture as of two kinds: "one more or less resembling a synarthrosis, the other like a diarthrosis, and accordingly, in its proper sense, a new joint.

"In the former case, the fractured ends of the bone are held together by a ligamentous tissue. Either a disc of ligament, the thickness of which may vary, is interposed between them, and allows but of little movement; or, as occurs when there has been loss of substance, either from injury, absorption of the fractured ends or otherwise, ligamentous bands connect the fragments, and allow them to move freely on each other. The connecting tissue appears to be nothing more than the intermediate substance, which has failed to become transformed into the secondary callus and remains in its first state.

"In the second case, a ligamentous articular capsule is formed, and is lined by a smooth membrane which secretes synovia. The fractured surfaces adapt themselves to each other and become covered with a layer of tissue, which is fibro-ligamentous, or more or less fibro-cartilaginous, or which resembles and sometimes (Howship) really is cartilage. They may articulate immediately with one another, or may have between them an intervening layer of ligament, which corresponds to an inter-articular cartilage; and their movement upon each other is more or less free, according to the size of the articular capsule, and the form of the articulating surfaces. These last are sometimes horizontal and smooth; they glide over each other and allow of restricted motion: sometimes one surface becomes convex and the other concave: sometimes both are rounded off, and, lying within a capacious articular capsule far apart, they come in contact only during particular movements. The articular capsule is the product of the inflammation of the soft parts: the cartilaginiform layer, which covers the ends of the bone, is secondary callus arrested in its metamorphosis and converted into a fibroid tissue. The other ligamentous cords which are sometimes present, and the structures resembling an inter-articular cartilage, are remnants of the intermediate substance. Both forms of new joint, but more particularly the synarthrodial form, have an analogue in the lateral new joints sometimes found betweeen the masses of callus which are thrown out around two adjoining fractured bones. In the fore-arm and leg, and between the ribs, for instance, new joints are sometimes met with between the masses of callus after fractures have united." (*Rokitansky, Patholog. Anat.* vol. iii. p. 216, *Sydenham Society's Translation.*)]

A false joint in the arm, or fore-arm, does not absolutely prevent the motion of the limb, which may yet be of considerable use; but, when the disease is in the thigh or leg, the member cannot support the weight of the body, and the patient is unable to walk without crutches.

The diversity of causes which may be concerned in preventing the union of fractures, plainly shows that the treatment should be different in different cases.

When the want of union is ascribable to the ends of the fracture not being in a state of coaptation, and to their having been moved about too frequently, the obvious indications are, to set the fracture better, and to take adequate measures for keeping its extremities in contact and perfectly motionless.

If the union has been prevented by a portion of muscle, or other soft part, getting between the ends of the bone, the only means of affording a chance of union would be cutting through the integuments, removing the displaced soft parts, and placing the ends of the bone in contact. (*Wardrop, in Med. Chir. Trans.* vol. v. p. 363.)

When the advanced age of the patient seems to be the cause of the union not taking place, the application of the proper apparatus is to be continued a considerable time, since experience proves that in old subjects the cure of fractures often requires many months. In such examples, also, tonic and cordial medicines, with a nutritive diet, are highly proper.

Anything in the state of the constitution likely to account for the want of union should be removed or rectified. "One patient may require to be put upon a better diet; another may require purgative medicine; another may stand in need of tonics. Mr. Wilson used to relate the case of a woman who was a dram-drinker, and who broke her leg. At first she was not allowed to take her customary drams, and the bones showed no disposition to unite. At last, she was allowed to take a certain quantity of spirit, and union took place immediately." (*Brodie,* op. et vol. cit. p. 58.)

When several months have elapsed since the accident, and there is reason to apprehend that a preternatural joint or a ligamentous union has taken place, a variety of local plans have been proposed.

Here I may remark that no severe operation will be justifiable, unless the inconvenience, arising from the want of bony union, be considerable. If a broken rib were not to unite, by osseous matter, it would be of little consequence. I opened an old man who was in this state, yet he had never complained of it, nor indeed had he ever been aware of it. Sir Benjamin Brodie has a specimen of a joint, formed in a rib after fracture; and the patient was believed to have suffered little or no inconvenience from it. (See *Lond. Med. Gaz.* for 1833-34, p. 58.)

The most ancient method of treatment is that of forcibly rubbing the ends of the fracture against each other, so as to make them inflame, and take on a disposition to form callus. This plan was recommended by Hunter, and has had the approbation of many other distinguished modern practitioners. In a disunited fracture of the leg or thigh, Mr. Hunter used to let the patient get up, and attempt to walk with the splints on the limb, so that the requisite irritation might be produced. The idea of exciting a degree of inflammation in the situation of the fracture, certainly appears rational, and the practice has been attended with a degree of success. Mr. White records an example, in which he cured a broken thigh on this principle, a strong leather case having been made for the limb. (*Cases in Surgery,* p. 75.) A broken tibia, treated on similar principles, is mentioned by Mr. Amesbury. (*On Fractures,* p. 211, ed. ii.) The method is spoken of in Celsus: *si vetustas occupavit, membrum extendendum est ut aliquid lædatur: ossa inter se manu dimovenda, ut concurrendo exasperentur, et ut si quid pingue est, eradatur, totumque id quasi recens fiat, &c.*

I have seen cases in which the union was thus brought about. In numerous instances (says Sir Benjamin Brodie), I have known patients in the hospital kept in bed for ten weeks, and even longer, without union taking place. A splint has then been bound on each side of the limb; we have put the patient on crutches, made him walk about, put the limb to the ground, and exercise it with the splint on, and the fracture has become united. Then in other cases I have applied blisters to fractures which were slow in uniting:" but, if this method is to be useful, it must be tried in eight or ten weeks after the accident. (*Brodie,* in *Med. Gaz.* for 1833-34, p. 58.)

The foregoing treatment, however, is only likely to answer before a new joint, or a ligamentous connection, has been completely formed, and when the limb has hitherto been kept motionless.

When the case is old, and there are grounds for believing that a new articulation, or ligamentous connection, has taken place, we are advised to cut down to the ends of the bone, rasp or saw them off, and then treat the limb just as if the case were a recent compound fracture.

Sir Everard Home used to mention the case of a man with ununited fracture of the humerus, who was under Mr. Hunter's care. There was an artificial joint, and Mr. Hunter made an incision into it, and then having introduced a spatula, he irritated the whole surface of the artificial joint. This brought on considerable inflammation, which ended in ankylosis, and the patient was cured. (*Sir B. Brodie,* in *Med. Gaz.* for 1833-34, p. 58.)

This bold practice was first suggested by Mr. C. White. "Robert Elliott, of Eyham, in Derbyshire, a very healthful boy, nine years old, had the misfortune, about Midsummer, in the year 1759, by a fall, to fracture the humerus, near the middle of the bone. He was immediately taken to a bone-setter in that neighbourhood, who applied a bandage and splints to his arm, and treated him as properly," says Mr. White, "as I suppose he was capable of, for two or three months. His endeavours, however, were by no means productive of the desired effect, the bones not being at all united. A surgeon of eminence, in Bakewell, was afterwards called in; but as he soon found he could be of no service to him, and as the case was very curious, he advised the lad's friends to send him to the infirmary at Manchester. He was accordingly brought thither the Christmas following, and admitted an in-patient. Upon examination, we found it to be a simple oblique fracture, and that the ends of the bone rode over each other: his arm was become not only entirely useless, but even a burden to him, and not likely to be otherwise, as there was little probability that it could ever unite, it being now six months since the accident happened.

"Amputation was therefore proposed as the only method of relief: but I could not give my consent to it, for as the boy was young, and had a good constitution, it was hardly possible that it could be owing to any fault in the solids or fluids, but that either nature was disappointed in her work by frequent friction, while the callus was forming, or rather that the oblique ends of the bone, being sharp, had divided a part of a muscle, and some portion of it had probably insinuated itself betwixt the two ends of the bone, preventing their union. Whichever of these might be the case, I was of opinion," continues Mr. White, "that he might be relieved by the following operation, viz. by making a longitudinal incision down to the bone, by bringing out one of the ends of it, which might be done with great ease, as the arm was flexible, and cutting it off, either by the saw or cutting pincers; then by bringing out the other, and cutting off that likewise, and afterwards by replacing them end to end, and treating the whole as a compound fracture.

"The objections, made by the other gentlemen concerned, to this proposal, were, first, the danger of wounding the humeral artery by the knife; secondly, the laceration of the artery by bringing out the ends of the bones; and thirdly, that we had no authority for such an operation. As to the first, that was easily obviated, by making the incision on the side of the arm opposite to the humeral artery. The place of election appeared to me to be at the external and lower edge of the deltoid muscle, as the fracture was very near to the insertion of that muscle into the humerus; the danger of wounding the vessel not only being by that means avoided, but, after the operation, while the patient was confined to his bed, the matter would be prevented from lodging, and the wound be easily come at, to renew the dressings. The second objection will not appear to be very great, when we consider that, in compound fractures, the bone is frequently thrust with great violence through the integuments, and seldom attended with laceration of any considerable artery; and as this would be done with great caution, that danger would appear very trifling. The third and last objection is no more than a general one to all improvements.

"This method which I have been proposing," says Mr. White, "was at last resolved upon, and I assisted in the operation, which was performed by a gentleman of great abilities in his profession, on January 3, in the present year (1760). The patient did not lose above a spoonful of blood in the operation, though the tourniquet was not made use of. When the operation and dressings were finished, the limb was placed in a fracture box, contrived on purpose, the lad confined to his bed, and the rest of the treatment was nothing different from that of a compound fracture.

"The wound was nearly healed in a fortnight's time, when an erysipelas came on, and spread itself all over the arm, attended with some degree of swelling: this, by fomentations, and the antiphlogistic method, soon went off, and the cure proceeded happily, without any other interruption. In about six weeks after the operation, the callus began to form, and is now quite firm. The arm is as long as the other, but somewhat smaller, in consequence of such long-continued bandages: he daily acquires strength in it, and will soon be fit to be discharged." (*Cases in Surgery*, p. 69, &c.)

In another instance of a broken tibia, which continued disunited an extraordinary length of time, Mr. White practised an operation, somewhat similar to the foregoing one, with complete success. He made a longitudinal incision, about four inches in length, through the integuments, which covered the fracture. By the application of a trephine, he cut off the upper end of the bone, and as the lower end could not be easily sawn off, he contented himself with scraping it. In the course of the subsequent treatment, he had occasion to take off, with the cutting pincers, a small angle of tibia, and to touch the lower part of the bone with the butter of antimony, as well as to introduce the same caustic between the extremities of the fracture, in order to destroy a substance which intervened. A trifling exfoliation followed. In twelve weeks the bone was firmly united. (Op. cit. p. 81, 82.)

Besides Mr. White's cases, there are now some other instances upon record, where the operation, which he first proposed, has succeeded. In the year 1813, Langenbeck operated upon a humerus in the foregoing manner, and the result was perfectly successful. The ununited fracture was situated at the insertion of the deltoid. (*Neue Bibl.* b. i. p. 95.) Mr. Rowlands, of Chester, by a similar operation, believed that he had cured a fractured thigh, which had lost all disposition to unite. (See *Med. Chir. Trans.* vol. ii. p. 47.) I understand, however, from Sir Benjamin Brodie, that the subject of this operation lately died, and that on examination of the broken part of the limb, there was no bony union. Viguerie, surgeon to the Hôtel-Dieu, at Toulouse, practised Mr. White's operation with success. (See *Larrey, Mém. de Chir. Militaire*, t. ii. a. 132.)

On the other hand, the operation has frequently failed. In the instance in which I saw it executed on the humerus by Mr. Long, in St. Bartholomew's Hospital, it did not answer, though the ends of the bone were most fairly sawn off, and the case treated with particular care and skill. Boyer states that he once performed the same operation in a similar case; but that it had not the desired effect. (*Traité des Mal. Chir.* t. iii. p. 110.) Dr. Physick, of New York, when he was a student in 1785, saw this proceeding unsuccessfully adopted in a case where the humerus remained disunited. (See *Medical Repository*, vol. i. *New York*, 1804.) Besides these examples, I have heard of others, in which Mr. Cline, Mr. Green (*Med. Chirurg. Review, February* 1828; and *Lond. Medical Gazette*, p. 357), and other practitioners tried the experiment with no better success. What is still more discouraging, the operation has sometimes proved fatal. (*Richerand, Nosogr. Chir.* t. iii. p.

39, ed. 2. *Larrey, Mém. de Chirurgie Militaire*, t. ii. p. 132.)

Baron Dupuytren deemed the removal of one end of the fracture sufficient, and gives two cases in which the plan succeeded; one of a thigh-bone, the other of a lower jaw. In the latter instance, however, he scraped away the ligamentous texture from the anterior fragment. (See *Journ. Univ. des Sciences Méd.* t. ix. 1820; and *Clin. Chir.* t. iv. p. 667, 8vo. Paris, 1834.)

The difficulties, the danger, and the frequent ill success of White's operation, had rendered another mode of treatment extremely desirable, when Dr. Physick of New York suggested the plan of introducing a seton through the preternatural joint, with the view of exciting inflammation, and bringing about the union of the bone. It was, in fact, a practice founded on Hunter's principles. Dr. Physick had an opportunity of performing the new operation on the 18th of December, 1802, in an example of disunited humerus, twenty months after the occurrence of the accident. "Before passing the needle (says Dr. Physick), I desired the assistants to make some extension of the arm, in order that the seton might be introduced as much as possible between the ends of the bone. Some lint and a pledget were applied to the orifices made by the seton-needle, and secured by a roller. The patient suffered very little pain from the operation. After a few days the inflammation (which was not greater than what is commonly excited by a similar operation through the flesh of any other part) was succeeded by a moderate suppuration. The arm was now again extended, and splints applied. The dressings were renewed daily for twelve weeks, during which time no amendment was perceived; but soon afterwards the bending of the arm at the fracture was observed not to be so easy as it had been, and the patient complained of much more pain than usual, whenever an attempt was made to bend it at that place. From this time the formation of the new bony union went on rapidly, and on the 4th of May, 1803, was so perfectly completed that the patient could move his arm in all directions as well as before the accident happened. The seton was now removed, and the small sores occasioned by it healed up entirely in a few days. On the 28th of May, 1803, he was discharged from the hospital perfectly well, and he has since repeatedly told me his arm is as strong as ever it was." (*Physick, in Medical Repository*, vol. i. *New York.*) In the London Medical Repository for Aug. 1823, a case is also noticed, in which Dr. Physick cured an ununited fracture of the lower jaw by means of a seton.

On this subject an interesting memoir was read by Laroche to the Ecole de Médecine at Paris (Germinal, an 13). It was entitled "*Dissertation sur la non-réunion de quelques fractures, et en particulier de celles du bras, et sur un moyen nouveau de guérir les fausses articulations qui en résultent.*" The author of this production affirms, that when he was at Augsberg, he saw Baron Percy, then with the army of the Rhine, pass a seton through the imperfectly healed cicatrix of a componud fracture of the thigh, which fracture seemed to have lost all disposition to unite. The method answered so well, that in two months the patient was able to walk without crutches.

Sir Benjamin Brodie has successfully employed the seton in a case of ununited fracture of the thigh. The patient was a boy about 13. (See *Med. Chir. Trans.* vol. v. p. 387, &c.)

[He has subsequently recorded three other cases in which he employed this method. One of these three, a case of fractured clavicle of some years' standing, succeeded perfectly, but the other two failed. In one of them, a man with ununited fracture of the thigh, the seton caused so much constitutional disturbance that it became necessary to remove it. In the other, although it was left in for several months, it produced no beneficial effect. (See *Lectures on Pathology and Surgery*, p. 131. 1846.)]

In this country the same operation has been practised for the cure of a disunited humerus by Mr. Stansfield of Leeds. (See op. cit. vol. vii. p. 103., &c.) It appears, also, that Sir Charles Bell applied the method to a fracture of the leg, at the time when M. Roux was in England. The patient was a child six years old, and the broken bones had continued without union three years. The case had been originally mistaken by some unskilful surgeon for a mere contusion. The result is not stated. (*Parallèle de la Chir. Angloise, &c.* p. 195.) In University College Hospital, Mr. Liston lately employed a seton for an ununited fracture of the radius and ulna. The result was successful in reference to the latter bone. After cutting down to the fracture, he destroys the ligamentous connections as much as possible, and then passes the seton, which he takes out again sooner than is usually done.

We are not to expect that Dr. Physick's operation will succeed in every instance. Like most other surgical means, it is liable to occasional failures, amongst which, I believe, we must include the attempt, made on a disunited thigh by Mr. Wardrop (see *Med. Chir. Trans.* vol. v. p. 365), though a partial amendment is mentioned. In a case recorded by Mr. Amesbury, the seton did not answer. Mr. A. C. Hutchinson was also obliged to take out the seton, in a case of ununited humerus, and only partial benefit was effected. (See *Practical Obs.* p. 389, ed. 2.) Three instances of failure were seen by Mr. Amesbury (*On Fractures*, p. 224), and an additional one has been recorded by Mr. Earle. (See *Med. Chir. Trans.* vol. xii. p. 195.)

In the same case, and also in another, which I saw under this gentleman's care, the plan of cutting down to the ends of the fracture, and rubbing them with caustic potash, was tried, but without success.

The result of the practice with the seton is, that it has sometimes succeeded in the upper extremities; but that, where it has been performed on the lower ones, so far as Sir Benjamin Brodie has been able to ascertain, it has only answered in a single instance, which was that of a patient under him in St. George's Hospital. "Dr. Dorsey (who was Dr. Physick's nephew), in the last letter which I had from him before his death, informed me as the result of the operations with the seton in the United States, that it had generally succeeded in the upper limbs, but that it had always failed in the lower." He added that "in the former case it was often necessary to keep the seton in for several months" (op. et vol. cit.) M. Portal, however, surgeon to the Palermo Hospital, cured by the seton an ununited fracture of the upper third of the femur in a child two years old. (See *Archives*

Gén. Juillet 1835.) An instance of an ununited fracture of the tibia was also successfully treated with a seton by Dr. Browne. (See *Dublin Hospital Reports*, vol. iv. p. 320.) A very similar case was published by Mr. Boggie. (See *Med. Chir. Trans.* vol. vii.) Dr. Mott has treated eleven cases of ununited fractures in this manner. Of these, three were of the femur; three of the tibia, and five of the humerus. In all, the plan is stated to have succeeded perfectly, except in three of the humerus, which were afterwards cured by sawing off the ends of the bones. (*Amer. Journ.*) These results are different from those which might have been expected from the investigations of Sir Benjamin Brodie, and the statements of others, concerning the success of sawing off the ends of the bone.

Instead of several of the foregoing severe and often unsuccessful plans, Mr. Amesbury has tried the influence of local pressure and rest. He maintains the ends of the fracture closely pressed together, the pressure, when the fracture is transverse, operating longitudinally, and when oblique, transversely. On this subject, Sir Benjamin Brodie observes, " I do not know that this firm pressure produces the union of the bone by a process at all like that which takes place in the first instance after fracture. I think it more likely that it causes the surfaces to grow together without the provisional callus being formed on the outside. However that may be, I know that in several cases it has succeeded. I have attended two cases with Mr. Amesbury in which this plan was adopted, and in which it succeeded perfectly. I had a patient in St. George's Hospital on whom I tried this method of treatment, and in that case also it succeeded, so that at the end of some weeks the fractured bone, which had been ununited for many months, became completely consolidated. The pressure must here be considerable, so as to give the patient a good deal of pain, yet not sufficient to do him injury." Sir Benjamin Brodie, however, has known of several cases in which this method has failed; but notwithstanding this fact, he pronounces it to be on the whole a more successful plan than any other. A short sling, pads, and a particular apparatus are used accordingly. (*On Fractures*, p. 236.) Mr. Buchanan, of Hull, has related two cases in which the union of fractures followed a perseverance in the application of tincture of iodine. (*On Diseases of Joints*, p. 75.)

[Instead of the seton, Dieffenbach has proposed to cut down upon and expose one or both ends of the fracture, and then to bore holes in the bone, into which he inserts pegs of ivory, which are to be left in for several weeks in the hope of inducing the necessary amount of reparative action. This method has been adopted occasionally in this country by Messrs. Stanley, Hey, Bowman, and others, in some cases with complete, in others with partial, success.

Subcutaneous sections in the neighbourhood of the fracture have been practised with success by Mr. Miller, of Edinburgh, and the method is worth trying before resorting to the more serious practice of the seton, or of resection of the ends of the bones. The inflammation thus excited is of the adhesive instead of the suppurative kind, and is therefore attended with little or no risk, while in some cases it may produce sufficient irritation to cause the required effusion of osseous matter.]

OF PARTICULAR FRACTURES.

Fractures of the Nasal Bones.

These bones, from their situation, are much exposed to external violence. The fragments may be displaced, or not. In order to replace them, the surgeon must pass a female catheter, a ring-handled forceps, or any such instrument, into the nostrils, and, using it as a lever, push the fragments outwards; while with the index finger of the left hand, he prevents them from being pushed out too far. When the fragments are disposed to fall inwards again, some authors advise supporting them with an elastic gum canula, or lint, introduced into the nostril; but I am inclined to believe with Sir C. Bell, that no tubes can be employed so as to support the broken bones; and when these have been replaced, they will not readily change their position, as they are acted upon by no muscles. (See *Operative Surgery*, t. ii. p. 222.) Besides, as Delpech remarks, since the tubes cannot reach the fragments, they cannot support them, and they must be attended with all the inconvenience of foreign bodies placed in contact with parts already inflamed, or about to become so. (*Précis des Mal. Chir.* t. i. p. 222.)

As fractures of the ossa nasi are the result of falls, and direct blows on the face, the soft parts are always either contused or wounded. These fractures are sometimes attended with dangerous symptoms; depending either upon the concussion of the brain, produced by the same blow which causes the fracture; or, on the cribriform lamella and the crista galli of the os ethmoides being driven inwards, so as to compress the brain. This last danger, however, some modern surgeons consider as void of foundation; and whenever the symptoms indicate an affection of the brain, the nature of the case is referred to the intimate connection between the bones of the nose and the os frontis. (*Delpech, Précis des Mal. Chir.* t. i. p. 221, 8vo. Paris, 1816.)

Sometimes the fissure extends through the nasal process of the upper maxillary bone, and across the fossa for the lachrymal sac, and is attended with discharge of blood from the puncta lachrymalia and nostril, and obstruction to the passage of the tears. Mr. Hooper of the London Road had a case in which not only the fissure extended in this way, but the brain received injury from the blow, and the patient died. The accident was produced by a horse-brush being thrown with violence, and striking the face.

When there are symptoms of pressure on the brain (see Head, Injuries of,) and the ossa nasi are much depressed, the surgeon must immediately raise them, and endeavour to draw gently forwards the perpendicular process of the os ethmoides, which is connected with the cribriform lamella and crista galli. Perhaps a pair of closed common forceps, introduced into each nostril, might best enable the surgeon to do what is necessary. Bleeding and the antiphlogistic treatment may sometimes be required: for the vicinity of the eye renders it liable to become inflamed; and when there are symptoms of injury of the brain, extravasation, &c. the necessity of such practice is still more strongly indicated.

[FRACTURES OF THE ZYGOMATIC ARCH, AND OF THE MALAR, AND SUPERIOR MAXILLARY BONES.]

[*The arch of the zygoma* may be broken by a blow or a fall on the side of the face, or by a carriage wheel passing over it, but the accident is a rare one, so much so that M. Malgaigne has only been able to collect five examples of it.] The fracture is not in itself serious, and if unattended with much displacement, no particular treatment will be necessary excepting for the accompanying contusion of the soft parts. The fragments may, however, be driven in so as to interfere with the insertion of the temporal muscle into the coronoid process and to interrupt its action, and in that case, if a reduction cannot be effected by pressure with the finger from within the mouth, it might be advisable to make an incision above the zygoma through the integuments and temporal fascia, and to raise the depressed ends of the fracture by an elevator introduced beneath them. This plan has been adopted with success. (See *Malgaigne, Traité des Fractures*, p. 357.)

The malar bones, from their prominent situation at the side of the face, are exposed to similar injuries. They may be driven in and more or less comminuted, or they may be separated from their connexions at the sutures. If there is much displacement, the finger should be introduced into the mouth to replace the broken pieces as nearly as possible in their natural position, and the attempt should be made at an early period after the accident, for they rapidly contract adhesions, and become fixed in their new situation.

The superior maxillary bones are sometimes fractured in such a manner that a portion of the alveolar process is detached from the rest of the bone. In such a case the broken piece must be replaced, and the teeth which it contains must be fixed with ligatures or wire to those belonging to the uninjured portion of the bone. An apparatus fitting on to the teeth, .and similar to that recommended for fracture of the inferior maxilla, may also be found useful to retain the detached piece in its proper position.

Other cases occur in which the superior maxillary bones are more severely injured. Mr. South records a remarkable accident in which a man received a violent blow on the face from the handle of a crane whilst flying round. The nose, cheek, and upper jaw bones were broken and crushed, so that the whole face below the eyes, including the floors of the orbits, could be moved with the least effort, and yielded in every way to pressure with the fingers, just as would beans in a bag. This man recovered after having had a little exfoliation from the mouth and nose ; but a shallow furrow across the face and a broken nose-bridge were the results of the injury. (See *Chelius' Surgery, translated by South*, vol. i. p. 528.)

M. Malgaigne mentions a case occurring to M. Simonin of Nancy, in which the left side of the face was driven in, and the superior maxillary and palate bones disjoined at their sutures in the median line, and separated from the bones of the opposite side by an interval of nearly half an inch. Notwithstanding other injuries, this patient recovered, with only slight subsequent deformity, and no inconvenience in speech or deglutition.

In all these cases the loose fragments should never be removed, as they are found to unite with remarkable facility.]

FRACTURES OF THE LOWER JAW.

This bone is sometimes fractured near the chin ; but seldom so as to produce a division of the symphysis, the solution of continuity generally happening between this part and the insertion of the masseter. In University College Museum, however, there is a specimen of a fracture situated precisely at the symphysis. In other instances, the fracture occurs near the angles of the jaw, that is to say, between the insertion of the masseter and the root of the coronoid process. The bone may also be broken on each side at the same time ; in which event the middle portion is extremely difficult to keep right, because many of the muscles which draw the lower jaw downwards are attached to that part. The condyles and coronoid process are also sometimes broken.

Fractures of the lower jaw may be either perpendicular to its basis, oblique, or longitudinal ; of the latter, examples have been known in which a portion of the alveolar process with the teeth in it, was detached from the rest of the bone.

The soft parts are generally contused and wounded. An instance is reported by Dr. Richelot of the accident being complicated with an injury of the facial artery. (*Archives Gén.* Jan. 1833.) J. L. Petit mentions one case in which the bone was broken, and the coronoid process quite denuded, by the kick of a horse.

When the fracture is near the median line, the side on which the symphysis is situated is drawn downward and backward by the sub-maxillary muscles, while the other fragment is supported by the muscles which close the jaw. When the fracture is more backward, the displacement occurs in the same way, but not so easily. When the bone is fractured in two places, the middle portion is always pulled downwards and backwards by the muscles attached to the chin, while the two lateral pieces are kept up by the levator muscles. When the ramus of the jaw is broken, the masseter, being attached to both pieces, prevents any considerable degree of displacement. When the neck of the condyle is fractured, the pterygoideus externus will pull the condyle forwards.

[M. Malgaigne thinks that too much has been attributed to the action of muscles, and that the displacement is often determined by the direction of the blow which occasioned the fracture, and which in most cases operates on one side of the fracture more than on the other. In oblique fractures, also, the direction of the obliquity may determine the direction of the displacement ; and he found that in the majority of cases the bone was broken obliquely as regards its thickness, the obliquity passing backwards from the external towards the internal surface. In such a case the posterior piece may project outwards and ride more or less over the larger anterior portion.]

When a blow has been received on the lower jaw, or the bone injured by a fall, or the pressure of some heavy body; when an acute pain is experienced in the part, and an inequality can be felt at the basis of the bone; when some of the teeth, corresponding to that inequality, are lower than the others; and when a crepitus is perceptible on moving the jaw ; there can be no doubt of a fracture. When the gums are lacerated, or the bone denuded by a wound, the case is (if possible) still more manifest.

Fractures of the rami and condyles produce great pain near the ear, particularly when the jaw is moved ; and a crepitus may be felt.

Treatment.—Fractures of the lower jaw, whether simple or double, are easily set, by pushing the displaced part upward, and a little forward, and then pressing on the basis of the bone, so as to bring it exactly on a level with the portion which has preserved its natural position. Indeed, the correctness of the reduction may always be rightly judged of by attending to the line which the base of the jaw ought to form, and observing that the arch of the teeth is regular. The maintenance of the reduction, however, is difficult; and can only be well executed by supporting the lower jaw, and keeping it applied to the upper one. As the latter indication cannot be properly fulfilled in persons whose teeth are very irregular, it is sometimes necessary to interpose an even piece of cork between the teeth on each side of the mouth, and against this cork the lower jaw is to be kept up with the bandage presently noticed, while the aperture left between the incisor teeth in the situation where no cork is placed, allows food and medicines to be introduced with a small spoon.

When the bone is fractured in two places, one on each side of the symphysis, and great difficulty is experienced in keeping the central fragment from being drawn downwards and backwards towards the os hyoides by the depression of the lower jaw, the instruments proposed by Graefe, Lonsdale, and others, will fix the bone and prevent the displacement. The apparatus consists of a groove, for the reception of the arch of the teeth, and of a square plate of steel, which is placed under the chin, and admits of being screwed up to the part. On this plate a piece of cork or a compress is put.

[Some surgeons recommend fixing the teeth together with a ligature or a piece of silver or gold wire twisted around them, and this may be of service in maintaining the fractured surfaces in contact, but will not be sufficient unless a bandage or some other apparatus be also employed.]

As soon as the fracture is set the surgeon should adapt some thick pasteboard or gutta-percha, previously wetted and softened, to the outside of the jaw, both along its side and under its basis. Over this moistened pasteboard a bandage with four tails is to be applied, the centre being placed on the patient's chin, while the two posterior tails are to be pinned over the forehead, and the two anterior ones over the occiput. When the pasteboard becomes dry, it forms the most convenient apparatus imaginable for surrounding and supporting the fracture. A piece of soap-plaster may now be applied to the skin underneath, which will prevent any ill effects of the hardness and pressure of the pasteboard.

Until the bone is firmly united, the patient should be allowed only such food as does not require mastication, and it may be given by means of a small spoon, introduced between the teeth. Broths, soups, jellies, tea, and other slops appear most eligible.

In order to keep the middle portion of the bone from being drawn downwards and backwards towards the larynx, it is frequently necessary to apply tolerably thick compresses just under and behind the chin ; which are to be well supported by the bandage already described. I need hardly state the necessity of enjoining the patient to avoid talking, or moving the jaw more than can be avoided. He should also be advised to lie on his back at night, as the pressure of either side of the face upon the pillow will be likely to produce displacement.

[In a case which was under the care of the writer in St. Mary's Hospital, and in which every attempt to remedy the displacement had failed, an apparatus was devised by Mr. H. Hayward, the dentist, which answered the purpose admirably. It consisted of a silver cap made to fit the teeth and gums accurately, and to enclose several teeth on each side of the fracture, a wax cast having been first taken of the parts, and the silver plate having been moulded from it. A piece of gutta-percha was placed under the chin, and was held in its place by being tied on each side with string to two curved bars of silver, which were fixed to the plate inside, and which passed out at the angles of the mouth. By this means the most accurate contact was maintained, and the patient was able to speak and eat without pain and without any risk of disturbing the fracture. The transition from a state of extreme pain and discomfort to one of almost perfect ease as soon as this instrument was applied, was most remarkable. (Further particulars will be found in the *British Med. Journ.* Oct. 9, 1858, p. 845.)]

When the condyle is fractured, as it is incessantly drawn forward by the action of the pterygoideus externus, and, on account of its deep situation, cannot be pressed back, the neck must, if possible, be pushed towards it. For this purpose the bandage must be made to operate particularly on the angle of the jaw, where a thick compress should be placed. [There is some fear, however, notwithstanding every precaution, that the mouth may remain permanently turned toward the injured side.]

Compound fractures of the lower jaw are to be treated on the same principles as similar injuries of other bones. If possible, the external wound should be healed by the first intention ; and when this attempt fails, care must be taken to keep the wound clean by changing the dressings about once in three days ; but not oftener, lest the fracture suffer too much disturbance. Compound fractures of the jaw, and even simple ones, which are followed by abscesses, are liable to be succeeded by necrosis and exfoliations.

It now and then happens that fractures of the lower jaw continue ununited : Dr. Physick's successful treatment of one such case with a seton, and Dupuytren's by sawing off the end of one fragment, I have already noticed.

Fractures of the coronoid process are stated not to admit of bony union.

Fractures of the Vertebræ.

On account of the shortness and thickness of these bones, they cannot be broken without considerable violence. The spinous processes, which project backwards, are most exposed to such injury; for they are the weaker parts of the vertebræ, and most superficially situated. On this account, it is possible for them to be broken without any mischief being done to the spinal cord. The violence which is great enough to break the bodies of the vertebræ, must produce more or less concussion, or other mischief of the spinal cord; from which more perilous consequences are to be apprehended than from the injury of the bones, abstractedly considered. The displaced pieces of bone may press on the spinal cord, or even wound it, so as to occasion a paralytic affection of all the parts, which derive their nerves from the continuation of it below the fracture.

There may be fractures of the vertebræ without displacement; or fractures complicated with dislocation, or extravasation of blood on the membranes of the spinal cord, of which last occurrence several specimens are preserved in University College Museum. Sir Benjamin Brodie has noticed that, in consequence of external violence, a narrow clot of blood may be extravasated within the substance of the spinal cord, and that from its peculiar situation it may be productive of the most dangerous symptoms. With respect to laceration of the cord and its membranes, he observes that it may be torn completely through, or lacerated in one part and not in another; and he refers to a case described by M. Ollivier, in which the attachments of the nerves on one side were destroyed and not on the other.

As for the concussion, the minute organisation of the spinal cord may be injured by it, even when there is neither fracture nor dislocation, and the investing membranes exhibit no effects of the injury. "In such cases, if there be an opportunity of examining the spinal cord at a very early period after the accident, the central part of it is found to be softer than natural, its fibrous appearance being lost in that of a semifluid substance. If the patient survives for a longer period, the alteration of structure is perceptible in the whole diameter of the cord, and occupies from one to two inches, or even more of its length; and at a still later period, it has often proceeded so far as to terminate in its complete dissolution." (*Sir B. Brodie in Med. Chir. Trans.* vol. xx. p. 121, 122.)

Sir Astley Cooper divides fractures of the bodies of the vertebræ with displacement into two classes: first, those which occur above the third cervical vertebra; and, secondly, others which happen below that bone. The first cases, he says, are almost always *immediately* fatal, if the displacement be to the usual extent. In the second description of cases, death takes place at various periods after the injury. The reason of this difference is ascribed to the circumstance of the phrenic nerve originating from the third and fourth cervical pairs, whence in the first class of cases death is immediately produced by paralysis of the diaphragm, and the stoppage of respiration. (*On Dislocations*, p. 552.)

Sir Benjamin Brodie correctly refers the symptoms which arise as an immediate consequence of injuries of the spine; 1st, To concussion of the spinal cord; 2nd, To laceration, or division of its substance; 3rd, To pressure made on it, either by displacement of bone, or by extravasated blood. Afterwards inflammation of the membranes of the cord may take place, and other organs may be secondarily affected, giving rise to another order of symptoms which did not exist in the beginning. He adds that, when the symptoms are viewed generally, they vary: 1st, according to the part of the spinal cord on which the injury has been inflicted; 2nd, according to the kind and degree of injury which the cord has sustained; 3rd, according as, from accidental circumstances, the life of the patient is prolonged for a longer or shorter period, or ultimately preserved. (See *Brodie in Med. Chir. Trans.* vol. xx. p. 127.) These facts deserve to be particularly remembered, for without the recollection of them the practitioner would be extremely perplexed in his endeavours to explain the great differences in the symptoms and results of different cases.

As the mere concussion of the spine may occasion symptoms which resemble those usually occurring when the vertebræ are fractured, the diagnosis is generally obscure. An inequality in the line of the spinous processes, and a crepitus, may sometimes be distinctly felt. The lower extremities, and the rectum and bladder, are generally paralytic; the patient being afflicted with retention of urine and involuntary discharge of the fæces.

According to Sir Benjamin Brodie's observations, the patient is generally unconscious of the bladder being distended; but occasionally he suffers as from an ordinary retention of urine, though in a less degree. "The incapability of voiding the urine is usually an early symptom, and in fatal cases it continues to the last. When a complete or partial recovery takes place, the power of emptying the bladder is restored sooner than that of using the muscles of the lower limbs. In cases in which the catheter is not employed, the urine flows involuntarily, as in most other cases of over-distended bladder where the urethra is free." "At other times there is a constant dribbling of urine, although the bladder is in a contracted state, so that, on the introduction of the catheter, no urine flows." (*Sir B. Brodie, in Med. Chir. Trans.* vol. xx. p. 141.)

With respect to *paralysis of the voluntary muscles*, Sir Benjamin Brodie remarks, that, if the spinal cord be divided through its whole substance, or extensively lacerated, or subjected to any considerable pressure, the paralysis is immediate and complete. But if the injury be partial, certain muscles may be paralysed, while others retain their power of voluntary motion. He notices also the well-known fact, that paralysis of the lower limbs is more common than that of the upper. "In some cases, in which the injury has affected the spinal cord in the lower part of the neck, the lower limbs are rendered paralytic, while there is either no paralysis, or a less degree of it, in the upper limbs. The reason of this is sufficiently obvious to any one who considers what are the origins of the nerves which form the axillary plexus, some of them being probably above the part which is injured. But the circumstance is still remarkable in this respect, that it is contrary to what happens, when the functions of the spinal cord are interrupted in consequence of caries of the cervical vertebræ. In these last cases the paralysis is often complete in the upper limbs for many weeks, or even for months, before it extends to the lower. I have met with only a single case in which, after an injury of the cervical portion of the spine, there was almost complete paralysis of the muscles of the upper extremities, and none whatever of those of the lower." (*Sir B. Brodie, in Med. Chir. Trans.* vol. xx. p. 129.) I think we must agree with the same experienced surgeon that, when paralysis of the upper and lower limbs follows a fracture of the lumbar vertebræ, an instance of which is recorded by Mr. Stafford, or when it follows a concussion of the loins, as once seen by Sir Benjamin Brodie himself, we must suppose, that another part of the spinal cord, as high as the origin of the nerves which form the axillary plexus, has suffered from the effects of concussion.

On the subject of *affections of the nerves of sensation*, Sir Benjamin Brodie, after noticing the well ascertained fact, that if the spinal cord be lacerated, or subjected to any considerable degree of pressure, the sensibility of the parts below the seat of injury is totally destroyed, refers to another, which is, that, if the injury be in the situation of the sixth or seventh cervical vertebra, the destruction of sensibility is frequently partial in the upper extremities, while it is complete in the trunk and lower extremities. "In many instances, the destruction of sensibility is incomplete at first, but becomes complete afterwards, as the process of softening makes progress in the injured portion of the spinal cord." (*Sir B. Brodie in Med. Chir. Trans.* vol. xx. p. 135.)

With respect to the *affection of respiration*, if the fracture be as high as the third cervical vertebra, and the cord be there injured, the nervous influence cannot be transmitted either to the diaphragm or the other muscles of respiration; and a fatal asphyxia immediately takes place. But if respiration be performed artificially by inflating the lungs, the action of the heart and life may be maintained for several hours. When the spinal cord is seriously injured in the lower part of the neck, below the origin of the phrenic nerves, or in the upper part of the back, the action of the diaphragm is not interfered with, while the intercostal muscles, as well as the muscles of expiration, are paralytic. "The patient, therefore, breathes by the diaphragm only. The ribs are motionless, and the air is expelled from the lungs, not by the contraction of the abdominal muscles, but simply by the elasticity of the abdominal parietes, and the pressure of the abdominal viscera, operating on the lower surface of the diaphragm, when that muscle is relaxed." Under these circumstances, the patient is incapable of expectorating mucus, if it be collected in the trachea; if he coughs, it is by a forcible inspiration, followed by a sudden relaxation of the diaphragm; and respiration is carried on with more difficulty in the sitting than the recumbent posture. But it is further observed by Sir Benjamin Brodie that injuries of the spinal cord in the lower part of the neck are not necessarily followed by the foregoing consequences. The pressure on the spinal cord may be so small, or the disorganisation of it from concussion may be so trifling, that the muscles of respiration are not at any period affected by it; or they may not be so in the first instance, and yet become affected afterwards. In one case, which fell under Sir Benjamin Brodie's observation, a fracture of the seventh cervical vertebra, which was followed by a softening and dissolution of the spinal cord, the difficulty of respiration did not take place until the twelfth day; but death occurred in less than three days afterwards. (See *Med. Chir. Trans.* vol. xx. p. 138.)

Injuries of the spinal marrow, including those resulting from, or accompanying fracture, are well known to produce certain *changes in the urine and urinary organs.* Besides an inability of voiding the urine, there is sometimes, as Sir Benjamin Brodie has pointed out, a marked diminution in the quantity of this fluid secreted. In some cases, the urine first secreted, although of an acid quality and free from mucus, has a peculiarly offensive smell; while, in others, it is exceedingly acid, with an opaque yellow appearance, and a yellow amorphous sediment. But the most common changes are an ammoniacal smell, great turbidness, and a deposit of a large quantity of adhesive mucus, and the urine, when tested with reddened litmus, or turmeric paper, is found to be very alkaline. After some time, phosphate of lime, secreted by the inner coat of the bladder, is blended with the mucus, which is tinged with blood. These appearances may come on as early as the third or fourth day, or not begin for a week, or eight or nine days. Sir Benjamin Brodie has not found that injury of one part of the spine is more liable to produce them than that of another. In fatal cases they sometimes continue to the last. At other times they go on for two or three weeks, and then subside. Occasionally the urine varies from day to day, being now alkaline and depositing adhesive matter; then clear and acid; and afterwards alkaline again. (*Sir B. Brodie.*)

Fractures and other injuries of the spine frequently bring on inflammation of the mucous membrane of the bladder and ureters; and occasionally spots of extravasated blood are found in the kidneys. In University College Museum is a bladder, taken from a patient who died of an injury of the spine, which is in a softened and ulcerated state. In Mr. Barlow's case the infundibula and pelvis of the kidneys were dilated with urine, which was mixed with pus. The bladder, whose coats were thickened, also contained a considerable quantity of pus. (See *Med. Chir. Trans.* vol. xvii. p. 120.)

Wherever the injury of the spinal cord is situated, the bowels are torpid, and the abdomen tympanitic. In many cases where the cervical portion of the cord is injured, and the patient dies in two or three days, there is a disposition to vomit. In more protracted cases the discharges from the bowels are of a black colour, semifluid, and of a peculiarly offensive smell. It would appear also, both from the experiments of M. Chossat, and facts recorded by Sir Benjamin Brodie, that injuries of the superior portion of the spinal cord are sometimes followed by a remarkable evolution of animal heat. (See *Med. Chir. Trans.* vol. xx. p. 146.)

With respect to effects on the sensorium immediately after the accident, Sir B. Brodie has not observed any material ones, except where the injury was of the cervical portion of the spinal cord, and then he observes that the results are very different in different cases. (*Ib.* 149.)

If the lumbar vertebræ are displaced, the lower extremities are rendered so completely insensible, that they may be pinched, burnt, or blistered, without the patient suffering any pain. The penis in such cases is generally erect. In general, also, according to Sir Astley Cooper's observations, patients with fractured lumbar vertebræ die within a month or six weeks; but he knew of one patient that lived two years, and then died of gangrene of the nates. In fractures with displacement of the dorsal vertebræ the symptoms are very similar; but the paralysis extends higher, and the abdomen becomes excessively inflated. Death commonly follows in two or three weeks; but Sir Astley Cooper remembers one case in which a gentleman survived the accident nine months. According to Sir B. Brodie's experience, where a considerable injury has been inflicted on the spinal cord in the lower part of the neck, or in the neighbouring part of the back, of such a nature as to paralyse all the muscles of respiration excepting the diaphragm, the patient rarely lives to the end of the fourth or fifth day, and mostly dies still earlier. (See *Med. Chir. Trans.* vol. xx. p. 156.) Fractures of the cervical vertebræ below the origin of the phrenic nerve occasion paralysis of the arms, though it is seldom complete. Sometimes, when the fracture is oblique, one arm is more affected than the other. As the intercostal muscles are paralytic, great difficulty of respiration prevails. The abdomen is also considerably inflated. Death generally follows in from three to seven days.

Sir Benjamin Brodie has never known priapism occur from injury of the spinal cord, except in combination with paralysis. It "may take place (he observes) whether the patient suffers from the effects of simple concussion of the spinal cord, or from those of pressure. It seems to be connected with injuries of the upper, rather than with those of the lower portion of the cord, at least I am not aware that I have met with it where the seat of injury has been below the sixth dorsal vertebra. It is for the most part an early symptom, showing itself in the course of the second or third day, and it seldom continues after the first fortnight. It occurs even where the sensibility of the parts is totally destroyed, and may be induced by the mechanical irritation caused by the introduction of the catheter, where the patient is entirely unconscious of the operation. This circumstance was pointed out to me, many years ago, by Professor Macartney, of Trinity College, Dublin, and I have had many opportunities of verifying the correctness of the observation." (*Sir B. Brodie*, in *Med. Chir. Trans.* vol. xx. p. 140.) In University College Hospital, one case occurred under Mr. Liston, in which priapism accompanied a fracture of the lumbar vertebræ, and Sir Benjamin Brodie informs me that he has lately heard of another similar case. We had also in University College Hospital an instance where priapism was one of the symptoms following a violent blow on the occiput.

Sir Astley Cooper notices the following as the appearances found in *post-mortem* examinations. The spinous process of the displaced vertebra is depressed; the articular processes are fractured; the body of the vertebra is broken through, the separation rarely happening in the intervertebral substance. The body of the vertebra usually projects forward half an inch, or an inch. Between the vertebra and the sheath of the spinal marrow, blood is extravasated, and frequently on the spinal cord itself. When the displacement is slight, the spinal marrow is compressed and bruised. When greater, it is torn through by the bony arch of the spinous process, and a bulb is formed at each end, but the dura mater continues whole. (See *Sir A. Cooper, On Dislocations, &c.* p. 554, &c.)

Fractures of the spinous processes, without other serious mischief, are not dangerous. It has usually been thought that, even when a fracture of the spine is attended with displacement, any attempt to bring the fragments into a better position would be too dangerous to be made. Some practitioners have however ventured upon it. Mr. Barlow, of Writtle, did so, and though no harm resulted from the experiment, it cannot be said that any permanent good was derived from it, for, when the patient died some months afterwards, the fracture had united still in a displaced condition. It was "performed by persons pulling at the superior and inferior extremities, which had the desired effect; for the angular projection was greatly lessened, and the patient did not seem to experience any pain during the extension." The following particulars show, however, that the displacement was far from being obviated. The case was a transverse fracture of the first lumbar vertebra, extending obliquely downwards and forwards, through the upper portion of its body. "The upper part of the vertebral column, together with the upper fragment of the fractured vertebra, had been thrown forwards, the superior fragment resting on the fore and upper part of the inferior fragment, to which it was connected by callus. The corresponding articular process of the last dorsal and first lumbar vertebræ had been dislocated; those of the former having been thrown upwards and forwards. On the right side the inferior articular processes of the last dorsal vertebra was separated from the corresponding process of the first lumbar to the extent of a third of an inch, while their surfaces were rounded and nearly obliterated. On the left side the processes were about the same distance from each other, but connected by an intermediate portion of new bone. The foramen between the roots of the spinous processes was more than twice its natural dimensions. The ligamenta subflava must have been ruptured. The vertebral canal, immediately behind the line of fracture, was diminished one half in calibre." (*W. R. Barlow*, in *Med. Chir. Trans.* vol. xvii. p. 115.)

The following is the view adopted by one high authority: "Dislocations and fractures, with displacement of the cervical vertebræ, are not always immediately fatal; and I cannot say that no circumstances can exist which would justify the attempt to effect reduction in such cases; but it is evident that if the attempt be made at all, it must be with the greatest caution, and Boyer describes a case in which a child died under it. There can be no doubt, however, that when the injury is in the lower part of the spine, the attempt to effect reduction may be not only made with impunity, but that it may be successful. In proof of this assertion, I may refer to a case which occurred in the practice of Mr. Hardwicke, of Epsom; the patient being afterwards admitted into St. George's Hospital, labouring under paralysis of the lower limbs." Sir Benjamin Brodie likewise refers to another case under his care in the same hospital; a fracture, with great displacement of the third and fourth lumbar vertebræ. By fixing the thorax, and cautiously extending the pelvis, he endeavoured to restore the vertebræ to their proper place. "The attempt was in some degree successful, no ill effects of any kind resulted from it." (See *Med. Chir. Trans.* vol xx. p. 158.)

In the instances seen by Mr. Crosse, in which a fracture of the spinal column was attended with displacement, producing pressure on the medulla and paraplegia, the compressing portion of the bone was almost universally the body of a vertebra, so generally broken, and not the arch. (See *Trans. of Prov. Med. Assoc.* vol. v.)

[M. Malgaigne mentions a case of fracture in the lumbar region with projection backwards of the spinous process and paralysis, in which he endeavoured to remedy the displacement which was presumed to exist, by fixing the upper part of the body on an inclined plane and raising the lumbar region by cushions placed beneath it, so as to employ at the same time direct extension and pressure. The attempt appears to have succeeded, for the paralysis shortly disappeared and the patient recovered. (See *Traité des Fractures*, *&c.* t. i. p. 423.)

Mr. Tuson has also recorded two cases successfully treated in the Middlesex Hospital by extension. In the first there was irregularity and displacement of the last cervical and first dorsal vertebræ, with complete paralysis and priapism. "Upon extension being steadily used, by the head being fixed, and the legs gradually and progressively pulled, complete power of motion and sensation all at once returned as usual. He said he was quite right, and pulled up both his legs and kicked them about in every direction. The priapism soon ceased." He suffered from numbness in the arms and legs, and also from pain at the back of his neck, but was able to leave the hospital at the end of three weeks, and in another month is said to have been perfectly well.

In the second case, a depression was felt in the situation of one of the cervical vertebræ, with indistinct crepitus, but the history is not so satisfactory, as the man was insensible when admitted. Extension was made as in the last case, and during its use the breathing, which had previously been difficult, rapidly improved. Fourteen ounces of blood were taken from the arm, and he shortly became sensible and began to move himself about. Sensation, however, did not return for some hours afterwards. In two days this man was able to leave the hospital and go to his business. (See *Medical Times*, vol. x. 1844, p. 381.)]

If, after a certain time, circumstances justify the suspicion of inflammation of the spinal cord, and the state of the pulse will admit of the practice, venesection should be employed; but, inasmuch as cupping the part near the injury could not be performed without turning the patient, and disturbing the fracture, I deem it always unadvisable. The same remark applies to leeches. I believe with Sir Benjamin Brodie, however, that it is a great mistake to suppose that bleeding is always proper. "In the majority of cases, the state of the pulse is such as actually to contra-indicate the abstraction of blood; and the blood, when drawn, does not in general present those appearances which are supposed to mark the existence of inflammation." (*Sir B. Brodie*, in *Med. Chir. Trans.* vol. xx. p. 162.) Neither does blood-letting seem to this gentleman to arrest the process of softening and dissolution of the spinal cord, but, on the contrary, to accelerate it.

Keeping the vertebral column perfectly motionless is an indication plainly presenting itself, and the best mode of fulfilling it is to let the patient lie steadily on his back.

When the patient is affected with a flatulent distension of the abdomen, vomiting, hiccough, &c. the belly may be rubbed with camphorated liniment, and purgative or turpentine clysters and antispasmodics given.

In all cases in which the lower part of the body is paralytic the catheter is necessary. "It does not, however, prevent the urine becoming alkaline, nor the secretion of adhesive mucus from the lining membrane of the bladder. When these changes have taken place, the bladder should be emptied several times daily; and it may be advisable in some instances to inject tepid water into it, so as to prevent any portion of the mucus being retained in its cavity." (*Sir B. Brodie.*)

The torpid state of the bowels demands active purgatives, as calomel, jalap, castor and croton oil. Sir B. Brodie finds that the action of purgatives, in these cases, is promoted by combining them with ammonia. When the motions are black and offensive, attention to this part of the treatment is of high importance. (Op. et vol. cit. p. 163)

When the bladder, rectum, and lower extremities are paralytic, Boyer advised rubbing the back, loins, sacrum, and limbs with liniments containing the tincture of cantharides. With respect to the external and internal use of stimulants, however, it can never be judicious, when there is reason to apprehend much inflammation of the injured parts; and as for the idea of thus restoring the nervous influence, there can be little chance of success, the cause of its interruption being here of a mechanical nature. (*Delpech*, *Mal. Chir.* t. i. p. 222.) In an early stage of the case, who would venture to move the patient about for any purpose of this kind?

Some authors recommend trepanning, or cutting out a portion of the fractured bone, when the compression of the spinal marrow, or its injury by a splinter, is suspected; but, according to my judgment, the indication can never be sufficiently clear to authorise the operation, which, on account of the great depth of the intervening soft parts, must be tedious, and even difficult to effect, without risk of increasing the injury, which the spinal marrow may already have received. An unsuccessful operation of this kind was once performed by Mr. H. Cline, and another by Mr. Tyrrell.

Some cases, published by Sir C. Bell, tend to prove, that the danger to be apprehended from injuries of the vertebræ is the same as that which accompanies injuries of the brain. Hence, he is an advocate for general and local bleeding, and keeping the patient perfectly quiet. But, with respect to operations for the removal of fragments of bone, it is his decided belief, that an incision through the skin and muscles covering the spine, and the withdrawing of a portion of the circle of bone, which surrounds the marrow, would be inevitably fatal, the membranes of that part being particularly susceptible of inflammation and suppuration. And, even if a sharp spiculum of fractured bone had run into the spinal marrow, and caused palsy of the lower parts of the body, Sir C. Bell thinks, that exposing the medulla to extract the fragment would so aggravate the mischief, that inflammation, suppuration, and death, would be the inevitable consequences. (*Surgical Obs.* vol. i. p. 157.)

The question, respecting such an operation, seems to Sir Benjamin Brodie to lie in a very small compass. "If the whole, or nearly the whole, of a vertebra be driven forwards, the depression of the posterior part of it will, of course, occasion a diminution of the size of the spinal canal; but the removal of any portion of the vertebra, which is accessible to an operation, will be of little avail, as the irregularity in the anterior part of the canal, made by the displacement of the body of the vertebra, must be the same after, as it was before, the operation." This view coincides with that which I have long entertained. (See *First Lines of Surgery*, ed. vi. p. 586.) "If (observes Sir Benjamin Brodie) there be simply a fracture on each side of the spinous process, with a depression of the loose or intermediate portion of bone, there must be a corresponding diminution of the size of the vertebral canal; but, as that canal is much larger than the spinal cord, which it contains, it does not follow that the spinal cord is really compressed, or that any material diminution of the symptoms would follow the elevation or the depression. But let it be supposed that the spinal cord is really suffering from pressure, a much less degree of violence than that which is necessary to occasion a fracture of the spine may produce concussion, softening, and ultimately dissolution of the spinal cord, with a train of symptoms much worse than those which arise from simple pressure. Now, no operation can be of the smallest advantage in this respect; but, on the contrary, if it be necessary to apply the saw in the performance of it, the jar and disturbance of the parts, which it must occasion is even likely to aggravate the mischief. If these views be correct, it is evident that the cases, in which there are any reasonable grounds for the performance of the operation, must be of very rare occurrence." (*Sir B. Brodie*, in *Med. Chir. Trans.* vol. xx. p. 160.) In fact, no operation of this kind has yet been the means of preserving life, or even of relieving the worst symptoms.

Sir Charles Bell describes inflammation of the spinal marrow as "attended with an almost universal nervous irritation, which is presently followed by excitement of the brain: in the meantime, matter is poured into the sheath of the spinal marrow, and either by its pressure causing palsy, or by its irritation disturbing the functions of the part, so as to be attended with the same consequences. The excitement of the brain being followed by effusion, death ensues" (p. 159). Cases are also referred to where palsy of the lower extremities comes on several months after an injury of the spine, owing to thickening of the membrane of the medulla, or disease of the latter part itself. Here Sir C. Bell recommends perseverance in local bleeding and deep issues (p. 160).

When recovery takes place, the restoration of sensibility usually precedes that of the power of voluntary motion. The power of emptying the bladder is also sooner restored than that of using the muscles of the lower limbs. (*Sir B. Brodie*, op. et vol. cit. p. 136—141.)

A fracture of the processus dentatus almost always proves instantly fatal, as happened in the example mentioned by Sir A. Cooper. (*On Dislocations, &c.* p. 548.) In the article DISLOCATION, I have adverted to the remarkable instance of a fracture and displacement of the atlas, where the patient lived forty-seven weeks after the accident, and to the last week of his life was able to walk to the water-closet, which was on the same floor with his bed. After death "the condyles of the occiput still rested upon the articulating surfaces of the atlas, but the atlas was found to be not a separate and independent vertebra, but an appendix to the axis. So much of its anterior portion as includes the surfaces by which it is articulated with the occiput and with the axis, had been violently separated from the posterior portion of its ring, and had been carried in an oblique direction downwards and forwards, until it arrived upon the same plane, but anterior to the axis, to the body and transverse processes of which it became attached by perfect bony union, while the posterior fragment had suffered no displacement. Under these circumstances, the bone presented two spinal foramina, and four transverse, but no odontoid process. This organ having been fractured and separated, no organ passed through the anterior spinal foramen." (*B. Phillips*, in *Med. Chir. Trans.* vol. xx. p. 82.) In the practice of Mr. Cline, a case occurred in which a boy, with a fracture of the atlas, lived a year after the accident.

The particulars of the following case, under my care in University College Hospital, were registered by Mr. Morton, then house surgeon:—Thomas Robinson was admitted November 2, 1835, for injuries received by the fall of a very heavy piece of timber on the lower part of the neck, a short time before he was brought to the hospital. He was perfectly sensible; the pupils were quite active under the influence of light, and no symptom prevailed indicating affection of the brain. His arms and superior extremities were completely paralysed. If raised up, and the support then removed, they immediately dropped. The man had lost all sensation in the inferior extremities and in the trunk, as high as the middle of the chest; also in the arms, excepting from the point of the shoulder down to the elbow. He had *priapism*, with *emissio seminis*. Respiration was performed imperfectly, and in a short hurried manner. Though pain was experienced in the back of the neck when the head was moved, no crepitus was distinguishable. In respiration, no action of the intercostal and abdominal muscles could be perceived. The next day, as no urine had passed, a pint was drawn off with a catheter; and gr. viij. of calomel, followed by aperient mixture, were given to promote evacuations from the bowels. The mixture was rejected by vomiting. In the afternoon the pulse had risen to 120 beats in a minute, and the difficulty of breathing had increased. The face was flushed, and skin hot. Twenty-four ounces of blood were taken away; but without benefit, as the pulse afterwards rose to 156, and became irregular both as to rhythm and strength. Death took place twenty-four hours after the accident. In the *post mortem* examination, the right articular process was found detached from the body of the third vertebra. The left portion of the arch of the fourth was broken, *but not displaced*. The arch of the fifth was much comminuted, and the spinal cord exposed and pressed upon. The body of this vertebra was also broken through, and the sharp edge of the fracture had caused copious extravasation behind the pharynx, in front of the vertebral column.

William Parker, æt. 13, was admitted under me, October 15, 1836, in consequence of his cravat having been caught by some machinery, and his neck drawn against a projecting lever. In this position he had been suspended about a minute and a half, and directly he had been released he was brought to the hospital. His breathing was then slow, and somewhat laboured, the face slightly livid, the pupils acted, the hands were warm, and the pulse rather slow and feeble. In eight or ten minutes the lips became livid, the pulse sunk, and the surface of the limbs and trunk began to grow cold. Hot water was applied to the feet, the chest, and epigastrium, and artificial respiration was resorted to by closing the nostrils, and blowing air into the mouth through a piece of muslin. This soon brought a rosy colour into the cheeks, the pulse became stronger, the temperature of the body rose, and some slight effort at respiration was supposed to be made. Whenever the artificial respiration was discontinued, the breathing went on but slowly and feebly, the pulse sunk, and the lips became livid. In this manner he went on for some hours, the vital powers partially recovering, while artificial respiration was carried on, and sinking directly it was interrupted. Although there was great suspicion entertained that the spine had suffered injury, I wished to render the introduction of air into the lungs as complete as possible, and therefore performed tracheotomy, so that a small pair of bellows might be used for this purpose. But neither this plan, nor galvanism, tried by Dr. Ritchie, was of any material service ; and death took place at the end of six hours and a half. In the *post mortem* examination, blood was found effused between the muscles in front of the cervical vertebræ. The anterior common ligament was ruptured opposite the second and third vertebræ. A considerable quantity of blood was found in the intermuscular cellular tissue behind the cervical vertebræ, opposite the second, third, and fourth of them. A fracture of the arch of the third was detected, the part of it above the spinous process being broken off, and the portion of it on each side of that process also fractured. Although the fragment might have been depressed, it did not seem to be so at the period of examination. In the spinal canal blood was effused ; but there was no apparent laceration of the dura mater, or injury of the cord: the bowels were greatly distended with air. This case, which I have also referred to in the article ASPHYXIA, illustrates the consequences of an injury of the spinal cord, implicating the origins of the phrenic nerves.

A. Cooper, Op. cit. p. 549. See *L. T. Soemmering*, Bemerkungen über Verrenkung und Bruch des Rückgraths, 8vo. Berlin, 1793. *F. A. E. Cuenotte*, Dis. Med. Chir. sistens Casum Subluxationis Vertebræ Dorsi cum Fractura complicatæ, postfactam Repositionem et varia dira Symptomata duodecima demum Septimana funestæ. Argent. 1761. Case of Fractured Spine, Lancet, vol. ii. p. 97. *C. Wenzel*, Von den Krankheiten am Rückgrathe. Bamberg, 1824, fol. *Sir Charles Bell*, On Injuries of the Spine and Thigh-bone. Lond. 4to. 1824. *B. Phillips*, in Med. Chir. Trans. vol. xx. *Sir B. C. Brodie*, ibid.

FRACTURES OF THE STERNUM.

The sternum is less frequently broken than its exposed position might lead us to expect ; and the reason of this fact is imputed to the bone resting, as it were, upon the yielding cartilages of the ribs, and also, in some measure, to its spongy texture. When the accident does occur, it is in most cases from the direct application of external violence to the injured part ; and then the fracture is always accompanied with contusion, or even a wound of the integuments, and more or less injury of the thoracic viscera.

[Its direction is generally transverse or slightly oblique, and when there is displacement, it is found that most commonly the upper piece is depressed backwards towards the thorax. More rarely, the fracture has been found to take a vertical direction, so as to separate the bone into two lateral halves.]

As Boyer remarks, the sternum, in consequence of the elasticity of the cartilages of the ribs, may be readily propelled backward by pressure in this direction, and the result is an actual change in the form, and a real diminution of the chest. Now, since this cavity is always accurately filled by its contents, these alterations cannot happen in a considerable and sudden manner, without a risk of the thoracic viscera being contused and even ruptured. Thus, when the sternum has been fractured by violent blows on the chest, the heart and lungs have been found severely contused, and sometimes lacerated ; and there will always be greater danger of such mischief, when the fracture is attended with depression of one or more of the fragments. In the Museum of University College is a heart, the right ventricle of which was lacerated by the fragment of a broken sternum. M. Sanson saw a similar occurrence. (See *Dict. de Méd. et de Chir. Pratiques*, art. *Fracture.*) In some cases, a large quantity of blood is effused in the cellular tissue of the anterior mediastinum ; and in others, the accident is followed by inflammation and suppuration in the same situation, and necrosis of the broken part of the bone. Since the lungs are also liable to be ruptured by the same force which causes the fracture, or wounded by the depressed pieces of bone, emphysema may be another complication, as was exemplified in a case related by Flajani. (*Collezione d'Osservaz., &c. di Chir.* t. ii. p. 214. 8vo. Roma, 1802.)

[The sternum has been known to be fractured without direct violence either from the contre-coup occasioned by falls on the back or other parts of the body, or as some have supposed, by the violent action of the muscles connected with it. Chaussier saw two fractures from muscular action in the efforts of parturition. In both these cases the trunk and head were strongly bent backwards at the moment of fracture. (See *Malgaigne, Traité des Fractures, &c.* t. i. p. 451.)]

A fracture of the sternum is rendered obvious by the inequalities perceptible, when the surface of the bone is examined with the fingers ; by a depression, or elevation of the broken pieces ; a crepitus and an unusual movableness of the injured part in respiration. The breathing is difficult, and mostly accompanied with cough, spitting of blood, palpitations, and inability to lie on the back. According to the observations of Petit and Baldinger, several of these latter symptoms may continue, with less intensity, a long while after the fracture has been cured. (*Leveillé, Nouvelle Doctrine Chir.* t. ii. p. 243.) When displacement occurs, the lower fragment generally is pushed forwards, or even more or less overlaps the upper.

Fractures of the sternum, when they are mere solutions of continuity, only require common treatment; viz. a bandage round the chest, quietude, and a low regimen, with the view of preventing what may be considered as the most dangerous consequence, inflammation within the chest.

In cases attended with great depression of the fractured bone, the necessary incisions should be made, in order to raise with an elevator the portions of the bone driven inwards, or to extract with forceps any loose splinters, which seem to be similarly circumstanced. However, it is not often necessary to trephine the sternum, either to raise a depressed portion of the bone, or to discharge extravasated fluid. In the first circumstance, I believe with Sir C. Bell, that the formal application of the trephine can never be right, though the surgeon may be called upon to extract loose splinters. (See *Operative Surgery*, vol. ii. p. 218.) Such an operation, however, may occasionally be proper when abscesses form under the sternum, or the bone is affected with necrosis, and the natural separation of the diseased parts is likely to occupy a considerable time.

Fractures of the sternum are more frequently produced by gunshot violence, than by any other cause, and in these cases the splinters may require extraction. At the battle of Marengo, the French general Champeux received such a wound, with which he lived nearly a month: the injury was attended with so many splinters, that when they were removed, the pulsations of the heart were visible to a considerable extent. (*Leveillé*, vol. cit. p. 214.)

The ensiform cartilage, when ossified in old subjects, is liable to fracture. Little more can be done in such a case than to relax the abdominal muscles by raising the thorax and pelvis, and then apply a bandage to the part, for the purpose of keeping it steady.

FRACTURES OF THE RIBS.

Several of these bones are often broken together, but the first rib being protected by the clavicle, and the lower ribs being very movable, are less liable to fracture than the others.

[Fractures of the ribs may be caused either by direct violence, such as a blow or fall, in which case the fracture takes place at the point where the force is applied, and the broken ends are driven *inwards;* or by compression of the thorax, when they generally give way at the most convex point, and the fractured ends project *outwards.* Thus, if the pressure be applied in the antero-posterior direction, the fracture will most likely occur somewhere near the centre of the bones, and if it operate laterally, they will, in all probability, be broken in the neighbourhood of their angles.

The ribs have also been known to be broken by muscular action in the efforts of coughing. Of this singular accident, the possibility of which has been called in question, M. Malgaigne has collected seven recorded examples. (See *Traité des Fractures*, p. 429.)]

The case first mentioned is the most serious, for when the spicula of a fractured rib are beaten inward, they may lacerate the pleura, wound the lungs, and cause the dangerous train of symptoms attendant on emphysema. (See EMPHYSEMA.) The pointed extremity of the rib, projecting inwards, may cause an extravasation of blood; or, by its irritation, produce inflammation in the chest, A fracture, not at all displaced, or situated under thick masses of muscles, may be difficult to detect, particularly in fat subjects; and, no doubt, is frequently never discovered. The surgeon should place his hand on the part where the patient seems to experience a pricking pain in the motions of respiration, or where the violence has been applied. The patient should then be requested to cough, in which action the ribs must necessarily undergo a sudden motion, by which a crepitus will often be rendered perceptible. All the best practitioners, however, are in the habit of adopting the same treatment, when there is reason to suspect a rib to be fractured, as if this were actually known to be the case by the occurrence of a crepitus or the projection of one end of the fracture; which, indeed, in the instances which are displaced, makes the nature of the accident sufficiently plain.

A broken rib cannot be displaced either in the direction of the diameter of the bone, or in that of its length. The ribs being fixed posteriorly to the spine, and anteriorly to the sternum, cannot become shortened. Nor can one of the broken pieces become higher or lower than the other, because the same muscles are attached to both fragments, and keep them at an equal distance from the neighbouring ribs. The only possible displacement is either outward or inward. In the treatment of simple fractures of the ribs, free from urgent symptoms, the principal indication is to keep the broken bones as motionless as possible. For this purpose, a broad linen roller is to be firmly put round the chest, so as to impede the motion of the ribs, and compel the patient to perform respiration chiefly by the ascent and descent of the diaphragm. A scapulary will prevent the bandage from slipping downwards. As a roller is apt to become slack, many surgeons, with good reason, prefer a piece of strong linen, large enough to surround the chest, and laced with packthread, so as to compress the ribs in the due degree.

[Mr. Hilton recommends strapping the chest in such a manner as to prevent the movements of the ribs on the injured side only. For this purpose, he applies strips of adhesive plaster circularly (round the injured side) from the spine to a little beyond the sternum, thus leaving the opposite side of the chest free for the purposes of respiration, and also not impeding in any way the movements of the abdomen. He states that he has found this method give great relief in cases where the patient could not bear the usual bandage, which not unfrequently happens. (See *Lancet*, vol. i. 1852, p. 255.) This method has been frequently practised by the writer, who has found it produce almost perfect ease, where a bandage including the whole chest only aggravated the distress.

Sometimes compression of the chest is not desirable; for instance, where the ribs are broken in several places, or where they are much driven inwards, it would often only aggravate the mischief. Fortunately in all cases the surgeon has a safe guide in the sensations of the patient, and if the bandage increases the distress, he may be sure that it is doing mischief, and should immediately remove it.

If the broken rib has penetrated the lung, the circumstance is made known by the more severe dyspnœa, the expectoration of blood, and probably, emphysema of the subcutaneous areolar tissue in the neighbourhood of the fracture. This latter symptom may be considered as positive proof of the nature of the injury, as it can only be occasioned by the passage of the rib through both layers of the pleura into the substance of the lung. (See EMPHYSEMA.)]

When, therefore, there is reason from these symptoms to think the lungs injured, or disposed to inflame, copious and repeated bleedings should be practised; and as pleuritis or pneumonia is always liable to succeed such an accident, and is a most dangerous occurrence, the greatest possible vigilance is called for on the part of the surgeon: for the treatment, to be effectual, should be employed at the earliest period of the accession of the inflammatory symptoms.

Calomel in repeated doses, combined with antimony, should also be administered, and the mistura cetacei, with opium, will be found an excellent medicine for appeasing the cough, which disturbs the fracture, and gives the patient infinite pain.

[The patient should be kept perfectly quiet, with his head and shoulders raised, and should only take food of the mildest possible character.]

Fractures of the Clavicle.

This bone being long and slender, unsupported at its middle, and protected externally only by the integuments, is very often broken.

Its serving to keep the scapula at a proper distance from the sternum, and as a point of support for the os brachii, every impulse of which it receives, fully accounts for the fact.

The most frequent cause is a fall on the point of the shoulder, or on the elbow or hand, when the arm is separated from the side.

In fracture from this cause, the middle of the bone, where the curvature is greatest, is most frequently the situation of the injury. It is not very often fractured at its scapular, and still more rarely near its sternal extremity.

When the fracturing force is applied to the ends of the bone, as in a fall on the point of the shoulder, or on the hands, while the arms are extended, the clavicle may be bent, and fractured so obliquely, that the broken portions protrude through the skin.

Less frequently, the fracture is caused by direct violence, in which case the bone will be broken at the point on which the force immediately acts, and then the soft parts will be contused, or even lacerated.

A comminuted fracture may be thus occasioned, and if the violence be very great, the axillary nerves may be injured. Mr. Earle mentions an instance, in which the axillary plexus of nerves was crushed by a comminuted fracture of the clavicle, and paralysis of the arm occasioned. (See *Med. Chir. Trans.* vol. vii. p. 173.) I am not aware of any case in which the subclavian vessels have been wounded by the spicula of a broken clavicle.

[M. Malgaigne, in 1844, met with two cases in which fracture of the clavicle was caused by violent muscular efforts. (See *Traité des Fractures, &c.* t. i. p. 494.)]

The symptoms differ, according as the fracture happens to be situated between the scapular end of the bone and the coraco-clavicular ligaments, or between the insertion of these ligaments, and its sternal extremity. In the first case, the two fragments being fixed by the ligamentous bands, which connect them on one side with the coracoid process, and on the other with the acromion, are but little displaced; and the arm may yet have in the clavicle a sufficient point of support for the execution of its motions. Still, on careful examination, the outer end of the bone will be perceived to be somewhat depressed, and to incline obliquely downwards and forwards, so as to form an angle with the rest of the bone; but if the humerus and shoulder be pushed up, it will readily assume its proper direction. A crepitus is also generally distinguishable, when the surgeon applies his hand to the place of the fracture, and alternately raises and depresses the shoulder.

[If the fracture have happened just opposite to the coracoid process, and between the attachments of the conoid and trapezoid portions of the coraco-clavicular ligament, the displacement may be even less evident, since each side of the fracture will then be retained in position through its ligamentous connection with the coracoid process.

Mr. R. W. Smith has described the anatomical appearances presented by eight specimens of old fracture near the acromial end of the clavicle in the museum of the Richmond Hospital, Dublin. In three of these in which the bone had been broken between the conoid and trapezoid ligaments, the resulting deformity was very trifling, and limited to a slight increase in the natural curve of this part of the bone. In the other five, however, in which the fracture had been external to both portions of the ligament, the displacement was considerable, much greater, in fact, than the usual description of the symptoms of this accident would lead us to expect. In all the five, the pieces had become joined together at a right angle or nearly so, the fractured end of the external having united with the anterior surface of the internal fragment. The clavicle in consequence had become permanently shortened, and the shoulder was drawn forwards and inwards, so that in one case in which a cast of the body had been taken, the measurement between the sterno-clavicular articulation and the acromion, was found to be nearly an inch less than on the opposite side. In all the eight cases, there was abundant bony deposition on the under surface of the clavicle, and in one the conoid and trapezoid ligaments had become completely ossified, and the clavicle ankylosed with the coracoid process. (See *Treatise on Fractures and Dislocations*, p. 209.)]

In the second and far more frequent case, or that in which the fracture is situated between the insertion of the coraco-clavicular ligaments and the sterno-clavicular articulation, the displacement is much more considerable; and be it remembered, that the external portion of the clavicle is always that which is displaced. The internal part cannot be moved out of its natural situation, by reason of the costo-clavicular ligaments, and of its being drawn in opposite directions, by the sterno-cleido-mastoideus, and pectoralis major, muscles. The external portion, drawn down both by the weight of the arm, and the action of the deltoid muscle, and forward and inward by the pectoralis major, is carried under the internal portion, which projects over it. The broken clavicle no longer keeping the shoulder at a due distance from the sternum, the arm falls forward towards the breast. [The elbow or forearm is usually supported by the opposite hand, and the neck is bent towards the injured side, to relax the sterno-mastoid and trapezius muscles.]

The patient finds it impossible to put his hand to his forehead, because this act makes a semicircular motion of the humerus necessary, which cannot be done while that bone has not a firm point of support. [Abduction of the limb by separating and raising the elbow from the side, is also especially painful and difficult, as it increases the displacement inwards of the outer portion of the fracture.] The shoulder and upper extremity may be observed to be nearer the breast, than those of the opposite side. The motion of the pieces of bone on one another may be felt, as well as the projection of the end of the internal portion. When the shoulder is moved, a crepitus may also be perceived; but this is productive of great pain, and the diagnosis is so obvious, that it is quite unnecessary.

[Occasionally, the fractured ends remain in contact, either wholly or partially, and then the deformity will not be so evident, but movement of the shoulder will generally produce a crepitus. Sometimes, without being completely separated, they become so placed as to form an angle with each other.

In very rare cases, and when the fracture has been oblique from below upwards and inwards, the external piece has been found to ride over the internal, the direction of the obliquity having, no doubt, occasioned the unusual displacement.

Both clavicles are occasionally broken. Malgaigne records six examples of this double accident, and what is somewhat singular, in three out of the six, the fractures remained ununited. (See *Traité des Fractures*, p. 494.) Fracture of the clavicle is often met with in young children. It is, in fact, more frequent in them than fracture of any other bone.]

For the reduction, the two indications are, to push outwards and backwards the scapular fragment, and to bring it to the level of the sternal part.

The ancients and many moderns, have supposed that, in order to set a fracture of the clavicle, the shoulder should be drawn back, and fixed in that position. The patient was placed on a low stool, so that an assistant might put his knee between the shoulders, which he drew back at the same time with both hands, while the surgeon applied the bandage which was to keep the parts in this position. But when the shoulders are thus drawn towards one another, the scapula is obviously pushed towards the sternum, and with it the external portion of the clavicle, which passes under the internal fragment.

The figure of 8 bandage has commonly been used for maintaining the parts in this position. While the assistant keeps back the shoulders, as above described, the surgeon is to apply one end of a roller to the armpit on the side affected, and then make it cross obliquely to the opposite shoulder, round which it is to pass, and from this to the other shoulder, about which it is to be applied in the same manner, and afterwards repeatedly crossed before and behind. The tightness with which it is necessary to apply this bandage, produces excoriation about the armpits, and the effect is to make the ends of the fracture overlap each other; the very thing which it is wished to avoid. As Boyer remarks, many of the instruments which have been contrived, are only modifications of the figure of 8 bandage, and are not at all better.

Desault advised extension to be made by means of the limb which is articulated with the fractured bone. This is done by converting the humerus into a lever, by carrying its lower end forward, inward, and upward, pushing the shoulder backward, upward, and outward, and putting a cushion in the armpit to serve as a fulcrum.

Desault used to put in the armpit a hair or flock cushion, five or six inches long, and three inches and a quarter thick at its base. Two strings are attached to the corners of the base, which is placed upward: they cross the back and breast, and are tied on the shoulder of the other arm. The cushion being thus placed in the armpit, and the fore-arm bent, Desault used to take hold of the patient's elbow, and carry it forward, upward, and inward, pressing it forcibly against the breast. By this manœuvre, the humerus carries the shoulder outward, the ends of the fracture become situated opposite each other, and all deformity is removed. An assistant is to support the arm in this position, while the surgeon is to place one end of a roller, nine yards long, in the armpit of the opposite side, and then apply the bandage over the upper part of the arm, and across the back to the same situation. The arm and trunk are to be covered with circles of the roller, as far down as the elbow, drawing the bandage more tightly, the lower it descends. Compresses, dipped in camphorated spirit, having been placed along the fractured bone, Desault took a second roller of the same length as the first, and put one end of it under the opposite armpit, whence it was carried across the breast over the compress and fracture, then down behind the shoulder and arm, and after having passed under the elbow, upward on the breast. Desault next brought it across to the sound shoulder, under and round which he passed it, for the purpose of fixing the first turn. He then conveyed the roller across the back, brought it over the compresses, carried it down in front of the shoulder and arm, under the elbow, and obliquely behind the back to the armpit, where the application began. The same plan was repeated, until all the roller was spent. The apparatus was secured by pins, and the hand kept in a sling.

Boyer's apparatus for fractured clavicles is more simple than that of Desault. The cushion is to be applied under the arm. The apparatus consists of a girdle of linen cloth, which passes round the trunk on a level with the elbow. It is fixed on by means of three straps and as many buckles. At an equal distance from its extremities are placed externally on each side two buckles, two before and two behind the arm. On the lower part of the arm is to be laced a piece of quilted cloth, five or six fingers broad. Four straps are attached to it which correspond to the buckles on the outside of the girdle, and serve both to keep the arm close to the trunk, and from moving either backward or forward.

The principles of treatment inculcated by Desault are excellent; but his manner of bandaging the arm and shoulder is rather complicated, and in women, particularly inconvenient. We learn from Dr. Reese, that in the United States, till very lately, fractured clavicles were almost universally treated on Desault's plan. When the bandage was properly applied, it was found, indeed, adequate to fulfil all the necessary indications; but its complexity, its liability to be deranged, and the pressure it made upon the mammæ in female patients, rendered a substitute for it in many cases desirable. In 1816, Dr. S. H. Coale, of Baltimore, therefore invented an apparatus which, in his hands, was entirely successful in bad cases of oblique fracture of the clavicle. It was made of leathern straps and buckles, performing the triple purposes for which Desault's bandage was adapted; and its simplicity as well as permanence, together with its adaptation to female patients, has brought it into general use in the southern states of the Union. An improvement on Desault's mode of applying the bandage has been suggested by Dr. Stephen Brown, of New York, and is adopted in many parts of the United States. (See *Am. Med. Recorder*, vol. iv.; and *Reese's Am. ed. of this Dict.*) A simple and good apparatus for fractures of the clavicle and those of the neck of the scapula, was proposed many years ago by Mr. Earle. (See *Pract. Obs. on Surgery*, p. 187, &c.) It is also calculated for cases of dislocated clavicle, and other injuries of the shoulder.

[An apparatus was contrived by Heister for making extension upon the clavicle in the required direction, namely, backwards and outwards. It consisted of two pieces of iron or wood joined together in the form of the letter T, the perpendicular part being placed behind the patient's back and fixed with a strap round his waist, the transverse portion passing behind his shoulders and projecting outwards. To the extremities of this part the shoulders were fixed by straps passing round under the axilla. This transverse part of the instrument was so contrived as to be shortened or lengthened at pleasure, according to the width of the patient's shoulders and the degree of extension required.

A drawing of this contrivance will be found in Mr. Lonsdale's *Treatise on Fractures*, p. 214. It seems well calculated to fulfil the indications already insisted upon, but must have been extremely irksome to the wearer.

Mr. Henry Lee has lately contrived a more convenient instrument acting on similar principles. (See *London Journal of Medicine*, Sept. 1857, p. 799.) He recommends it as specially adapted to cases complicated with fractures of the ribs, in which the usual pads and bandages might prove injurious.]

The common figure of 8 bandage, with a sling, may be sufficient when the fracture is external to the coraco-clavicular ligaments; but in other instances, it is prudent to attend more strictly to the indications pointed out by Desault. If surgeons understand why the shoulder should be kept outward, as well as backward and upward, in order to bring the fragments into the best apposition, they will have no difficulty in accomplishing it with a thick wedge-shaped pad, or sling, and a roller; and if not with these means, at all events with Boyer's or Earle's apparatus.

Whatever method is followed, one principal indication is always to prevent the weight of the arm from drawing downward the external fragment; and for this purpose, in England, a sling is generally preferred to bandages, or any of the apparatus sold in the shops.

I cannot quit this subject without cautioning surgeons never to fall into the error of supposing the rising end of a broken clavicle to be that which is displaced. Although this is truly in its right situation, it has often been made by injudicious pressure, to protrude through the integuments, one or two instances of which have fallen under my own observation.

Fractures of the Scapula.

[Fractures of the scapula may be divided into—1, fractures of the body of the bone (including the spinous process and inferior angle, which latter some surgeons have considered separately); 2, fractures of the neck of the bone; 3, of the coracoid process; and 4, of the acromion process.]

Fractures of the body of the scapula are not common; a circumstance explicable by its deep and covered position, and its great mobility. Nor could such an accident arise without considerable direct violence. Fractures of the coracoid process, and of the neck of the scapula, are also rare; for though these parts may appear in the skeleton likely to be often broken, their deep situation in the living subject, and the great mobility of the entire bone, generally saves them. Indeed, as Boyer says, they generally require great violence to break them, and then the contusion of the soft parts is a worse injury than the fracture itself: thus, this author has seen the coracoid process broken by the blow of the pole of a carriage, and the patient lost his life from the violence at the same time inflicted upon all the soft parts about the shoulder. (*Mal. Chir.* t. iii. p. 161.) Fracture of the acromion is generally stated to be more frequent, as might be expected from its prominence and superficial position. Mr. Lonsdale found, however, out of a total of 1901 fractures, eighteen were of the scapula, and of these, eight were of the body, eight of the acromion process, two of the neck, and none of the coracoid process. Those of the acromion and lower angle are more troublesome to keep right; but the most serious cases are fractures of the coracoid process and neck of the bone, which cannot be kept right without great difficulty, and are said to be frequently followed by a considerable stiffness of the arm, inability to raise it, atrophy, and even paralysis.

1. [*Fractures of the body of the scapula* are most commonly transverse or slightly oblique, but sometimes they are vertical, and then the spinous process is included in the fracture. They are always occasioned by direct violence, and therefore are mostly accompanied by much contusion of the soft parts, and sometimes by injury of the thoracic viscera. Unless the fracture be in the neighbourhood of the inferior angle, the displacement is usually slight, but some irregularity or unnatural mobility may generally be distinguished by tracing the margins of the bone, especially the posterior, or a crepitus may be felt when the hand is laid flat on the bone and the patient's arm is moved about. If the fracture be in the vertical direction irregularity will be felt, and crepitus will be produced by tracing the spinous process with the fingers.]

When the lower angle is broken, the serratus major anticus draws it forward, while the rest of the scapula remains in its natural situation; or, if the angular portion be considerable, the teres major and some fibres of the latissimus dorsi contribute to its displacement forward and upward.

The detached portion also remains motionless, while the rest of the scapula is moved, and it is so separated, that no mistake can be made.

Treatment. — When the scapula is fractured longitudinally or transversely, it is merely necessary to fix the arm to the side by means of a bandage, which includes the arm and trunk from the shoulder to the elbow. Thus the motions of the shoulder, which are only concomitant with those of the arm, are prevented. A sling with one or two circles of a roller round the trunk and lower part of the humerus would answer every purpose.

When the inferior angle is broken and drawn downward and forward by the serratus major anticus, the scapula must be pushed toward the fragment by inclining the arm itself inward, downward, and forward, where it is to be kept with a roller. The fragment is also to be kept backward as much as possible with compresses and a roller, and the arm is to be supported in a sling.

In other respects the danger of fractures of the scapula depends less upon the solution of continuity in the bone than the contusion of the soft parts or injury of the thoracic viscera. However, when the fracture is comminuted and the splinters are forced into the subscapularis muscle, abscesses may form under the bone, and, according to Boyer, require a perforation to be made in it (*Mal. Chir.* t. iii. p. 165), a proceeding which I cannot bring myself to think would ever be judicious, as making a depending opening in the soft parts must be far better practice. In military surgery the scapula is often injured by sabre-cuts; but, as Dr. Hennen remarks, this bone, when preserved from motion, is found in these cases to unite with great readiness and without future inconvenience. (*Principles of Military Surgery*, p. 48, ed. 2.)

2. *Fracture of the neck of the scapula.*—[This is understood to mean fracture of the narrow part of the bone opposite the notch in the superior costa, so that the coracoid process with the glenoid cavity is separated from the rest of the bone.]

When this part of the scapula is fractured, the weight of the arm makes it drop down so considerably as to give the appearance of a dislocation; but the facility of lifting the humerus upward, the crepitus, and the falling of the limb downward again immediately it is unsupported, are circumstances clearly marking that the case is not a dislocation. According to Sir Astley Cooper, the crepitus is best perceived through the medium of the coracoid process. The degree in which the glenoid cavity and the head of the humerus descend, he observes, depends very much upon whether the ligaments between the under part of the spine of the scapula and the glenoid cavity are lacerated or not. (*On Dislocations, &c.* p. 459.)

[The descent of the glenoid cavity towards the axilla must also depend very much on the rupture of the coraco-clavicular ligaments, without which it can scarcely take place to any appreciable extent.

This accident is extremely rare, so much so that some surgeons, among whom may be mentioned Mr. South, doubt that it ever occurs. (See *Translation of Chelius*, vol. i. p. 549.) Sir A. Cooper, however, relates two cases which do not appear to admit of any doubt, and a dissection by Duverney has proved the *possibility* of its occurrence. Recently also Mr. Pirrie speaks of having seen three cases in which "all the symptoms were exceedingly well marked." (*Principles and Practice of Surgery*, p. 156.)]

The treatment of a fracture of the neck of the scapula consists in keeping the head of the os humeri outwards by means of a thick cushion in the axilla, in keeping the glenoid cavity and arm raised with a sling, and in preventing all motion of the arm by binding it to the trunk with a roller. In some of these cases the apparatus proposed by Mr. Earle might be useful. (*Pract. Obs. in Surg.* 1823.)

Sometimes great pain and a crepitus are experienced on moving the shoulder joint after an accident, and yet the spine, the neck of the scapula, and all the above parts are not broken. In this circumstance it is to be suspected either that a small portion of the head of the os brachii, or a little piece of the glenoid cavity of the scapula, is broken off, which latter occurrence, I think, is not very uncommon.

[M. Malgaigne is of opinion that the symptoms of fracture of the neck of the scapula, as described by Sir A. Cooper, are more likely to be caused by fracture of a portion of the glenoid cavity, accompanied by dislocation downwards into the axilla. (See *Traité des Fractures, &c.* t. ii. p. 551.)]

3. *Fracture of the coracoid process.*—[This fracture is always caused by direct violence, and therefore is likely to be accompanied by severe contusion of the soft parts, the swelling from which may obscure the nature of the injury. Indeed, the mischief done to the soft parts is often of more importance than the fracture, as in the case related by Boyer, which terminated fatally, and which has been already referred to.

When the coracoid process is fractured, the pectoralis minor, coraco-brachialis, and short head of the biceps concur in drawing it forward and downward, so that its apex will generally be felt lower down than on the sound side, and it may be made to move while the rest of the scapula is fixed. If, however, the fracture be at the root of the process, the displacement may be less evident, as it may remain attached to the under surface of the clavicle by the coraco-clavicular ligaments, and unless these fibres are ruptured when the fracture takes place, its descent may be prevented. The attempts of the patient to move his arm will occasion severe pain.]

Treatment.—When the coracoid process is fractured, the muscles attached to it are to be relaxed by bringing the arm forward towards the breast and confining it there in a sling, while the shoulder is kept downward and forward, and a compress confined just under the broken part with a roller.

[Union by ligamentous substance is all that can be expected.]

4. *Fracture of the acromion* is most commonly produced by a blow or fall on the shoulder. The fracture is almost always transverse, and may occur either towards the apex or base of the acromion. The outer fragment is drawn downward by the weight of the arm and the contraction of the deltoid muscle, while the trapezius and levator scapulæ draw the rest of the bone upward and backward. The roundness of the injured shoulder is diminished, and part of the attachment of the deltoid being broken off, the head of the os humeri sinks towards the axilla as far as the capsular ligament will permit.

[If the fracture be very near the root of the process, the depression will be greater, for then the clavicle will fall as well, and allow the whole anterior part of the muscle to be displaced downwards. (*Lonsdale, On Fractures*, p. 201.)]

On tracing the acromion from the spine of the scapula to the clavicle, the surgeon will feel a depression just at their junction. The distance from the sternal end of the clavicle to the extremity of the shoulder is lessened. The natural form of the shoulder may be restored by raising the arm by the elbow, but the deformity returns immediately the arm is suffered to fall again. The accident may be distinguished from a dislocation, if the surgeon raise the shoulder by pushing the humerus upwards, when a crepitus will be perceptible to the surgeon's hand applied over the acromion on the limb being rotated. The patient feels a sense of weight, as if his arm were dropping off, and there is but little power to raise the limb.

Treatment.—The fractured acromion requires the arm to be so raised that the head of the os brachii will push up the acromion, while an assistant pushes the scapula forward and downward in a contrary direction to that of the arm. To maintain this position, a circular bandage is to be applied round the arm and body.

Desault used to apply also a wedge-shaped cushion under the axilla before putting on the bandage, in order to make the head of the os brachii project more upward on bringing the arm near the side; but Sir Astley Cooper finds that a cushion so placed does harm by throwing the head of the os humeri outward, and widely separating the acromion from the spine of the scapula. He approves of raising the elbow and keeping the arm fixed. He also relaxes the deltoid muscle by means of a cushion put between the elbow and the side, the elbow inclining a little backwards; the limb is to be bound to the chest in this position with a roller. The union may take place by bone, but, owing to the difficulty of maintaining the coaptation, the uniting substance is generally ligamentous. (See *Sir A. Cooper*, *On Dislocations*, p. 455.)

FRACTURES OF THE HUMERUS.

[The humerus may be broken at any point of its length or at either of its extremities. The fractures of each of these divisions of the bone differ so much in their characters that each will necessarily require to be separately considered.]

Fractures of the Upper Extremity of the Humerus.

[The injuries occurring to this portion of the bone must again be subdivided into—1, *fractures of the surgical neck*; 2, *fractures of the anatomical neck*; and 3, *fractures of the tuberosities.* The surgical neck is that part of the bone which is bounded above by the tuberosities, and below by commencement of the insertion of the muscles attached to the margins of the bicipital groove, viz. the pectoralis major, the latissimus dorsi, and teres major. The anatomical neck is the circular narrowing which separates the tuberosities from the head. The term *extracapsular* has also of late years been applied to designate the former, and *intracapsular* the latter class of cases. Separation of the epiphysis from the shaft of the bone not unfrequently happens in young persons, and this should be considered as a variety of the fracture of the *surgical*, and not of the *anatomical* neck, as it was described by Sir A. Cooper, since the line of union of the epiphysis with the shaft is situated below the tuberosities. Sir A. Cooper described the line of union of the epiphysis as the anatomical neck, while he spoke of the surgical neck as extending from the articulation as low down as the insertion of the coraco-brachialis and deltoid muscles. This description, from so eminent an authority, has given rise to considerable confusion, but it will be understood that in the present edition of this dictionary the terms are used strictly in accordance with the limitations above given.]

1. *Fracture of the surgical neck.*—[This is the most frequent injury met with at this end of the bone; it is generally caused either by a direct blow, or by a fall on the shoulder with the arm in contact with the side.]

An acute pain is experienced at the moment of the fall; sometimes the noise of something breaking is heard. There is always a sudden inability to move the limb, which, left to itself, remains motionless. But, on external force being applied, it readily yields, and admits of being moved with the greatest ease in every direction. Such motion is attended with severe pain, and if carried too far may cause ill consequences, as has been observed in patients in whom the fracture has been mistaken for dislocation.

Fractures of the neck of the humerus are always attended with displacement, produced by the action of the pectoralis major, latissimus dorsi, and teres major, which, being attached to the lower portion near its superior extremity, draw it first inward and then upward, in which last direction it is also powerfully urged by the biceps, coraco-brachialis, and long portion of the triceps. In this case the superior portion itself is directed a little outward by the action of the infra-spinatus, supra-spinatus, and teres minor, which make the head of the humerus perform a rotatory motion in the glenoid cavity.

Below the acromion a depression is remarkable, always situated lower down than that which attends a dislocation. If we place one hand on the head while the lower part of the bone is moved in various directions with the other hand; or if, while extension is made, an assistant communicates to the bone a rotatory motion, the following circumstances are perceived:—1, the head of the humerus remains motionless; 2, a more or less distinct crepitus is felt arising from the two ends of the fracture rubbing against each other. These two symptoms are characteristic of the accident, but the swelling of the joint may prevent us from detecting them.

Sometimes there is no displacement of the ends of the fracture, and then, as most of the symptoms are absent, the diagnosis is more difficult. In general, however, the ends of the fracture are displaced, and in this circumstance it is the lower one which is out of its proper position, and not the upper one, which is of little extent, and is not acted upon by many muscles.

The displacement is generally not very perceptible in regard to length, unless the fracture be very oblique, and its pointed spicula irritate the muscles and make them contract with increased power; or unless the blow, which was violent, continued to operate after the bone had been broken and forced the ends of the fracture from their state of apposition. In this way the body of the humerus has been drawn or driven upward, so as to protrude through the deltoid muscle and integuments far above the height of the head of the bone.

But commonly, as Petit observes, the weight of the limb powerfully resists the action of the muscles, and the displacement of the fracture is more liable to be transverse. In this circumstance the lower end of the fracture is displaced inward, and rarely in any other direction. In the most frequent case the elbow is separated from the trunk, and cannot be brought near it without pain, According to Sir A. Cooper, the upper end of the main portion of the humerus sinks into the axilla, where it can be felt, and the deltoid is drawn down by it so that the roundness of the shoulder is diminished. (*On Dislocations, &c.* p. 459.)

When the accident is produced by a direct blow or fall on the fleshy part of the shoulder, the deltoid is sometimes contused and affected with ecchymosis. Blood may even be effused from some of the ruptured articular veins or arteries, and form a collection.

[M. Malgaigne, on the other hand, states that in a great majority of the cases which he has met with the deformity was very trifling, and the fractured ends were seldom completely separated from each other. Out of more than twenty examples he only saw two in which there was "sensible and recognisable" displacement. (See *Traité des Fractures*, p. 515.)]

Fractures of the neck of the humerus have, not unfrequently from want of attention, been confounded with dislocations, notwithstanding the difference in the diagnostic symptoms of the two accidents.

On this part of the subject some admirable observations were made by Dupuytren. Every person, he remarks, who meets either with a dislocation, or a fracture of the upper end of the humerus, has fallen upon the corresponding side of the body; but the position of the limb at the moment of the fall has not been the same in both cases; and this difference commonly determines the kind of injury which is to follow, and furnishes the means of recognising it. If, in falling, the patient separates his arm from the side, and puts out his hand to weaken the effects of the fall, the accident will be a dislocation of the head of the humerus, without fracture. On the contrary, if the arm be kept close to the side, as in an unexpected fall, or when the hand is confined in the breeches pocket, the weight of the body then acts upon the cushion of the shoulder, and if there is any displacement, it arises from a fracture of the head, or upper part of the humerus. If the case be a dislocation, the hand having struck the ground is usually marked by mud, dirt, abrasions, or ecchymosis: if a dislocation, the violence having operated directly on the cushion of the shoulder, the hand is free from those appearances, and the part of the dress covering the deltoid presents traces of having come in contact with the ground; or the skin of the shoulder exhibits marks of contusion. In dislocation, ecchymosis is situated at the internal and forepart of the arm; in fracture, it is upon the very cushion of the shoulder. In dislocation, ecchymosis is less frequent than in fracture. In both accidents the acromion is prominent, but more so in dislocation; and in fracture the deltoid is shortened, and, as it were, swollen. In fracture the vacancy under the acromion is less than in dislocation, and the prominence in the axilla much less. In dislocation there is no crepitation — no ready movableness of the limb, as in fracture. Dislocation requires greater efforts for its reduction, for the maintenance of which it is sufficient to confine the arm close to the side; but in fracture of the upper part of the humerus an apparatus is indispensable to hinder the muscles from reproducing the displacement. A fracture, without displacement, may be mistaken for a simple contusion. The crepitus and mobility felt in the injured part, on rotating the lower portion of the humerus, are the only means of ascertaining the nature of the accident; but care must be taken not to be deceived by the kind of crackling felt in examining the shoulder after a severe contusion, and which arises from inflammation of the articular surfaces, and a deficiency of synovia. (See *Dupuytren*, in *Clin. Chir.* t. iii. p. 106.)

[The position of the limb at the moment of the fall, and the situation of the ecchymosis, are however, by no means such reliable signs as Dupuytren supposed them to be, for it is now known that dislocations are also not unfrequently caused by falls upon the shoulder, with the arm close to the side. (See DISLOCATION OF THE SHOULDER.)

There is a class of cases, however, in which the symptoms are by no means so distinct as usual, and this is when the fragments have become impacted, the upper end of the shaft having been driven into the cancellated texture of the head and tuberosities. In these cases the fractured surfaces may be only very slightly movable on each other, and there may be, therefore, great difficulty in detecting crepitus; the deformity may be only trifling, and the head of the bone may even be felt to move with the shaft when the latter is rotated.

Mr. R. W. Smith thus describes the signs of this somewhat obscure injury:

"When a person falls on the upper and outer part of the shoulder, and at once loses the power of executing the motions natural to the articulation, when none of the characters of luxation, or of the ordinary fractures of the neck of the humerus are present, and where at the same time there is a certain degree of deformity, which, though slight, it is by no means easy to remove, and an unusual difficulty in detecting crepitus, we have grounds for suspecting the existence of an impacted fracture of the neck of the bone.

"In order, however, to form a more decided opinion as to the nature of the lesion which the bone has suffered, let the surgeon with both hands grasp the head of the bone with firmess sufficient to maintain it as nearly as possible in a fixed position, while an assistant rotates the elbow; by this method crepitus can be produced in the great majority of cases." (*Treatise on Fractures, &c.* p. 186, 1847.)

In young persons, instead of fracture, separation in the line of union of the epiphysis with the shaft most commonly happens, but the symptoms of this accident do not differ very materially from those of the ordinary fracture of the surgical neck. The head of the bone remains in the glenoid cavity; a slight depression is seen beneath it, and it remains motionless when the shaft of the humerus is rotated. The upper extremity of the shaft of the bone is drawn inwards by the muscles which constitute the folds of the axilla, and forms an abrupt projection beneath the coracoid process, but it is seldom drawn so far inwards as to enable it to clear completely the surface of the superior portion, and consequently there is but little displacement as regards the length of the bone. The projection of the upper surface of the shaft feels smoother than in an ordinary fracture, and the crepitus is less rough and grating than usual. (See *R. W. Smith*, op. cit. p. 200.)

It will be found that these are as nearly as possible the symptoms referred by Sir A. Cooper to the "fracture through the tubercles or at the anatomical neck"—(See *A. Cooper*, *On Fractures &c. ed. by B. Cooper*, p. 427)—but which really belong to the fracture of the surgical neck, or to the epiphysary disjunction, which is the same thing.]

Treatment of fractures of the surgical neck of the humerus.—The reduction takes place of itself, on employing a very little force, methodically directed. If the surgeon put his hands on the situation of the fracture, it is rather to examine the state of the ends of the broken bone, than to accomplish a thing seldom required, namely, what is implied by the term coaptation.

In the treatment, the three indications are, 1. To render the arm and shoulder immovable: 2. To bring outward the lower end of the fracture: 3. To draw downward the same.

[These objects may be accomplished by the application of four splints; one on the anterior, one on the posterior, one on the outer, and one on the inner side of the limb; the three first mentioned should extend as high as the acromion, but that on the inner side must of course cease at the axilla. These splints may be retained either by a bandage or by straps and buckles, and when they have been adjusted, a wedge-shaped cushion should be placed, with its base upwards, in the axilla, and the arm then bandaged to the side. The cushion is for the purpose of pressing outwards the lower end of the fracture, and to prevent its being drawn inwards towards the chest by the action of the muscles. Sir A. Cooper recommended two splints, one anteriorly and one posteriorly, with a pad in the axilla, and the arm fixed to the side by the clavicular bandage; the hand and not the elbow to be supported by a sling, as if the elbow be raised, the upper end of the bone projects forward, or the fragments, if the fracture is oblique, may be made to overlap, while, on the other hand, if the arm is allowed to hang by the side unsupported at the elbow, the weight of the arm is a constant source of extension upon the broken end of the bone. (*On Dislocations*, p. 430, 434.)

Mr. Tyrrell states that in one instance, in which he could not otherwise succeed in removing the deformity, he found the bone maintained its natural position when raised and supported at a right angle with the side; he therefore applied a rectangular splint, one portion of which rested against the side of the patient whilst the arm reposed upon the other part, and in this way he succeeded in retaining the pieces in their proper relative positions.

This case is worthy of attention, for the position, though no doubt irksome to the patient, is very advantageous as regards the position of the upper fragment, when as very frequently happens, it is directed outwards by the action of the capsular muscles; and since, from the small size of this piece and its deep situation, it is almost impossible to act upon it directly, the only way to remedy the deformity is to raise the shaft of the bone until the axes of both pieces are made to correspond.]

2. *Fracture of the anatomical neck of the humerus.*—Indisputable facts prove the possibility of the anatomical neck of the bone being fractured, and C. Larbaud showed Bichat the humerus of a young man, aged 17, the head of which bone was accurately detached from its body by a division which had passed obliquely through the upper part of the tuberosities. Another example, proved by dissection, was recorded by Delpech. (*Chirurgie Clinique.*) An instance of this kind was pointed out to me in the spring of 1821, in St. Bartholomew's Hospital. The patient was a boy, whose elbow had been strongly kept up, on the supposition that the case was a fracture of the neck of the scapula, and, consequently, the irregular end of the humerus formed a remarkable projection in front of the acromion, yet capable of being pushed back, where, however, it would not remain.

[In addition to these cases, there is now abundant evidence of the occurrence of this injury, though it is much more rare than fracture of the surgical neck. It may be completely *intracapsular*, the head of the bone being detached from the shaft and tuberosities, and lying loose in the cavity of the joint; or it may include a portion of one or both tuberosities, and it will then be partly an intracapsular, and partly an extracapsular fracture. The signs of this injury are somewhat obscure; it is always caused by direct violence, such as a severe blow or fall on the point of the shoulder; after which the patient loses all power to move the limb, and though the surgeon can readily do so, yet very severe pain is caused by the attempt. Usually there is not much displacement, the muscles attached to the tuberosities counteract the influence of those inserted into the margins of the bicipital groove, and retain the upper end of the bone in its place. The fractured surfaces. therefore, remain in contact, and crepitus may be felt when the arm is moved.

The impairment of the motions of the joint and crepitus are in fact, as Mr. Smith observes, almost the only direct symptoms upon which the surgeon can depend, but his opinion will be strengthened by the absence of the signs of any of the other injuries occurring in this region, and by finding that all the neighbouring prominences of bone retain their proper relations to each other. Sometimes, however, the shaft of the bone is drawn a little forwards and inwards towards the coracoid process, and there will then be a projection at the anterior part of the joint, and a corresponding depression posteriorly under the acromion. In most cases there is severe contusion of the soft parts covering the joint, and the swelling arising from this cause may add materially to the difficulty of the diagnosis.

In this case also, as in the extracapsular fracture, the fragments may become *impacted*, but it is now the superior piece which is the smaller, and which is driven into the inferior or larger between the tuberosities, one or other of which processes is usually at the same time broken off or bent outwards from the shaft. Mr. R. W. Smith thus describes the symptoms of the intracapsular impacted fracture, which are more marked than those of the simple or non-impacted variety. "The arm is slightly shortened, the acromion process projects more than natural, and the shoulder has lost to a certain extent its rounded form; the upper extremity of the shaft of the humerus is approximated to the acromion, and the entire of the globular head of the bone cannot be felt. In consequence of the accompanying fracture of the tuberosity crepitus can be readily detected, when the shoulder is grasped with moderate firmness and the arm rotated. The absence of a rounded tumor in the axilla, and the impossibility of feeling the glenoid cavity, are sufficient to enable us to distinguish this injury from luxation." (Op. cit. p. 188.) This author describes one very singular case, in which the head of the bone was found to be completely reversed in the articulation, so that its fractured surface was directed towards the glenoid cavity, and the cartilaginous articulating surface thrown towards the shaft, and driven to a considerable distance into the cancellated tissue between the tubercles (p. 194). M. Nélaton refers to two similar cases. (See *Élém. de Pathol. Chir.* t. i. p. 736.)

In the intracapsular fracture, accompanied with impaction, the fragments are retained in so firm and continuous contact with each other, that direct osseous union can take place without much difficulty. But in the non-impacted variety the superior fragment is cut off from all connection with the surrounding tissues, and is in danger of perishing for want of nutrition, and acting as a foreign body in the articulation. In some, though fortunately very rare instances, this has been found to occur, and the head of the bone has been eliminated from the joint by suppuration.

Notwithstanding, however, these unfavourable circumstances, even where there is no impaction, osseous consolidation may still be accomplished. But it is highly probable, that in the cases in which this fortunate result has occurred, the vascular communication between the fragments has not been entirely cut off, but that they have remained partially connected together by the attachment of the capsular ligament, the vascular supply derived from which proves adequate to the preservation of the vitality of the head of the bone, although it may not be sufficient to enable it to take a very active part in the process of osseous union. (*R. W. Smith*, op. cit. p. 190.) In all cases, indeed, whether impacted or not, the reparation of the injury is chiefly accomplished by the lower fragment, which throws out bony matter in great profusion, so as to incase, as it were, the superior fragment. (See also *A. Cooper, On Dislocations*, p. 428.)

Treatment of fractures of the anatomical neck of the humerus.—In the non-impacted intracapsular fracture no coaptation is required, since the parts remain in contact, and are usually in their natural situation or nearly so. The object of the treatment, therefore, is merely to keep the parts at rest as completely as possible while union is going on, and for this purpose all that is necessary in most cases is to bandage the arm to the side and support the forearm in a sling. The pad in the axilla should not be used, since by throwing outwards the shaft of the bone it would tend to separate the fragments, and so to prevent osseous union, which can in this case scarcely be expected to take place unless the surfaces are maintained in close and continuous apposition.

The impacted intracapsular fracture always unites with a certain amount of deformity, which it would be imprudent to attempt to obviate, for even if we succeeded, we should thus materially diminish the chance of osseous consolidation. It is sufficient, therefore, to keep the arm at rest in the way above recommended, but to inform the patient at the same time, that a certain degree of deformity and of impairment of the motions of the joint will be a permanent result of the injury. (*R. W. Smith*, op. cit. p. 191.) Mr. Smith gives a drawing of a bone in which this fracture had occurred, and which he had an opportunity of examining some years after the accident. Firm union has taken place; the head of the bone is deeply sunk into the shaft, the upper extremity of which, with the tuberosities, appears as if bent outwards. In the museum of St. Mary's Hospital is a humerus which is almost identical in appearance with this drawing.

In all these cases, passive motion should be employed as soon as the union has become firm.]

3. [*Fracture of the greater tuberosity*, by which that process is detached from the rest of the bone, occasionally happens. In this injury the pieces are widely separated, the tuberosity being drawn backwards by the muscles attached to it, and the shaft of the bone forwards and inwards by the pectoralis major and subscapularis. The result is a great increase in the breadth of the shoulder from before backwards, while its rotundity is at the same time diminished, and the acromion becomes more prominent than natural. On a closer examination, two prominences may be distinguished, separated by an intervening depression. The anterior of these, situated beneath the coracoid process, belongs to the head of the bone; it will therefore be felt to move when the arm is rotated at the elbow. The posterior is the detached tuberosity, and does not follow any movement communicated to the shaft of the bone. Crepitus may perhaps be produced when the shoulder is compressed so as to bring the two portions of bone into contact. The patient cannot raise his arm by his own efforts beyond the horizontal line; it is usually separated from the side, but can be approximated to it without difficulty.

When the head of the humerus is situated *beneath the coracoid process*, it is questionable whether the accident might not with greater propriety be considered as a dislocation of the shoulder-joint complicated with fracture of the tuberosity. (See Dislocations, antè, p. 520.) The tuberosity may, however, doubtless be broken off without so great a displacement of the rest of the bone as has been here assigned to it, in accordance with the description given by Mr. Smith.

The treatment consists in fixing the shoulder, and drawing backwards the shaft of the bone by the figure of 8 bandage, and binding the arm to the side. (See *R. W. Smith, On Dislocations, &c.* p. 176, and also *A. Cooper*, p. 435.)

[*Fracture of the neck of the humerus with dislocation of the head of the bone.*— This accident, according to Sir A. Cooper, is generally caused by a violent fall on the shoulder. By the first impression of the accident the os humeri is dislocated, and by a second the neck of the bone is broken, and the head is detached and lodges in the axilla. The symptoms bear some resemblance to those of the simple dislocation downwards, inasmuch as the head of the bone may be felt in the axilla when the arm is raised; but it cannot, as in dislocation, be made to move when the arm is rotated at the elbow. There is also less hollow below the acromion, because the broken extremity of the shaft of the bone quits the head and becomes lodged in the glenoid cavity of the scapula. An indistinct crepitus may be produced by the friction of these latter parts against each other. The injured arm is shorter than its fellow, and is usually drawn somewhat inwards by the action of the coraco-brachialis and deltoid muscles. The nature of the accident will often be much obscured by the effusion of blood, and by the inflammation which speedily follows. Sir A. Cooper mentions four cases in which death ensued at some distance of time after the accident, and the parts were examined. In two the fracture was at the anatomical neck, and within the capsule; in the other two it appears to have been situated below the tubercles. In all four a more or less perfect joint had been formed between the glenoid cavity and the shaft of the humerus, and the head had become connected, either by bone or ligament, with the inferior costa of the scapula or with the subscapular fossa. All the lower movements of the shoulder were tolerably perfect, but the arm could not be raised beyond a right angle with the body. (*On Dislocations, &c.* p. 418.) M. Malgaigne records eight cases of fracture at the anatomical neck accompanied with dislocation; two of the eight, however, are the same which have been already referred to as related by Sir A. Cooper. In four the head was displaced into the axilla; in two it had escaped from the capsule backwards on to the dorsum of the scapula, and in the remaining two, forwards under the clavicle. (See *Malgaigne*, *Traité des Fractures, &c.* t. ii. p. 548.)

In the *treatment*, it is useless to attempt to reduce the dislocation of the head of the bone; but we should endeavour, as far as possible, to retain the fractured end of the shaft in apposition with the glenoid cavity. For this purpose Sir A. Cooper recommended a pad to be placed in the axilla, the shoulder to be steadied and drawn back by the clavicular or figure of eight bandage, the arm to be bound to the side, and the forearm supported in a sling.

When the inflammation has been reduced and the swelling has subsided, passive movement should be assiduously employed, in order that the movements of the new articulation may be rendered as extensive as possible. There is always some fear that the head of the bone, being completely separated from all its connections, may become necrosed, and so excite inflammation and abscess: in the majority of cases, however, it does not lose its vitality, but remains quiescent in its new situation, and contracts adhesions to the surrounding parts. Sometimes the tuberosities, or the upper part of the shaft, are severely comminuted, and the patient may even lose his life from the severity of the injury and the inflammation to which it gives rise.]

Fractures of the Shaft of the Humerus.

Fractures of this portion of the bone may be transverse or oblique, simple or compound. When the fracture takes place above the insertion of the deltoid muscle, the inferior portion is drawn outwards and upwards by that muscle, while the superior portion is drawn inwards by the action of the pectoralis, latissimus dorsi, and teres major muscles. When the fracture is below the insertion of the deltoid, the deformity will be in the opposite direction, as that muscle will then tend to draw outwards the superior fragment. Transverse fractures in the inferior third of the bone are attended with but little displacement, for the brachialis anticus and the triceps, being attached posteriorly and anteriorly to both fragments, counteract one another, and permit only a slight angular displacement.

Oblique fractures, however, are usually attended with displacement, whatever be the part of the bone broken. The inferior portion being drawn upward by the action of the biceps and long portion of the triceps, and if above the centre of the bone by the deltoid and coraco-brachialis also, glides easily on the superior, and passes above its lower extremity.

The shortening and change in the direction of the limb, the crepitus, which may be very distinctly perceived by moving the broken pieces in opposite directions, the pain, and impossibility of moving the arm, &c. joined to the history of the case, render the diagnosis sufficiently plain.

In a simple fracture of the shaft of the humerus, the prognosis is generally favourable; but fractures near the elbow are liable to be followed by more or less stiffness of the joint, often very difficult of removal.

Treatment of fractures of the shaft of the humerus.—In ordinary fractures of the humerus, extension, if necessary, should be made by an assistant, who draws the lower portion of the bone downward and bends the elbow, while the surgeon applies a roller round the limb. An external splint should then be applied, extending from the acromion to the outer condyle, and being lined with a soft pad, it cannot hurt the limb by pressure. An internal splint should reach from the margins of the axilla to a little below the inner condyle, and should also be well guarded with a pad, filled with tow or any other soft material.

Some surgeons are content with the application of two splints, but though the two above described are those on which we are to place the greatest reliance, yet, as the cylindrical form of the arm conveniently allows us completely to include this part of the limb in splints, I consider the employment of four better: one on the outside, one on the inside, one on the front, and another on the back of the arm. These are to be carefully fixed in their respective situations by means of tape or a roller. Throughout the treatment, the elbow and whole of the forearm are to be quietly and effectually supported in a sling.

[In doing this, care should be taken not to do more than *support* the elbow, for if it be *pressed* upwards, the broken ends may be made to overlap, especially if the fracture be oblique. On the other hand, if the elbow be left entirely unsupported, the weight of the limb may cause an undue separation of the fragments, and thus prevent consolidation taking place. This is probably the principal reason why ununited fracture is so much more frequent in the humerus than in other bones.

In the fracture above the insertion of the deltoid, where the upper fragment is displaced inwards, a cushion may be placed in the axilla after the splints are applied, in order to throw outwards this portion of the bone.

In very oblique fractures below the deltoid, there is sometimes considerable difficulty in preventing overriding of the fragments. In a case of this kind the splint devised by Mr. Lonsdale, for the purpose of making permanent extension, may be employed with advantage. It consists of a thin bar of iron, an inch and a half wide, to be used as an internal splint, and so contrived at its lower end as to admit of the elbow being firmly fixed to it, while at its upper end is a crutch which fits underneath the axilla, and which slides up and down by means of a screw. By screwing the crutch upwards, so as to press against the axilla, while the elbow is firmly fixed to the lower end of the apparatus, permanent extension may be kept up. Anterior, posterior, and external splints may be applied at the same time as usual. (See *Lonsdale, On Fractures*, p. 173.) In all fractures of the humerus it is desirable to retain the arm in contact with the side, by a few turns of a roller round the body.]

Fractures of the lower extremity of the humerus.

[The injuries occurring to this portion of the bone may be divided into—1. *Fracture just above the condyles*; 2. *Fracture of the internal condyle;* 3. *Fracture of the external condyle.*

1. *Fracture just above the condyles* is most frequently caused by a blow or by a fall on the elbow, but it is occasionally the result of a fall on the palm of the hand, by which the bones of the forearm are forcibly driven against the lower end of the humerus. This accident is often met with in children, but, in them it is not, strictly speaking, a fracture, but a separation of the epiphysis from the shaft of the bone, which usually takes place.

In most cases, the lower fragment is drawn upwards behind the shaft of the bone by the action of the triceps extensor on the olecranon process, and an unnatural prominence is thereby produced at the posterior aspect of the arm, which, without due caution, might cause the injury to be mistaken for a dislocation of the bones of the forearm backwards. This displacement will be produced all the more readily if the direction of the fracture happen to be oblique downwards and forwards, which Sir A. Cooper thinks is most frequently the case. The fracture may be distinguished from the dislocation by the greater mobility of the arm, and by the crepitus which its movement will produce in the fracture, also a moderate degree of force will remove the deformity, but it returns as soon as the extension is discontinued; whereas, in dislocation, much greater force is required, but after it has been reduced, the displacement has no disposition to recur. In addition to these distinctions, M. Malgaigne observes, that however much the olecranon may project posteriorly, it is never more distant from the condyles than natural, if it be a fracture, but is far removed from them in dislocation; and that in fracture, the counter-projection in the front of the arm is less broad and more rounded, and is situated above the bend of the elbow, while in luxation it is below it; also, that in measuring the arm from the acromion to the condyles, there is a shortening in fracture which does not exist in dislocation. (*Traité des Fractures, &c.* vol. i. p. 554.)

In all cases where the fracture is transverse, or oblique in the direction indicated by Sir A. Cooper, the rule above laid down respecting the displacement of the fragments will be found to hold good; an occasional exception may, however, be met with when the bone has been broken obliquely in the opposite direction, namely, downwards and backwards, since it is then almost impossible for the lower piece to pass behind the upper.

M. Malgaigne relates an instance of this obliquity, in which the upper piece descended behind the lower, and became lodged against the summit of the olecranon beneath the insertion of the extensor tendon. (Op. cit. p. 553.) This case well exemplifies the manner in which the oblique direction of a fracture may modify the displacement which the action of the muscles would otherwise tend to produce.

A modification of this accident, first noticed by Desault, is sometimes met with, in which the fracture above described, is complicated by a longitudinal division separating the condyles, and extending downwards into the elbow-joint, so that there will be three separate pieces of bone and two fractures.

The fracture of the condyles may be more or less oblique, and the pieces may be equal or unequal in size.]

In this complication the deformity is greater, and the fractured part is more movable. When pressure is made, either before or behind, on the track of the longitudinal fracture, the two condyles, becoming further separated from each other, leave a fissure between them, and the fractured part is widened. On taking hold of the condyles, and moving them in different directions, a distinct crepitus is perceived.

[In all fractures in the immediate vicinity of the elbow, swelling rapidly supervenes, and unless the part can be examined very shortly after the accident, there may be great difficulty in forming an exact diagnosis.]

Treatment.—The treatment advised by Sir Astley Cooper, consists in bending the arm, drawing it forwards so as to reduce the parts, and then applying a roller. The best splint for this case is one formed at right angles, the upper portion of it being placed behind the upper arm, and the lower under the forearm. He also directs the application of a splint to the fore part of the upper arm. The splints are to be fixed with straps; evaporating lotions used; and the arm kept in a bent position in a sling. In a fortnight, if the patient be young, and, in three weeks, if he be an adult, passive motion may be gently employed for the purpose of hindering ankylosis. (*On Dislocations, &c.* p. 464.)

When there is also a fracture through the condyles into the elbow joint, the detached fragments being drawn in opposite directions by the muscles of the arm and forearm, commonly remain unmoved between these two powers, and are but little displaced. External force may, however, put them out of their proper situation, and they may then be displaced forward or backward, or they may separate from each other sideways, leaving an interspace between them. Hence, the apparatus should resist them in these four directions; and this object is easily accomplished by means of four splints, kept on with a roller. The two lateral splints are particularly necessary, when the condyles are separated from the body of the bone, with an interspace between them. If one of them be still continuous with the humerus, no splint on this side will be requisite.

[Even when there is no separation, its occurrence should be provided against by a moderate degree of lateral compression, though the side splints may not then be required. For this purpose, a bandage round the elbow, applied before the antero-posterior splints are adjusted, will generally be found sufficient. Often, when there is much swelling and effusion into the joint, it will be better not to apply any apparatus for a few days; but to keep the arm at perfect rest upon a pillow, and to apply leeches and evaporating lotions until the inflammation has subsided.]

Desault recommends the front and back splints to be flexible at their middle part, which should be applied to the bend of the arm and elbow.

The old writers considered the communication of a fracture with a joint a fatal kind of complication. Swelling and inflammation of the adjacent parts; continuance of pain after the reduction; large abscesses; even mortification of the softer parts, and caries of the bones, are, according to such authors, the almost inevitable consequences of these fractures, and ankylosis the most favourable termination. Paré, Petit, Heister, Duverney, all give this exaggerated picture. However, the experience of these and other fractures into joints, amply prove that this representation is magnified beyond truth.

2. [*Fracture of the internal condyle.*—The internal condyle consists of an articular and a non-articular portion, to which the terms trochlea and epitrochlea are now frequently applied. The fracture may merely implicate the non-articular prominence or epitrochlea, or the whole of the condyle with its trochlear surface may be broken off obliquely from the rest of the bone.

Sir A. Cooper speaks of the latter fracture as of frequent occurrence, while Malgaigne on the other hand considers it to be extremely rare, and states that he has never himself met with an instance. The French surgeon, however, records several examples of the fracture in which the epitrochlea alone is broken off. According to Sir A. Cooper, the symptoms are the following: the ulna appears dislocated because it projects behind the humerus with the broken condyle when the arm is extended; but it resumes its natural situation on bending the arm. By grasping the condyles, and bending and extending the forearm, a crepitus is perceived at the internal condyle. When the arm is extended, the lower end of the humerus (*i.e.* the external condyle) advances upon the ulna so as to be felt at the anterior part of the joint. (*On Dislocations, &c.* p. 466.)

Fracture by which the epitrochlea alone is broken off, most commonly happens in children, in whom it may be an epiphysary disjunction, instead of a fracture, which takes place, since this process is ossified separately, and is not joined to the rest of the bone till towards adult age.

It may be caused by a fall or a blow on the part itself, or sometimes as some have supposed by the action of the muscles arising from it. These muscles after the fracture will also tend to displace the detached fragment downwards and forwards towards the forearm. The detached process may generally be felt, unless the swelling be very great, and on moving it crepitus will probably be obtained. The patient holds his arm semiflexed, and his hand pronated, and pain is produced in both these fractures if supination or extension is attempted.

The treatment of both these fractures of the internal condyle consists in applying a roller round the joint, to maintain the broken piece in apposition with the rest of the bone; in keeping the limb bent at a right angle, and supporting it in a sling. When the epitrochlea alone is broken off, the hand should at the same time be pronated and the fingers flexed, in order that the muscles arising from the small detached fragment may be relaxed as completely as possible. In the more extensive fracture of the condyle, if there be much tendency to displacement backwards of the ulna, it may be advisable to apply splints in the way recommended for the fracture above the condyles.]

3. [*Fracture of the external condyle*, as of the internal, may involve a larger or smaller portion of the bone. The non-articular prominence (sometimes called epicondyle) may be broken off alone, or the fracture may extend into the elbow-joint, and detach more or less of the articular surface for the radius; or it may extend beyond it so as to include a portion of the trochlear surface of the internal condyle. Fracture of the non-articular portion alone, is not so likely to happen in the external as in the internal condyle, on account of its slighter projection. The arm is semiflexed, there is swelling on the outer side of the elbow; the movements of the joint are painful; crepitus is produced when the radius is rotated, and if the swelling be not very great the detached condyle may be felt. According to Sir A. Cooper, if the portion of the fractured condyle be large, it is drawn a little backwards and carries the radius with it, but if it be small, this circumstance does not occur. (*On Dislocations, &c.* p. 467.) M. Malgaigne has remarked, that simultaneously with this displacement backwards, the upper extremity of the detached fragment is sometimes tilted forwards; and also that sometimes it is separated in the lateral direction from the rest of the bone, so as to cause a sensible increase in the breadth of the elbow-joint. He considers this fracture to be one of the most frequent in the vicinity of the elbow. Desault speaks of one case in which he found the limb always retained in the supine position.

Treatment.—Sir A. Cooper recommends a roller round the joint, which will prevent lateral displacement, and afterwards the same rectangular splint used for the fracture above the condyles; (*On Dislocations, &c.* p. 468) or a rectangular splint may be applied laterally on the outer side of the arm and forearm. It will be well to retain the hand in the supine position, with the fingers not much flexed, so as to relax the supinators and extensors which take origin from the external condyle.

This fracture does not always unite by bone. Sir A. Cooper speaks of two cases in which the union was ligamentous; in one of them the fracture was intracapsular, only a small portion of the condyle being obliquely split off. M. Malgaigne also has met with cases of fibrous union, and he represents one in which a proper false joint had been formed surrounded by an external fibrous capsule. (*Traité des Fract. &c.* t. i. p. 558.)]

FRACTURES OF THE FOREARM.

The forearm is more frequently broken than the arm, because external force operates more directly upon it than upon the latter part, especially in falls on the hand, which are frequent accidents. The forearm is composed of two bones, the ulna and the radius. The last is much more liable to fractures than the first, because it is articulated with the hand by a large surface, and all the shocks received by the latter part are communicated to it. The situation of it also more immediately exposes it to such causes as may break it. However, both the bones are frequently broken together. Bichat in his account of Desault's practice, mentions, that fractures of the forearm often held the first place in the comparative table of such cases kept at the Hôtel-Dieu, and other records point to the same conclusion.

Baron Dupuytren, states that in 1829, out of 109 fractures brought to the Hôtel-Dieu, 23 were of the forearm, 16 being of the radius, 5 of both bones, and 2 of the ulna. In 1830, in 97 fractures, 22 were of the forearm, 16 being of the radius alone, 4 of both bones, and 2 of the ulna.

[Mr. Lonsdale reports that out of 1901 fractures occurring during six years at the Middlesex Hospital, 386 were of the forearm ; of these 93 were fractures of both bones, 197 of the radius alone ; 64 of the ulna alone (its shaft) ; 30 of the olecranon ; and 2 of the coronoid process. M. Malgaigne, out of 1024 fractures at the Hôtel-Dieu, found 305 of the forearm ; of which 107 were of both bones ; 160 of the radius ; 29 of the shaft of the ulna : and 9 of the olecranon process. From all these records, it appears (if we exclude fractures of the olecranon, which in Mr. Lonsdale's table appear to be unusually numerous) that fractures of the radius alone are by far the most frequent, while fractures of both bones hold the second place, and fractures of the ulna the third.]

Fractures of both bones may occur at the extremities or middle of the forearm. They are most frequent in the middle third, somewhat less common below, and very rare at the upper part, where the numerous muscles, and the considerable thickness of the ulna, resist causes, which might otherwise occasion a fracture. These accidents may be produced by direct external violence ; or indirectly by a fall on the palm of the hand. The former case is the more frequent; in the latter, the radius, from its more extensive connection with the hand, receives the greater part of the shock, and is usually the only bone broken.

[The two bones may be broken at the same, or at different levels. The first will always be the case in a fracture caused by direct violence ; the second may happen when it is the result of a fall on the hand, in which case, the radius is first broken, and the force then tells upon the ulna, which in its turn gives way at its weakest point. When they are broken at different levels, M. Malgaigne has always found the radius broken above the ulna, and this is what might be expected from the relative strength of the two bones above and below.

An incomplete fracture, or bending of the bones, is not unfrequently met with in children ; indeed, this kind of injury is much more common in the forearm than in any other bones. M. Malgaigne believes that in these cases there is almost always a partial fracture, and not a mere bending of the bone, the fracture being situated on the side of the convexity of the curve and extending through a portion only of the thickness of the bone.]

Sometimes the bones are broken in more than one place; the fracture is, in fact, comminuted: Desault speaks of a patient over whose forearm a cart had passed, so as to break the bones, at their middle and lower part, into six distinct portions. The middle ones, notwithstanding they were quite detached, united very well, with hardly any deformity.

The symptoms indicating fractures of the forearm are not likely to lead the surgeon into any mistake ; motion at a part of the limb, where it was previously inflexible ; a crepitus, almost always easily felt ; sometimes a distinct depression in the situation of the fracture ; occasionally a projection of the ends of the fracture beneath the skin ; pain on moving the part; a noise sometimes audible to the patient at the moment of the accident ; an inability to perform the motions of pronation and supination; and an almost constantly half-bent state of the forearm.

[Displacement in the longitudinal direction seldom occasions the surgeon much trouble. It may take place to a slight extent when the fracture is oblique, but when it is transverse, the broken surfaces seldom become so completely clear from each other as to enable them to overlap. When it does occur, this displacement is to be ascribed rather to the cause of the fracture than to muscular contraction. An angular deformity, either forwards or backwards, may also be the result of the violence which causes the fracture; but the most important of all is the transverse displacement, in which the four pieces approach one another, and the interosseous space is diminished or entirely obliterated near the seat of fracture. This approximation is mainly due to the action of the pronator muscles; it is attended with an increase in the antero-posterior and a diminution in the transverse dimensions of the forearm ; it may affect the two upper fragments only, the two lower maintaining their natural distance apart, or the converse of this may happen. Lastly, there may be displacement in the direction of rotation, caused by the upper and lower portions of the fracture not remaining in an equal state of pronation or supination.

Fracture of both bones in the immediate vicinity of the wrist-joint are not very frequent, although fractures of the radius alone in this situation are, as will be presently seen, exceedingly common. It, however, is occasionally the result of a fall, probably more violent than usual, on the palm of the hand. The injury produced is a fracture, generally transverse, of both radius and ulna, close to the wrist-joint, or, in children, through the line of union of the epiphyses ; the lower fragments are displaced directly backwards, and the superior consequently project in front. (See *R. W. Smith, On Fractures, &c.* p. 166.)

This accident is very liable to be mistaken for a dislocation of the carpus backwards on the forearm ; but the fracture may be known by the crepitation, by its greater mobility, and greater facility of reduction ; and also by the fact mentioned by Boyer, that the styloid processes are displaced backwards with the carpus, and will follow any movements imparted to the hand, while in dislocation the reverse of this is the case. Any dislocation of the wrist-joint is of extremely rare occurrence. (See DISLOCATIONS.)]

Treatment.—In the reduction, and also in the subsequent treatment of a fracture of both bones, the forearm should be bent to a right angle with the arm, and the hand placed in a position between pronation and supination. For the reduction, an assistant should take hold of the patient's hand, and extend the fractured parts, while another assistant makes counter-extension by fixing the humerus. The surgeon's attention should be particularly directed to preserve the interosseous space;

for, if this be obliterated, the radius cannot rotate on the ulna, nor the motions of pronation or supination be executed; and this object may be obtained with certainty by applying compresses and splints in such a manner that the fleshy parts may be forced into, and confined in, the interosseous space.

Boyer first applied two longitudinal and graduated compresses on the anterior and posterior surfaces of the forearm. These he retained in their position by a bandage, and he then applied an anterior and posterior splint. Both compresses and splints extended from the elbow to the wrist. In general, the longitudinal compresses, used by Boyer, for preserving the interosseous space, are not resorted to England; [but anterior and posterior splints only are applied, and retained in their position by a bandage or by straps and buckles. The effect of a compress may be obtained in a more simple manner, by having the splints more thickly padded at the centre than at the sides, or by using convex splints, as suggested by Mr. Amesbury. It is desirable also that the breadth of the splints should slightly exceed the breadth of the forearm, in order to prevent the bandage from exercising any lateral compression. For the same reason, it is better not to apply any bandages beneath the splints, as recommended by Boyer. The palmar splint should extend as far as the fingers, to support the hand and retain it in a line with the forearm; for, when both bones are fractured, if the hand be permitted to hang down, its weight may produce an angular deformity at the seat of fracture.] The splint, however, should not pass beyond the first joint of the fingers; for many patients, after having had their fingers kept, for several weeks, in a state of perfect extension, have been a very long time in becoming able to bend them again. The posterior splint need not pass beyond the wrist.

If the fracture be simple, and the contusion inconsiderable, the patient need not be confined to bed, but may walk about, with his arm in a sling.

[The above treatment, with the hand in a state of semi-pronation, is that most usually adopted, and is certainly the most convenient to the patient. Some surgeons, however, recommend that the forearm should be kept in the supine position during the treatment. Mr. Lonsdale advocates it on the ground that, by the usual method, the radius is likely to unite with its lower piece more pronated than the upper, and that the movement of supination is afterwards often imperfect in consequence. The splints in the ordinary method, according to Mr. Lonsdale, retain the lower portion of the radius securely in one position, but do not prevent the upper piece from rotating on its axis, and in most instances it does so rotate in the direction of supination under the influence of the biceps and the supinator radii brevis, more especially if the fracture be above the insertion of the pronator radii teres, for then the two first-named muscles are not contracted by any antagonist whatever. He thinks that the supine position will obviate this inconvenience by bringing the axis of the lower piece, which is so much more easily acted upon, into correspondence with that of the upper. Another argument for the supine position is mentioned by Mr. Lonsdale, and in this M. Malgaigne also concurs, namely, that by it the interosseous space is more easily preserved, and the bones have not the same tendency to fall towards each other as when the radius is partly rotated across the ulna. M. Malgaigne recommends it, therefore, when there is any difficulty in maintaining the interosseous space, but in an ordinary case he thinks that the usual semi-prone position is less inconvenient and equally advantageous. (See *Lonsdale*, *On Fractures*, p. 123; and *Malgaigne*, vol. i. p. 591.)]

Fractures of the Ulna.

[It will be necessary to consider separately: 1. *Fractures of the olecranon.* 2. *Fractures of the coronoid process.* 3. *Fractures of the shaft of the ulna.*]

1. *Fracture of the olecranon process.* [This fracture is not very uncommon. It is almost always caused by external violence directly applied to the part by a blow or fall on the elbow; but in some rare instances it has been known to be produced by the violent action of the triceps muscle. The fracture may happen at its base, its centre, or its extremity; the second case is by far the most frequent. The division is usually transverse, but occasionally it is more or less oblique. M. Malgaigne has met with cases of fracture at the base of the process which extended obliquely downwards and backwards so as to include an inch and a half or more of the posterior surface of the ulna. Fractures of the summit of the olecranon are the most uncommon; in two cases mentioned by Malgaigne, they were the result of muscular action, which had torn off the surface of bone receiving the insertion of the triceps.]

With regard to symptoms, the contraction of the triceps, being no longer resisted by any connection with the ulna, draws upward the short fragment to which it adheres, so as to produce between it and the lower one a more or less evident interspace. This interspace is situated at the back of the joint; it will be increased by flexion of the forearm, and diminished by its extension. Another symptom is a difficulty or inability of the patient to extend his forearm, the necessary effect of the detachment of the triceps from the ulna. It appears from the dissections made by Sir Astley Cooper, that the extent of the separation depends upon the degree of laceration of the capsular ligament, and of that portion of the internal lateral ligament which proceeds from the side of the coronoid process to that of the olecranon. (*On Dislocations, &c.* p. 487.) [The periosteum covering this process is also considerably strengthened by aponeurotic fibres prolonged downwards from the insertion of the triceps tendon.]

It must be owing to the untorn state of these parts that sometimes no appreciable separation takes place, and that patients occasionally retain the power of extending the forearm, as is exemplified in the case reported by Mr. Earle, where, on the sixth day after the accident (and not before), this power was destroyed by a sudden flexion of the forearm. (*Practical Obs.* p. 147.) The forearm is constantly half bent, the biceps and brachialis having no antagonists. The olecranon is more or less drawn up above the condyles of the humerus, which latter parts, on the contrary, are naturally situated higher than the olecranon when the forearm is half bent. The upper piece of bone may be moved in every direction, without the ulna participating in the motion. Besides these symptoms, we must take into the account the considerable pain experienced, and the crepitus perceptible, when the fragment is approximated to the surface from which it is detached.

[Fracture of the base of the olecranon may be accompanied by a dislocation of the radius and ulna forwards on the condyles of the humerus. Cases of this kind are recorded by Malgaigne. (*Traité des Fractures*, &c. t. ii. p. 633.)

Treatment.—The indications are to push the retracted portion of the olecranon downwards, and to keep it in this position at the same time that the ulna is made to meet it, as it were, by extending the forearm.

When there is much swelling, Sir A. Cooper employs leeches and evaporating lotions for two or three days; but when not much violence has been done to the limb, he applies a bandage at once. He places the arm in a straight position, presses down the fragment until it touches the ulna, and, after putting a slip of linen along each side of the joint, puts a roller round the limb above and below the olecranon. By tying the slips of linen which pass under the rollers, these are drawn nearer together, and the fragment of the olecranon is thus kept as near as possible to the ulna. Lastly, a splint, well padded, is applied along the front of the arm, and secured with a bandage, which is frequently wetted with spirits of wine and water. (*On Dislocations*, &c. p. 490.)

Baron Dupuytren applied what is termed the uniting bandage, with a compress above the upper fragment, and an anterior splint. (See *Clin. Chir.* t. i. p. 328.)

According to Desault, however, the forearm should not be completely extended, as, when the pieces of bone touch at their back part, they leave a vacancy in front, which is apt to be followed by an irregular callus, prejudicial to the free motion of the elbow. Hence, it was his practice to put the arm between the half bent and the completely extended state, and to maintain this posture by means of a splint along the fore part of the arm. But, as position operates only on the lower part of the olecranon, the upper one requires to be brought near the former, and fixed there, which is doubtless the most difficult object to effect, because the triceps is continually resisting.

Desault used to adopt the following method:—The forearm being held in the above position, the surgeon is to begin applying a roller round the wrist, and to continue it as high as the elbow. The skin covering this part being wrinkled, in consequence of the extension of the limb, might insinuate itself between the ends of the fracture, and consequently it must now be pulled upward by an assistant. The surgeon is then to push the olecranon towards the ulna, and confine it in this situation with a turn of the roller, with which the joint is then to be covered, by applying it in the form of a figure of 8.

A strong splint, a little bent, just before the elbow, is next laid along the arm and forearm, and fixed by means of a roller. The limb is then to be evenly supported on a pillow.

Camper laid great stress upon the inutility of keeping the arm perfectly extended: he found patients recover sooner and better when the elbow was kept half bent, and the joint gently exercised at as early a period as possible. "Agglutinationem scilicet motiri non debet chirurgus, sed sublatis tumore ac inflammatione quiete et remediis aptis, cubitum quotidie prudenter movere, ut unio per tricipitis tendinem, seu per concretionem membranosam formetur, et os ossi non admoveatur. Verbo quemadmodum C. Celsus in *Med.* lib. viii. c. 10, § 4, p. 537, de cubito fracto præcepit. Quod si ex summo cubito quid fractum sit, glutinare id vinciendo alienum est, fit enim brachium immobile, ac, si nihil aliud quam dolore occurrendum est, idem qui fuit ejus usus est." (*Camper de Fracturâ Patellæ*, p. 66, Hagæ, 1789.) Mr. Earle is also an advocate for placing the limb in a slightly bent position. (*Pract. Obs.* p. 165.)

The cure of the fractured olecranon is seldom effected by the immediate reunion of its fragments; there generally remains a greater or lesser interspace between them, which is filled up by a ligamentous substance.

[The impossibility of maintaining the fragments in apposition is the only reason why this fracture is so seldom followed by bony union. In Sir A. Cooper's experiments on animals, transverse fractures of the olecranon were always followed by ligamentous union; but when he divided it in the longitudinal direction, osseous consolidation took place without difficulty. If, therefore, we could succeed in preventing the retraction of the broken piece, we might expect union by bone to take place in this as readily as in any other fracture.

Mr. Lonsdale says he is certain he has seen cases, where close apposition of the ends of the bone had been maintained, in which ossific union had been produced, or something very like it, for not the least motion has existed afterwards, and a distinct ridge of substance like bone has been felt opposite to the seat of fracture. He has not, however, had any opportunity of further verifying this statement by dissection. Sir A. Cooper has met with union by bone when the fracture has been situated very near to the shaft of the ulna. M. Malgaigne also represents in his atlas (pl. xxiv.) a drawing of an oblique fracture of the base of the olecranon united by bone, though with considerable deformity. This case was complicated with luxation of the bones of the forearm forwards. Ligamentous union may, however, undoubtedly be considered the rule, to which union by bone is a very rare exception; the case in which the exception is most likely to take place is when separation is prevented on account of the fibrous tissues connecting the olecranon with the rest of the bone remaining entire. Sir. A. Cooper has observed that the arm is weakened in proportion to the length of the ligament; for if this be very long, extension of the arm is rendered difficult from the necessarily diminished power of the triceps muscle; and that when it is of considerable length, it is often incomplete, having an aperture, or sometimes several apertures, in it. In about a month the splint should be removed, and passive motion begun; but all attempts at movement must be made with the greatest gentleness, for if it be commenced too soon, there is danger of the ligament becoming lengthened and weakened, or even of its being entirely absorbed again. (*On Dislocations*, &c. p. 473.) On the other hand, if movement be too long delayed, there may be great difficulty in overcoming the stiffness of the elbow resulting from the continuance of the extended position.]

Ankylosis of the elbow-joint has been known to follow a fracture of the olecranon. I have seen a case in which the upper fragment was ankylosed to the humerus.

On an average the olecranon becomes firmly united about the twenty-sixth day. (*Desault.*)

2. *Fractures of the coronoid process.*—These fractures are very rare. Two examples are noticed by Sir Astley Cooper: in one case seen by him several months after its occurrence, the ulna projected backwards whilst the arm was extended, but it could be drawn forwards, and the elbow bent without much difficulty, when the deformity disappeared. In the other instance, which was met with in the dissecting-room, the coronoid process which had been broken off was united by ligament, and so movable that, when the forearm was extended, the ulna glided backwards upon the condyles of the humerus. Sir Astley Cooper is of opinion that the case admits of no other mode of union: he recommends keeping the arm steadily in the bent position for three weeks. (*On Dislocations, &c.* p. 470.)

[Mr. Liston mentions a case of this fracture from muscular action, in which the injury arose in consequence of the patient, a boy of eight years, having hung for a long time from the top of a high wall, afraid to drop down. (*Pract. Surg.* 3rd ed, p. 77.) Two cases are recorded in Mr. Lonsdale's tables from the Middlesex Hospital, but he only speaks of having seen one, and in this the process was felt more prominent than natural when the arm was extended, but very little retraction was present. (*On Fractures,* p. 162.) M. Malgaigne records two others in which this process is presumed to have been fractured, and one which was met with by M. Velpeau in a dissection. (*Traité des Fractures,* vol. ii. p. 634.)]

3. *Fractures of the shaft of the ulna* are less frequent than those of the radius, and take place generally towards its lower extremity, where it is most slender and least covered. The fracture is almost always the result of a force acting immediately on the part fractured, as, for instance, when in a fall the internal side of the forearm strikes against a hard resisting body, or when the arm is raised to ward off a blow aimed at the head. The superior portion of the ulna is unable to move on account of its mode of connection with the humerus at the elbow; but the inferior piece may be displaced towards the radius, partly by the weight of the hand, partly by the action of the pronator quadratus muscle. This displacement is less considerable than in fractures of the radius, and is sometimes so slight that there is danger of the injury being overlooked. The nature of the case is in most instances easily ascertainable.

Treatment.—An assistant should make whatever little extension may be necessary, and should incline the hand to the radial side of the forearm, while the surgeon pushes the flesh between the two bones, and applies an anterior and posterior splint in the manner recommended for fracture of both bones. [Special care should be taken to support the hand in a line with the forearm, or even to direct it slightly towards the radial side, in order that its weight may not displace the lower fragment of the ulna and cause it to encroach on the interosseous space. For this purpose, besides fixing the hand securely to the anterior splint, a sling of pasteboard or leather to afford equal support to both forearm and hand will be found useful.]

Fractures of the Radius

Are the most frequent of those of the forearm, as proved by records noticed in the foregoing section. The radius being almost the sole support of the hand, and placed in the same line with the humerus, is, for both these reasons, more exposed to fractures than the ulna. These, whether transverse or oblique, near its middle part or extremities, may be caused by a fall or blow on the forearm, sometimes by a fall on the back of the hand (see *Dupuytren, Clin. Chir.* t. iv. p. 182—184), or, as happens in most cases, by a fall on the palm of the hand.

In fourteen examples of broken radius, referred to by Dupuytren, three were caused by falls upon the back of the hand, and eleven by falls upon the palm. These facts refute one of Cruveilhier's inferences that the radius cannot be fractured by a fall upon the back of the hand. (*Clin. Chir.* t. iv. p. 182.) When likely to fall, we extend the arm and let the hand come first to the ground, in which case the radius pressed between the hand on the ground, and the humerus, from which it receives the whole momentum of the body, is bent, and if the fall be sufficiently violent, broken either near its middle part, or which is more frequent, about an inch above its lower extremity. The right radius appears to be more frequently broken than the left, for in ninety-seven cases fifty-nine happened to the right arm. (See *Clin. Chir.* t. iv. p. 181.) [It will be convenient to speak separately of—1, fractures of the upper extremity; 2, fractures of the shaft; and 3, fractures of the lower extremity of the bone.]

1. *Fracture of the upper extremity of the radius.*—[Fractures of the head or neck of the bone are extremely rare, except as forming part of a comminuted fracture of the elbow-joint. Sir A. Cooper never met with a case of fracture of the neck of the radius, and he thinks, therefore, that there must be some mistake in the assertion formerly made that they are of frequent occurrence. (*On Dislocations, &c.* p. 476.) M. Malgaigne mentions two cases of fracture of the head of the radius, both of which were complicated with fracture of the coronoid process and dislocation backwards at the elbow, but has never seen an unequivocal fracture of the head or neck of the radius alone. (*Traité des Fractures, &c.* t. ii. p. 636.) Mr. South, however, has recently repeated the statement that fracture through the neck of the radius is not uncommon, and is liable to be confused with dislocation of the bone forwards on the external condyle, but he does not bring forward any facts to support this opinion. (See *Trans. of Chelius,* vol i. p. 558.) Such a fracture would probably be difficult to detect on account of this part of the bone being thickly covered with muscles; but Sir A. Cooper thinks that a crepitus would be produced by fixing the external condyle of the humerus and rotating the radius, probably also the shaft of the bone would be drawn forward by the action of the biceps muscle. The most appropriate treatment would be that which has been recommended for fracture of the external condyle.]

In all fractures of the bones of the forearm, and particularly in those which are near the head of the radius, a false ankylosis is to be apprehended, and should be guarded against by moving the elbow gently and frequently when the consolidation is advanced to a certain point.

Fractures of the forearm always require the part to be kept quietly in a sling.

2. [*Fracture of the shaft of the radius* may happen at any point from direct violence, or somewhere near the centre from a fall on the palm of the hand, though this latter cause most frequently produces a fracture near the lower extremity of the bone. Fractures of the shaft of the radius are probably not more frequent, as M. Malgaigne observes, than those of the shaft of the ulna, the excess in the proportion of injuries to the former bone being caused by the frequency of fracture at its lower extremity.]

When, after an accident of the kind above mentioned, pain and difficulty of performing the motions of pronation and supination supervene, the probability of a fracture of the radius is very strong. The truth is fully ascertained by pressing with the fingers along the external side of the forearm; also in endeavouring to perform supination or pronation of the hand, a crepitus and a motion of the broken portions will be perceived. When the fracture takes place in the upper third of the radius, the diagnosis is more difficult on account of the depth of soft parts over that part of the bone. In this case the thumb is to be placed under the external condyle of the os humeri, and on the superior extremity of the radius, and at the same time the hand is to be brought into the prone and supine positions. If in these trials, which are always painful, the head of the radius rests motionless, there can be no doubt of the bone being fractured. The ulna serves as a splint in fractures of the radius, and the more effectually as the two bones are connected with one another throughout their whole length. [Shortening, therefore, is impossible, unless the ulna be at the same time dislocated, and if there is any displacement it must be in the direction either of the diameter or of the circumference of the bone. The pronator muscles will tend to draw the bone inwards towards the ulna, and so to diminish the interosseous space; if the fracture be below the pronator teres, this muscle will influence the upper piece and the pronator quadratus the lower, but if the bone be broken above the point mentioned, both pronators will act on the lower piece, while the upper piece will be supinated by the supinator brevis and biceps, the latter muscle flexing or drawing it forwards at the same time that it assists in the supination. Such a displacement would implicate the bone both as regards its diameter and its circumference, and both these points should be well understood, as they require to be carefully attended to in the treatment. In this, however, as in most other fractures, the original violence may modify or even supersede muscular action, and produce a displacement of one or both fragments either backwards, forwards, or laterally.]

Treatment.—In general, when the radius alone is fractured, no extension is requisite. Splints padded in the same way as for the fracture of both bones, should be applied on the anterior and posterior surfaces of the forearm, the same care being taken to press outwards the ends of the fracture and to preserve the interosseous space, the only difference being that the hand should not be kept in a line with the forearm, but should be inclined towards the ulnar side, that it may act upon the lower portion of the fracture so as to draw it outwards away from the ulna. During the treatment the elbow is to be bent, and the hand put in the mid-state between pronation and supination; that is to say, the palm of the hand is to face the patient's breast.

[Mr. Lonsdale recommends the supine instead of the semiprone positions in these fractures, for the same reasons as in the fractures of both bones, and which have been already stated. (*Ante*, p. 725.)]

3. *Fracture of the inferior extremity of the radius.*—[This, although it is one of the most frequent of all fractures, was not well understood till within a comparatively recent period, but was very generally confounded with dislocation of the wrist. Mr. Colles of Dublin, in 1814, was the first to give an accurate description of the injury. (See *Ed. Med. and Surg. Journal*, vol. x. p. 182.) Somewhat singularly, however, this memoir of Mr. Colles has not been much noticed by subsequent writers, and was not alluded to in former editions of this Dictionary, though the accident is often familarly spoken of as Colles' fracture of the radius. Dupuytren in 1820, and subsequently, paid great attention to the subject, and strongly insisted on the frequency of fracture, and the almost impossible occurrence of dislocation of the wrist. This accident is almost constantly caused by a fall on the palm of the hand. The direction of the fracture, was stated by Dupuytren to be in general, oblique from above downwards, and from the dorsal to the palmar surface. (See *Clin. Chir.* t. iv. p. 183.) Subsequent investigations have, however, shown that it is more commonly transverse, although the obliquity when present, most frequently takes the direction just mentioned. Its situation is from half an inch to an inch above the inferior extremity of the bone; seldom so much as an inch and a half, as stated by Mr. Colles, who had not at that period had any opportunity of making post-mortem examinations of the injury. This is in reality the weakest part of the bone, notwithstanding its greater bulk, for it is composed entirely of light cancellated texture, only covered on the surface by an extremely thin layer of compact bone.]

The consecutive displacement will have a greater resemblance to a dislocation, the nearer the fracture is to the wrist. Fractures of the lower end of the radius seem to occur at all ages; for, in 14 examples, alluded to by Dupuytren, the ages of the patients varied between 8 and 88; but, in young subjects, a separation of the epiphysis is more likely to occur than a fracture. Occasionally the lower fragment is split vertically in two or more pieces. In a few rare cases, besides a fracture of the radius, the ulna is dislocated, and projects through the skin. (*Dupuytren*, vol. cit. p. 190.)

[Fracture of the styloid process of the ulna is a not unfrequent complication.

The direction in which the force is applied. when a person falls on the palm of the hand, causes the upper portion of the radius to be displaced forwards, and the lower fragment with the carpus to project backwards, producing the appearances thus described by Mr. Colles:—" The posterior surface of the limb presents a considerable deformity, for a depression is seen in the forearm, about an inch and a half above the end of the bone ; whilst a considerable swelling occupies the wrist and metacarpus ; indeed the carpus and base of the metacarpus appear to be thrown backwards so much, as, on first view, to excite a suspicion that the radius has been dislocated forward. On viewing the anterior surface of the limb we observe a considerable fulness, as if caused by the flexor tendons being thrown forwards ; this fulness extends upwards to about one third of the length of the forearm, and terminates below at the upper edge of the annular ligament of the wrist. The extremity of the ulna is seen projecting towards the palm and inner edge of the limb ; the degree, however, in which this projection takes place is different in different instances. (See *Ed. Med. and Surg. Journal*, 1814, vol. x. p. 183.)

This description however, though so far perfectly correct, does not comprise quite the whole of the truth ; and Dupuytren appears to have been the first to notice that the lower fragment of the radius undergoes at the same time a further alteration in its position, by which its articular surface is directed outwards and the hand is placed in a position of abduction. On this point Mr. R. W. Smith observes that "the lower fragment of the radius along with the carpus, besides being displaced backwards, is also drawn towards the side of supination, and this twofold displacement causes the wrist to assume a singularly twisted appearance, such as might be supposed to result, were it possible to supinate the hand and wrist, the forearm being at the time fixed in a state of pronation. Dupuytren and others have described the hand as being in a state of abduction, but this statement is not strictly correct, for the hand is displaced outwards along with the carpus and lower fragment of the radius 'par un mouvement de totalité.'" (*On Fractures, &c.* p. 139.) Mr. Smith's own description, however, of what takes place, would seem to show that Dupuytren was right in calling it a movement of abduction, rather than as Mr. Smith here declares, a "*mouvement de totalité*" of the hand and lower fragment of the radius. The following extract from the latter gentleman's work will render this more apparent:—"This double displacement is the result of the action of the supinator longus upon the one part, and of the long extensors of the thumb upon the other; the latter draw the lower fragment of the radius, with the carpus, towards the side of extension, thus directing the articular surface of the radius upwards (?) and backwards, while the former muscle, viz. the supinator longus, besides supinating the lower fragment, also elevates the styloid process, giving the carpal surface an inclination outwards,"—and also that "as long as the inferior radio ulnar ligaments remain unbroken" (which he believes to be most frequently the case) "and the lower end of the ulna entire, it is obvious that the inferior fragment of the radius must be displaced *obliquely;* that, in fact, the styloid process when being drawn upwards and backwards, must move through a portion of the circumference of a circle, and thus the upper end of the lower fragment is thrown towards the ulna." (p. 141.)

The pronator quadratus acts almost exclusively on the upper fragment, and draws it towards the ulna ; this displacement, however, is inconsiderable, on account of the small extent of the interosseous space at this level. The forearm is in consequence but slightly, if at all, diminished in its transverse diameter at the seat of fracture ; but its antero-posterior dimensions are very perceptibly increased. The patient has lost all power over the movements of pronation and supination, and generally supports the injured part on the palm of the opposite hand. From the firm way in which the fragments are locked together, there may be considerable difficulty in eliciting a crepitus, and the head of the radius may even be felt to move when the hand is rotated ; the surgeon should therefore first employ a degree of extension sufficient to restore the fragments to their proper relative position, and then, on rotating the hand, the grating of the broken surfaces will usually be felt, and the head of the radius will be found to remain motionless. (*R. W. Smith*, loc. cit. p. 138.)

M. Voillemier believes that these fractures are almost always attended with impaction or penetration of the fragments, and that the compact tissue of the upper portion, by the continuance of the force after the fracture has taken place, is driven into the cancellated tissue of the lower fragment. He describes several varieties in the way in which this penetration may take place, but thinks that in most cases it extends to a greater depth posteriorly than anteriorly and externally than internally, thus giving rise to the double deformity at the seat of fracture, which has been already described. This author also thinks that the circumstance of impaction may explain the difficulty of detecting crepitus which is so often met with in these cases. (See *Archives Gén. de Méd.* vol. xiii. 1842, p. 261.) Mr. Smith, however, differs from M. Voillemier respecting the occurrence of impaction, and offers a different explanation of the appearances adduced by the French surgeon in support of his theory. This difference of opinion has, no doubt, arisen from the fact that opportunities of examining this fracture in a recent condition are very seldom met with. Both statements are probably too exclusive, and the truth will no doubt be found to be, that the fracture is sometimes attended with impaction and sometimes not. Mr. Smith, after stating the arguments against the occurrence of impaction, says, "he thinks that as long as the ulna remains unbroken, and the ligamentous connections between the two bones uninjured, it is scarcely possible for either fragment to penetrate the other, even to the extent of half an inch." (p. 159.) Probably this is very nearly as much as M. Voillemier would himself contend for. The subject is fully discussed in Mr. Smith's admirable treatises on fractures and dislocations, and M. Voillemier's essay, above referred to, is also well worth an attentive perusal.

The remarks hitherto made refer exclusively to the fracture caused by a fall on the palm, but the lower extremity of the radius is occasionally, though rarely, broken by a fall on the back of the hand. Out of fourteen cases of fractured radius, seen at the Hôtel-Dieu, in 1830, Dupuytren found three from this cause ; but this must be considered as an unusually large proportion. The characteristics of the injury are in this case reversed ; the upper portion of the radius projects backwards, and the lower portion with the carpus is thrown forwards towards the palm ; the lower end of the ulna is prominent at the posterior and inner part of the wrist. Both kinds of fracture might be mistaken for dislocation, the former most resembling a dislocation backwards, the latter a dislocation forwards, of the carpus. Besides the usual signs, however, such as crepitus, increased mobility, &c. the fracture may be known by the altered position of the styloid process, with reference to the shaft of the radius, and by its following any movement communicated to the hand; and also by the oblique or twisted appearance of the deformity in both varieties of fracture of the radius singly, which does not belong to a dislocation, since both bones are then displaced together, either in one direction or the other. For this reason the mistake is not so likely to be made in the fracture of the radius alone as when the lower end of the ulna is also broken. (See FRACTURE OF BOTH BONES.) The surgeon should always bear in mind the frequency of fracture of the lower end of the radius, and the extreme rarity of dislocation of the wrist. (See DISLOCATION.)

Treatment.—In the treatment of the ordinary fracture of the lower extremity of the radius, after the deformity has been reduced by a suitable degree of extension and counter-extension, special attention is required to prevent any recurrence of the displacement of the lower fragment; first, in the direction backwards; secondly, in the direction outwards or towards the side of supination. Mr. Colles, aware of the necessity of fulfilling the first of these indications, used anterior and posterior splints, with a thick compress beneath the anterior splint opposite the seat of fracture, to press the lower end of the shaft of the bone backwards. He also used a third narrow splint on the ulnar side to press the extremity of this bone against the side of the radius.

Dupuytren employed anterior and posterior splints in the ordinary way, with a third on the inner side, so contrived as to counteract the abduction of the hand. This ulnar splint was composed of a steel plate covered with leather, about fifteen inches long and an inch and a quarter wide; it consisted of a straight portion corresponding to the ulna, and a part curved downwards corresponding to the hand. The hand was bound to this curved portion, and by that means securely maintained in the position of adduction. This plan effectually fulfilled the second indication; but it must have been insufficient as regards the first, as no compresses appear to have been used under the splints to prevent displacement backwards.

Sir A. Cooper used an anterior and posterior splint with a compress posteriorly on the lower fragment of the radius, and another internally to press upon the ulna. Following the plan recommended by Mr. Cline, the splints, which reached to the extremities of the metacarpal bones, were not bandaged lower than the wrist, and the hand was allowed to hang between them unsupported, so that by its weight it should draw upon the radius in the direction of adduction. The sling which supported the forearm was for this reason not permitted to extend beyond the wrist.

M. Malgaigne uses anterior and posterior splints with compresses to prevent the displacement backwards, and two lateral splints also with compresses beneath them, one so placed as to press inwards the lower fragment of the radius, the other to press outwards the lower extremity of the ulna. He thinks the splints should not extend beyond the first row of carpal bones, and that there is no object in confining the hand if the lower extremity of the radius is securely fixed, but that on the contrary it is much better to leave it free, that there may be less risk of permanent stiffness of the wrist and fingers.

The following plan, recommended by Mr. R. W. Smith, seems calculated to fulfil very completely all the required indications. "The hand being moderately adducted, a cushion is to be placed on the posterior surface of the limb, of sufficient length to extend from the elbow to the fingers; the portion of this cushion which corresponds to the lower fragment of the radius and to the carpus, should be thicker than any other part, and from its ulnar to its radial border should gradually increase in thickness. A transverse section of this portion of the cushion would represent an isosceles triangle, the base of which would correspond to the radial border of the limb. The objects proposed to be attained by constructing the pad of this form are, to press the lower fragment of the radius forwards, and to direct its external border towards the side of pronation. A second cushion, thicker below than above, is to be placed upon the front of the limb, but should not descend below the lower margin of the superior fragment, for otherwise it would, to a certain extent, counteract the influence of the dorsal cushion, and would tend to maintain the displacement backwards of the inferior fragment. An anterior and a posterior splint are then applied, each of which should be at least an inch broader than the forearm; the posterior should extend from the elbow to the fingers, and should be curved from the wrist downwards, to receive the adducted hand; the anterior need not descend below the palm of the hand: a roller is then to be carried round the splints in the ordinary manner.

By constructing and placing the cushions in the manner above described, the two fragments are pressed in opposite directions, and the carpal surface of the inferior fragment is directed forwards, while the curved splint, by maintaining the hand moderately adducted, tends to restore to the articulating surface its natural direction inwards, quite as effectually as the ulnar splint of Dupuytren, and with much less uneasiness to the patient. It is scarcely necessary to mention that the form recommended can be readily given to that portion of the dorsal cushion which corresponds to the lower fragment, by the employment of graduated compresses. The apparatus recommended by Nélaton is very similar to that just described, and is identical with it in principle; the use of the curved dorsal splint, instead of the ulnar splint of Dupuytren, constitutes the only difference of importance. (*On Fractures, &c.* p. 167.) Instead of the ulnar splint, M. Nélaton has since used a dorsal splint, curved at its lower end in the shape of the handle of a pistol, and very similar therefore to that recommended by Mr. Smith.

The splints should be retained for three weeks in young persons, and for four or five in the aged, before passive motion is attempted. The recovery in these cases is slow, and six months will sometimes elapse before the motion of the fingers is completely restored. (See *A. Cooper*, *On Dislocations, &c.* p. 496.)

In the fracture with displacement of the lower fragment forwards, the same principles of treatment will apply; but the position of the pads used to press the ends of the fracture into position, must of course be reversed.]

Fractures of the Carpal and Metacarpal Bones, and Phalanges of the Fingers.

The bones of the carpus, when broken, are usually crushed, as it were, between very heavy bodies, or the limb has been entangled in powerful machinery, or suffered gunshot violence. It must be obvious, therefore, that, as the soft parts are also seriously injured, these cases are generally followed by severe and troublesome symptoms, and sometimes require the performance of amputation, either immediately or subsequently. When an attempt is to be made to save the part, the chief indications are to extract loose pieces of bone, and prevent inflammation, abscesses, and mortification. The parts may at first be kept wet with a cold evaporating lotion, any wound present being lightly and superficially dressed ; but, afterwards, as soon as all tendency to bleeding is over, emollient poultices may be applied over the dressings instead of the lotion. Should abscesses form, early openings should be practised, so as to prevent the matter from extending up the forearm.

Fracture of a *metacarpal bone* may be produced by direct or indirect violence. Fractures caused by striking a blow with the closed fist, or by a fall on the closed hand, are examples of the latter kind. In this case, the third metacarpal bone, from its greater length, is most likely to suffer ; but in a fracture from direct violence, those of the little finger and thumb are more frequently broken than the other three, though, in most cases, unless the force has operated by a very limited surface, more than one metacarpal bone is fractured. The fracture may be simple or compound ; if from direct violence, it is most commonly the latter, and the soft parts are wounded and lacerated by the same violence which has injured the bone. [The upper piece, from its mode of connection with the carpus, is nearly immovable, but the lower fragment may be displaced either towards the dorsal or palmar surface. Most frequently, according to Malgaigne, its fractured extremity forms an angular projection posteriorly, and the head of the bone in consequence is prominent towards the palm.

According to Sir A. Cooper, the head of a metacarpal bone is sometimes broken off, and gives the appearance of dislocation of the finger, as the head of the bone sinks towards the palm of the hand. In the treatment of this case, a large ball is to be placed in the hand, and to be grasped by it, and the hand is to be bound over it by a roller; and thus the depressed extremity of the bone is raised to its natural situation. (*On Dislocations*, p. 506.) The same plan is also recommended for fractures of other parts of the metacarpal bones, but care must be taken lest it increase the tendency to project backwards already alluded to: this evil may be avoided by making the pressure operate upon the head of the metacarpal bone, and not opposite the seat of fracture. If there is no displacement a piece of pasteboard or gutta percha moulded to the hand will be found to answer every purpose. There is no necessity to include the ends of the fingers, and it is better that they should not be kept permanently extended.

In a compound or comminuted fracture, the hand and forearm should be kept at rest on a splint, and treated according to the suggestions above given for fracture of the carpus. In some cases, of course, when the hand is badly crushed, amputation becomes necessary.

Fractures of the phalanges of the fingers are almost always produced by direct violence, and are therefore very frequently compound or comminuted — force applied indirectly is more likely to cause a dislocation than a fracture. In compound fractures of the extreme phalanges, if the soft parts are much injured, it is better to amputate at once, but in the first or second phalanges an attempt should always be made to save the finger, unless the parts are so much injured as to preclude all chance of success. In a simple fracture, the finger should be placed on a small wooden splint; or a piece of wetted pasteboard may be moulded to the part; but in compound fractures, and especially when several fingers are injured, it is better to confine the whole hand on a splint, and to keep the part at rest in a sling.]

Fractures of the Sacrum.

The sacrum is less frequently broken than the other bones of the pelvis ; a fact attributable to its thickness, its spongy texture, and the advantageous way in which it supports the weight and efforts of the whole trunk. For the sacrum to be broken, the violence must be exceedingly great, like that resulting from the fall of a very heavy body, or the passage of a carriage wheel over the convex side of the bone, or a fall from a great height on that part. Fractures of the sacrum, when they do happen, are generally accidents of a most dangerous kind, because, in addition to other injuries, with which they, in common with all fractures of the pelvis, are liable to be complicated, great damage may be done to the sacral nerves. Hence, retention of urine, inability to retain this fluid, involuntary discharge of the fæces, paralysis of the lower extremities, &c. Another principal danger also depends upon the injury which the pelvic viscera may have suffered from the same violence which broke the bone.

When the fracture is situated at the upper part of the sacrum, which seldom happens on account of the thickness of the bone in that situation, there is no displacement unless the bone is smashed, and the fragments are driven inwards by the same force which produced the fracture; a case which always implies severe injury of the external and internal soft parts. But when the fracture is transverse, and occupies the lower portion of the bone, where it is less thick, the inferior fragment may be displaced forwards, towards the rectum. In general, fractures of the higher part of the bone are not easily detected. (See *Boyer*, *Mal. Chir.* t. iii. p. 152.)

[The displacement, according to Malgaigne, is usually such that the inferior fragment remains in contact with the other by its base, but is inclined more or less forward at its apex. The coccyx of course shares in the displacement of the lower portion of the sacrum, and may project forwards sufficiently to cause an obstruction at the lower part of the rectum. (*Traité des Fractures*, t. i. p. 636.) These fractures generally take a transverse direction; there is, however, a specimen of vertical fracture of the sacrum in the Museum of the College of Surgeons.

If the nature of the injury is doubtful, the finger should be introduced into the rectum, when if there is a fracture, an unusual mobility of the coccyx and lower part of the sacrum will probably be felt, and if there is displacement forwards of the lower fragment the finger may be used to press it back into its proper situation.]

When the violence has been such as to make it probable that it has extended its effects to the pelvic viscera, every means in the power of art must be adopted to prevent and allay inflammation. Leeches should be applied to the vicinity of the sacrum, and bleeding from the arm should, if it appears necessary, be practised. Any difficulty, either in the expulsion or retention of the urine and fæces, will likewise claim immediate and constant attention. (See URINE, *Retention of*, *Incontinence of*, *&c.*) With regard to the particular means for promoting the union of the fractured sacrum, quietude is the most important; and is in most cases the only treatment necessary.

[If, however, the lower fragment should project forwards to a painful extent, and appear likely to produce inconvenience, and if, after it has been reduced by the finger in the rectum, the displacement should recur, it might be advisable to apply permanent pressure from within by means of some substance, such as a pessary, introduced into the rectum. Treatment on this principle has been practised in France in two cases, by MM. Judes and Bemond, and with sufficient success to afford encouragement for further trial, should the exigencies of the case seem to require it. (See *Malgaigne,* op. cit. p. 638.) Mild laxative medicines, or enemata, should be given to render the action of the bowels as gentle and free from irritation as possible.]

FRACTURES OF THE OS COCCYGIS.

Though much slighter than the sacrum, it is less frequently broken, because less exposed to external force, and capable of a degree of motion, by which it eludes the effects of violence. But, in elderly persons, in whom the different pieces are connected by ankylosis, a fall on the buttock, or a kick, may fracture this bone. The accident is known by the movableness of the fragments, and the acute pain produced when the thighs are moved, and the act of defæcation, the fragments being then disturbed by the action of the external sphincter, gluteus maximus, and coccygeus.

The treatment of fractures of the coccyx consists in enjoining quietude. If the lower portion of the bone project forwards it may be replaced by the finger introduced into the rectum, but all attempts of this kind should be made with great gentleness, as the soft parts are not in a state to bear much handling without ill effects. The patient should avoid walking about, as this would put the gluteus maximus muscle into action, and disturb the broken bone. He should refrain from lying upon his back, or placing himself in a sitting position.

[The recovery from this accident is sometimes very tedious. Mr. South mentions two cases, in both of which it occupied a period of nearly two years. Great relief was obtained, and a cure at last effected, by constantly wearing a pair of thick oblong pads on the ischial tuberosities, so that the coccyx was protected from all possibility of pressure in the sitting position. (See *Translation of Chelius,* note, p. 543, vol. i.)]

FRACTURES OF THE OSSA INNOMINATA

Are generally produced by the passage of the wheels of heavy carriages over the pelvis, falls from great heights, the kicks of horses, &c., and are always attended with considerable contusion of the soft parts, and sometimes with great injury of the pelvic viscera. The anterior superior spinous process of the ilium is sometimes broken off by the kick of a horse. I have seen several examples of fracture of the pelvis by gunshot, some of which were accompanied by injury of the bladder or rectum.

The two ossa innominata may be broken together; but commonly only one of them is thus injured. Most frequently the fracture takes place in the upper expanded portion of the bone, known under the name of the ilium, though sometimes it happens either in the ischium, or the os pubis. The solution of continuity may be limited to one part of the bone, or extend to several parts of it; and there may be a greater or lesser number of fragments, and these attended, or not, with displacement. In many instances, in which the pelvis has been violently jammed between two bodies, or run over by a heavy carriage, the bones of the pelvis, besides being fractured, are dislocated, some interesting examples of which accident are recorded by Sir A. Cooper. (*Surgical Essays,* part i. p. 49, &c.)

Fractures of the ossa innominata are unavoidably attended with more or less contusion of the soft parts; and when the violence has been very great, the pelvic viscera may be seriously bruised, crushed, or lacerated, and the large nerves contained in the pelvis, or the spinal marrow itself, injured: hence, extravasation of blood or urine in the cellular tissue of the pelvis; ecchymosis deeply situated; injury of the kidneys; complete loss of motion; paralysis of the lower extremities; discharge of blood, or a black bilious matter, by vomiting or stool, either immediately or at more or less distant periods from that of the accident; retention of urine; fever; painful tension of the abdomen from inflammation of the peritoneum and bowels; the formation of abscesses, which are sometimes of great extent; sloughing; and death. (*Boyer*, *Mal. Chir.* t. iii. p. 154.)

As the same author has observed, the violence, occasioning a fracture of the ossa innominata, may produce a displacement of the fragments, and carry them more or less away from their natural situation. When the os pubis, or ischium, is broken, the splinters may be propelled into the urethra, or even through the bladder, and give rise to extravasation of urine; or by merely compressing these organs, they may cause more or less interruption of their functions. But, unless the fragments be displaced by the same force which caused the fracture, they can hardly be drawn out of their place by any other circumstance, since they are retained by the muscles attached to both fragments, and by surrounding ligamentous expansions.

Owing to the deep situation of fractures of the pelvis, and to there being generally no displacement nor mobility of the fragments, the diagnosis is sometimes attended with difficulty. A suspicion of the accident may be entertained when the pelvis has suffered considerable violence, the patient experiences great agony, and all motion of the trunk and lower extremities is difficult and painful. If the fracture should be in the ilium, especially its upper and front portion, or in the os pubis, the mobility of the fragments, or even a crepitus, may be distinguished in a thin subject, if, when he is lying horizontally, with his thighs and legs bent, and his head and chest elevated, the projecting part of the os innominatum be taken hold of, and an attempt be made to move the fragments in opposite directions.

When the fracture is of a part of the os innominatum very deeply placed, and is limited to a single point of the os pubis, or ischium, so that no detached movable fragment has been produced, the exact nature of the case can rarely be made out with certainty, before the patient's death, and the dissection of the parts.

Fractures of the ossa innominata are accompanied with serious danger. When the fragments are displaced, and do not admit of being rectified again, the disorder arising from this cause may have fatal consequences. And, as Boyer observes, even when such displacement does not exist, these fractures are not the less to be apprehended, on account of the injury which the spinal marrow and the nerves, vessels, muscles, and viscera within the pelvis are likely to have sustained. These complications, which are exceedingly frequent, may prove directly fatal, or destroy the patient at a period more or less remote from the time of the accident. One terrible accident of this kind, which happened close to my house at Shepperton, proved fatal in half an hour.

When the pelvic viscera and urethra have escaped injury, a cure of the fracture may be effected by means of rest; a position in which all the chief muscles attached to the pelvis are relaxed; and a roller or T bandage. (*Boyer*, *Mal. Chir.* t. iii. p. 156.) Or the patient may be placed on a double inclined bed; a broad leather bandage may be passed round the pelvis, and buckled firmly in front of it, and the feet secured to the foot-board. (*Earle.*) The grand indication is to obviate the consequences of inflammation of the parts within the pelvis, and even of the peritoneum and abdominal viscera, by copious and repeated blood-letting. Any complaints respecting the evacuation of the urine and fæces must also receive immediate attention. When there is great contusion, and the bones are badly broken, the patient cannot move nor go to stool without suffering the most excruciating pain. To afford some assistance in such circumstances. Boyer, in a particular case, passed a piece of strong girth web under the pelvis, and collecting the corners into one, fastened them to a pulley suspended from the top of the bed. This enabled the patient to raise himself with very little effort, so that a flat vessel could be placed under him. In these and other cases, particularly compound fractures and paralytic affections from diseased vertebræ, the use of a bed constructed on the principles suggested by the late Sir James Earle, is of great service. (See *Obs. on Fractures of the Lower Limbs; to which is added, an Account of a Contrivance to administer Cleanliness and Comfort to the bed ridden.* 1807.) Mr. Earle has also exerted his mechanical ingenuity with great success in the invention of a bed, admirably well calculated for the treatment of fractures, and other cases, in which it is an object of high importance to enable the patient to empty the bowels, without changing his position.

Sometimes, notwithstanding the rigorous adoption of antiphlogistic measures, abscesses cannot be prevented from forming in the pelvis, particularly when there are detached splinters driven inwards. These collections of matter should be opened as soon as a distinct fluctuation can be felt. The splinters may wound the urethra or bladder, and cause an extravasation of urine. Desault extracted a splinter, which had had this effect, from the bottom of a wound made for the discharge of the effused urine. In these cases a catheter should be employed without delay, and kept introduced in order to prevent the urine from collecting in the bladder, and afterwards insinuating itself into the cellular tissue of the pelvis, or even into the cavity of the abdomen. (*Chopart.*) In University College Museum is a specimen of a fracture of the pelvis, which runs through the rami of the ischium and os pubis. The injury caused retention of urine and laceration of the urethra by one of the fragments, followed by fatal extravasation of urine. An interesting case of fracture of the ossa innominata, attended with rupture of the bladder, and followed by fatal peritonitis, has been recorded by Cloquet. (*Nouveau Journ. de Médecine*, Mars 1820). The ossa pubis were forced half an inch from each other. The horizontal branch of the os pubis, and the ascending ramus of the ischium, were broken; the sacrum was dislocated from the ossa ilii, and driven forwards within the cavity of the pelvis. The right sacro-iliac symphysis was broken only at its fore part, and its bones still retained their connection. Vast quantities of blood were found extravasated in the lumbar region and about the pudenda. As soon as the abdomen was opened, three pints of a yellowish fluid, having a urinary smell, immediately gushed out. In this case catheters of various sizes were introduced, even a syringe adapted to them was used, but nothing could be thus drawn off but a few drops of blood.

[The bottom of the acetabulum may be fractured, and the head of the thigh bone driven into the cavity of the pelvis. Sir A. Cooper mentions a case of this kind, the symptoms of which are stated to have resembled those of a dislocation into the sciatic notch. The patient died four days afterwards. (*On Dislocation, &c.* p. 114.) In three or four examples, Dupuytren found the acetabulum fractured and forced inwards by the head of the femur, by a fall on the feet or knees. In the most remarkable of these cases, the uninjured head of the thigh bone had passed entirely into the pelvis; and the neck, which was free from fracture, was so firmly wedged in the opening, that the reduction of this new species of dislocation was exceedingly difficult, even in the dead subject. In children, force, directed against the bottom of the acetabulum, may disjoin the pieces of the os innominatum combining to form it. (See *Dupuytren*, *Clin. Chir.* t. ii. p. 110.) Mr. C. H. Moore has recorded a remarkable case of injury of the pelvis, in which the acetabulum of the left side had been broken into three pieces, corresponding with the primary divisions of the bone, and the head of the femur had passed into the pelvic cavity. There was also fracture of the rami of the pubes and ischium on the opposite side. This patient lived for several years and was able to walk without any very serious lameness. It was found after death that the pelvis had become greatly distorted, but no union had taken place, though there was copious deposit of bone in the neighbourhood of the fracture. (See *Med. Chir. Trans.* vol. xxxi. p. 107.]

In some well marked cases of fracture of the os innominatum, extending into the acetabulum, Mr. Earle found that the symptoms nearly resembled those of fracture of the neck of the femur. Thus, in one example of fracture of the acetabulum in two directions, with an extensive comminuted fracture of the ilium, with some displacement, and a fracture of the os pubis in three places, the patient "had lost all control over the left lower extremity, and could not raise it from the bed. There was no visible shortening of the limb, but the foot was everted. Any attempt to rotate the limb caused great pain, and was accompanied with a very sensible crepitus when the hand was applied over the hip-joint." The trochanter on the injured side was not nearly so prominent as on the sound one, and almost on a level with the anterior superior spinous process of the ilium. The patient recovered from these severe injuries, and after a time died of disease in the chest. The reparation of the fractures was complete.

[In a second case symptoms were observed as nearly as possible similar to the above. Both resembled fracture of the neck of the femur in the loss of power over the limb, the eversion and crepitus, but differed from it in the absence of shortening and in the freedom of motion, especially of abduction, which is always attended with severe pain in fracture of the neck of the femur. (See *Med. Chir. Trans.* vol. xix. p. 249.)]

In University College Museum is a preparation also exemplifying a recovery from an equally severe fracture of the pelvis, implicating the ilium, ramus of the left ischium, and the sacrum. The fractures are all united. In this instance also the loss of prominence of the trochanter, and the freedom of motion of the joint, particularly of abduction, were the most marked symptoms.

[Another instance of this kind, which also survived several years, was observed by M. Morel-Lavallée. This case was treated for fractured neck of the femur, but after death it was found that the acetabulum had been fractured, and that the head of the thigh bone had sunk more than an inch into the pelvis. The fracture was irregularly consolidated. (See *Malgaigne, Traité des Fractures*, vol. ii. p. 881.)

The margin of the acetabulum is sometimes broken off, usually at the upper or posterior part, and if the detached portion be sufficiently large, it may permit a partial dislocation of the head of the femur. Some of the cases of this kind which have been noticed have been in fact dislocations of the hip, complicated with a fracture of the acetabulum; in others, however, the dislocation seems to have been subordinate to, and consequent upon, the fracture, as the ligamentum teres has been found entire. This was the case in one instance recorded by Dr. M'Tyer, and another somewhat similar by Mr. Wormald, has been already alluded to. (See DISLOCATIONS.) The symptoms will be somewhat perplexing. They will resemble for the most part those of dislocation, either on the dorsum ilii or into the sciatic notch, according as it is the upper or the posterior part of the acetabulum which is broken off; but there will be crepitus more or less evident when the limb is moved, the reduction will be accomplished without difficulty, but after reduction the displacement will recur; all of which circumstances happen equally in fracture of the neck of the femur. Two cases related by Dr. M'Tyer were mistaken for fractured neck of the femur, a third case was considered to be a dislocation on account of the difficulty met with in the reduction. (See *Wm. M'Tyer, On Fractures connected with the Hip-Joint; Glasgow Med. Journ.* No. xiii.)

Such cases as these require the greatest circumspection to distinguish them with certainty; if the surgeon can succeed in feeling the head of the bone in its new situation, all doubt will be removed, otherwise the means for arriving at a correct diagnosis are very insufficient.

In the treatment the principal indication is to maintain the reduction of the dislocation while union of the fracture is going on. M. Maisonneuve succeeded in doing so by keeping the limb in a position of extreme abduction, in order to throw the head of the femur against the bottom of the acetabulum, and to prevent it from acting upon the detached fragment of bone. This plan might therefore be tried, but should it prove insufficient, permanent extension of the limb according to the method used in fractures of the thigh should be resorted to.]

FRACTURES OF THE FEMUR.

[Fractures of the femur, like those of the humerus, will require to be subdivided into—1. Fractures of the upper extremity or neck. 2. Fractures of the shaft. 3. Fractures of the lower extremity or condyles.]

1. *Fractures of the Neck of the Femur.*

As this is a subject which has excited considerable discussion, the reader cannot be too particular in noticing that three distinct kinds of fracture, very different in their nature, treatment, and result, were formerly confounded together under the name of "fractures of the neck of the thigh-bone;" for much of the dispute that has prevailed whether these fractures will unite like those of other bones, seems to have proceeded from the three species of fracture not having been properly discriminated. Two of the cases unite by means of callus, like other fractures; but the other, as it usually occurs, is conceived by some surgeons not to admit of a similar mode of union; or, at all events, they declare that such a termination is very difficult to procure. Sir A. Cooper has, therefore, divided these cases, first, into *fractures which happen through the neck of the bone, entirely within the capsular ligament;* being the examples in which a union by bone had not, some years ago, presented itself to his notice: secondly, into fractures through the neck of the bone *at its junction with the trochanter major, which fractures are of course external to the capsular ligament;* thirdly, into *fractures through the trochanter major, beyond its junction with the neck of the bone.* (*On Dislocations, &c.* p. 114—116.) [Sir A. Cooper has also described a fracture of the trochanter major, by which this process is broken off from the rest of the bone, without any further fracture of the neck or shaft.]

Fractures of the neck of the thigh-bone are infinitely more frequent than dislocations at the hip, and may arise from a fall, either upon the great trochanter, the sole of the foot, or the knee.

According to Desault and Dupuytren, the first accident produces the injury much more frequently than the two latter. (*Clin. Chir.* t. ii. p. 90, 93.) The causes are arranged by Dupuytren, according to their greater frequency, as follows: 1. Falls on the great trochanter. 2. Direct violence, as that from gunshot. 3. Falls on the foot or knee. 4. Muscular action, as reported of a negro afflicted with tetanus. Of thirty cases which were seen by Desault, four-and-twenty arose from falls on the side of the pelvis. Sir Astley Cooper observes, that in London the fracture within the capsule is most commonly produced by a person slipping off the edge of the foot-pavement. He admits, however, that the accident is frequently caused by a fall upon the trochanter major. (*Surgical Essays*, part ii. p. 35, 36. Also, *Larrey*, *Journ. Complém.* t. viii. p. 98. 8vo. Paris, 1820.) [It is not improbable that in some of the cases attributed by the French surgeons to falls upon the trochanter, the fall may have been subsequent to the fracture, which was really produced by violence applied to the sole of the foot, or knee.] Dupuytren, and all surgeons of experience, recognise the truth of the remark made by Sir Astley Cooper, namely, that a fracture of the neck of the thigh-bone, within the capsular ligament, seldom happens but at an advanced period of life; and the reason of the facility with which the injury takes place in old persons, he ascribes to the interstitial absorption which that part of the femur undergoes in individuals past a certain age, whereby it becomes shortened and altered in its angle with the shaft of the bone. Dupuytren never had a case of fracture of the neck of the femur in a child, and he notices the great rarity of such an accident in young persons. (See *Clin. Chir.* t. ii. p. 82.) He refers, however, to one example in a boy, aged 15, as recorded by Sabatier. (*Mém. de l'Acad. Royale de Méd.*) Another, I think, has been published by Mr. Stanley. (See *Méd. Chir. Trans.*) Possibly some cases, supposed to have been fractures, might have been separations of the epiphyses. (See *Dupuytren, Clin. Chir.* t. ii. p. 90.) Fractures of the neck of the thigh-bone, within the capsule, are more common in women than men. (*J. Wilson, On the Skeleton, &c.* p. 245. *A. Cooper*, *On Dislocations*, *&c.* p. 122.)

Almost all the patients under Dupuytren, in the Hôtel Dieu, with fractures of the neck of the femur, were more than fifty years of age; and he found the frequency of the accident increase with old age. The reason of the rarity and frequency of the accident at different periods of life, is correctly ascribed by him to the anatomical disposition of the parts, which is not the same in different ages and in both sexes. In childhood the axis of the neck of the thigh-bone approaches that of the shaft; and the great trochanter forms but a slight prominence. Falls on this process were observed by Dupuytren to be the most common cause of the accident; and the frequency of the injury he found to be in a direct ratio to the degree of prominence of the great trochanter, or dependent upon the length of the neck of the bone, and the angle formed by it with the shaft. In children the trochanter projects but little, being concealed under the prominence of the os innominatum. Hence, in falls upon the side of the pelvis, the violence does not operate upon it. Dupuytren notices, in addition to the above facts, the greater flexibility of the neck of the femur in a child; the diminutive breadth of the pelvis; and the abundance of adipose cellular tissue protecting the great trochanter.

In adults under a certain age fracture of the neck of the thigh-bone is rare, yet less so than in children. The phosphate of lime, as Dupuytren observes, has accumulated in the skeleton, though not so copiously as in old subjects; the neck of the femur is much longer; the angle formed with the body considerably more marked; consequently a greater projection of the trochanter, and an increased facility for the operation of the causes productive of fracture of the neck, whether they act from below upwards, or from above downwards. But, as Dupuytren further explains, this length of the neck of the bone, and projection of the great trochanter, differ according to the period of life, the sex, and the individual. In women the neck of the femur is longer, the great trochanter more prominent, and consequently the frequency of fractures of the former parts greater than in men. The bulk and fulness of the muscles, which deaden the effect of falls in male adults, of course lessen the frequency of these fractures in them; while, on the other hand, the accident is common in those male adults whose conformation approximates to that of women in the breadth of the pelvis, the length of the neck of the femur, and the projection of the great trochanter. (See *Dupuytren, Clin. Chir.* t. ii. p. 83—86.)

In advanced life the pelvis retains its extreme width, the great trochanter is prominent, the neck of the femur inclined to a right angle, the organised substance of the bones lessened, and the phosphate of lime so redundant as to render the bones very brittle. These circumstances, together with the diminished quantity of adipose cellular tissue, and the flaccidity and atrophy of the muscles, account for the frequency of the accident in old men.

The division is more frequently transverse than oblique; the neck being sometimes, in the former case, wedged in the body of the bone, as Desault found in several instances; a model of one of which, in wax, is preserved at Paris, and the natural specimen of which was in the possession of Bichat. A fracture of the neck of the thigh-bone is sometimes complicated with one of the trochanter major.

With respect to the diagnosis of a fracture of the neck of the femur, an acute pain is felt, a sudden inability to walk occurs, and the patient cannot raise himself from the ground. The latter circumstance, however, is not invariable. In the fourth vol. of the *Mém. de l'Acad. de Chirurgie*, a case is related in which the patient walked home after the accident, and even got up the next day. Desault published a similar example; and several others fell under the observation of Dupuytren. (See *Clin. Chir.* t. ii. p. 96.) The locking of one end of the fracture in the other affords an explanation of this circumstance.

The diagnosis is not always free from considerable difficulty: some individuals have the rational signs of the accident, and yet are not the subjects of it; while others, who have really encountered it, may not exhibit the symptoms of it. Sometimes a fall producing a contusion of the hip will bear some resemblance to a fracture of the neck of the femur, while the same cause occasioning the latter injury, may not hinder the patient from getting up and walking. Dupuytren concurs with other surgeons in ascribing this fact to the fracture being situated within the capsular ligament, and the fragments not being displaced, but the lower wedged in the upper. Then the circumstances of their becoming separated after a longer or shorter time, and of the fracture then being rendered manifest, he imputes to the fragments changing their situation with respect to one another, either in consequence of the weight of the body, the action of the muscles, or the removal of some portion of the fragments themselves. I think, however, with Mr. R. W. Smith, that it is more frequently owing to the fibrous covering of the neck giving way after a certain time (see *Dubl. Journ. of Med. Science*, vol. vi. p. 213); and his observation seems well founded, that a sudden retraction, at a period more or less remote from the receipt of the injury, denotes a fracture within the capsule. The shortening and rotatory displacement of the limb, arising from the displacement of the fragments, then leave no doubt of the fracture, provided they are connected with no other cause than a fall a few days previously. Sometimes, as Dupuytren adds, the two foregoing signs do not occur till fifty, sixty, or eighty days after the commencement of the treatment by rest and extension, owing to the callus having yielded to the contraction of the muscles or the weight of the trunk. Dupuytren further explains, that the internal fragment may be wedged in the external one, directed either forwards or backwards; that, when it happens, the shortening of the limb is only to the extent that one fragment is impelled into the other; and that this may account, in some cases, for the occasional inversion of the foot, which is an exception to what is usually noticed. (See *Clin. Chir.* t. ii. p. 97—100.)

Another remark made by Dupuytren is perfectly correct, namely, that, when there is displacement, the nature of the accident is easily made out; but that, when no displacement exists, a suspicion may be entertained of the fracture; yet there can be no certainty about it. When the shortening of the limb is only to the extent of a few lines, the discrimination of it from what is produced by the ascent of the pelvis from a contusion, is attended with difficulty; but the diagnosis is plainer if the retraction amounts to half an inch, an inch, or an inch and half, or two or three inches. The latter degrees of shortening rarely occur but consecutively, and when the patient has attempted to walk. (*Dupuytren*, *Clin. Chir.* t. ii. p. 103.)

The dissections made by Dr. Colles led to the discovery, that sometimes the solution of continuity does not extend completely through the neck of the femur. (See *Dublin Hospital Reports*, vol. ii.) Three cases proving this fact are adduced; a fact which at once explains the ability of some patients to walk directly after the injury, and the absence of all retraction of the limb. According to Mr. Amesbury, incomplete oblique fractures of the neck of the femur are easily produced in the recently dead subject. (*On Fractures of the Upper Third of the Thigh-bone*, p. 3.) [See also on this subject, *R. Adams, on Abnormal Conditions of the Hip-joint, in the Cyclopædia of Anatomy and Physiology.* Mr. R. W. Smith, however, expresses considerable doubt as to the reality of a partial fracture of the neck of the femur, and has shown, by actual examination of the specimens, that in *some*, at any rate, of the alleged examples, the fracture of the cervix was complete, and the trochanter likewise broken.]

A shortening of the limb almost always takes place; "the leg becomes," according to Sir Astley Cooper, "in a case of fracture within the capsule, from one to two inches and a half shorter than the other; for the connexion of the trochanter major with the head of the bone, by means of the cervix, being destroyed by the fracture, the trochanter is drawn up by the muscles as high as the ligament will permit, and consequently rests upon the edge of the acetabulum, and upon the ilium above it." (*On Dislocations*, *&c.* p. 117.)

With respect to the degree of retraction specified by Sir Astley Cooper as attendant on fracture of the neck of the femur within the capsular ligament, its correctness is not admitted by some surgeons; Mr. R. W. Smith, of Dublin, declares that it is completely opposed to the result of his experience; nor does he conceive it possible that the capsule of the hip-joint could admit of displacement to the extent of two inches and a half without being extensively torn; an occurrence very rare indeed; and if, as is frequently the case, the fibrous reduplications, which constitute the periosteum of the neck of the bone, remain entire, or nearly so, retraction may be almost completely prevented. In several instances of recent fracture of the neck of the femur within the capsule, Mr. Stanley found this to be the case. (See *Med. Chir. Trans.* vol. xiii.) Mr. R. W. Smith refers also to the statements of Boyer and Earle, in support of the same view; and he adds, "But when the fracture is external to the capsule, there is an opportunity for retraction occurring to its greatest degree: there is, in fact, nothing to prevent the full force of muscular action upon the lower fragment of the bone, while, at the same time, the upper is forced downwards by the weight of the body." (See *Dublin Journ. of Med. Science*, vol. vi. p. 207.)

Mr. Smith excepts from this observation the case in which the upper fragment is driven into the cancellated texture of the lower, the ascent of which is not only prevented, but sometimes the restoration of the limb to its original length. Here the degree of shortening will be much less than what is usually the result of a fracture external to the capsule; and this relative position of the fragments, Mr. Smith conceives, ought to be suspected whenever unusual difficulty is experienced in detecting crepitus, and extending the limb to its original length.

[In the impacted variety of the extracapsular fracture, all the leading symptoms are much less strongly marked than in an ordinary case. Instances have even occurred in which the patient has raised himself from the ground after the fall which caused the fracture, and has walked a considerable distance, bearing his weight upon the injured limb. Such cases have probably not unfrequently been mistaken for mere contusions of the hip, and great care may be required to distinguish them. On close examination, however, some shortening and eversion of the limb may usually be detected.

In the extracapsular fracture, according to Mr. R. W. Smith, whose opinions are founded upon the examination of a large number of specimens, there is always a second fracture traversing some part of the trochanteric region of the femur, and separating either a portion or the whole of the greater trochanter, or the greater and lesser trochanter together. The extracapsular fracture, he thinks, is always in the first instance impacted, and the second lesion of the bone is the necessary result of the forcible impaction of the broken cervix into the shaft of the femur. It depends, he thinks, principally upon the violence with which the injury has been inflicted, whether the neck of the bone shall *remain impacted* or not. If the force has not been very great, the neck of the femur is wedged in between the trochanters, and one or both of these processes are split off from the shaft, while, if the periosteum and surrounding fibrous structures have not been injured, these broken portions of the trochanters are still held firmly in their places, and the impacted cervix does not become loosened; but if the force has been more considerable, the trochanters are not only broken from the shaft of the femur, but are so far displaced and separated from their connexion with the soft parts, that the cavity, into which the superior fragment has been received, is destroyed, and the impacted cervix, thus set free, no longer opposes the ascent of the inferior fragment, and the case then presents the character of the ordinary extra-capsular fracture, with great shortening of the limb. (*R. W. Smith, On Fractures, &c.* p. 17. Dublin, 1847.)

Impaction may occur in the intracapsular as well as in the extracapsular fracture, though it is not so frequent as in the latter case, and it is, as Mr. R. W. Smith describes it, a dovetailing together of the fragments, rather than a true impaction, which usually takes place. In all the examples which he has examined, the head of the bone appeared sunk below its natural level, and the upper margin of the head was buried in the cancellated tissue of the neck, while the lower margin of the neck penetrated the reticular structure of the head of the bone. These are precisely the cases in which the very rare event of union by bone is most likely to occur.]

In general, the degree of shortening when the fracture is within the capsule, I believe, with Mr. Smith and others, often depends upon the extent to which the fibrous reduplications have been torn. According to this gentleman's investigations, the degree of shortening, when the fracture is within the capsular ligament, varies from a quarter of an inch to one inch; when external to the capsule, from one inch and a half to two inches and a half. At the same time, the great differences in the direction of the solution of continuity must have, as Dupuytren has admirably explained, vast influence upon the degree of retraction, as well as upon the rotatory displacement of the limb. (See *Clin. Chir.* t. ii. p. 113.)

The action of the muscles drawing upward the lower end of the fracture, and the weight of the trunk in propelling downward the pelvis and upper end of the fracture, are the two causes of the shortening of the limb. In general a slight effort suffices for the restoration of the natural length of the limb; but the shortness recurs almost as soon as the extension ceases. "This evidence of the nature of the accident continues," as Sir A. Cooper correctly remarks, "until the muscles acquire a fixed contraction which enables them to resist any extension which is not of the most powerful kind." (*Surgical Essays*, part ii. p. 31.) Goursault, Sabatier, and Dupuytren found that sometimes the shortening of the member did not take place till a long while after the accident. Dupuytren refers to examples in which several hours, and even from two to thirty days, elapsed, before any displacement of the fragments took place, and which was then produced either by the patient's own movements, or by the surgeon's examination of the part. (*Clin. Chir.* t. ii. p. 96.) In opposition to the common belief that the limb is shortened, Baron Larrey asserts that the member is at first actually lengthened. (*Journ. Complém.* t. viii. p. 99.) This statement I have never seen confirmed, and it is contradicted by daily experience. And, to prove how widely Larrey differs from Sir A. Cooper, the following passage will suffice. "In order to form a still more decided judgment of this accident (says the latter writer), after the patient has been examined in a recumbent posture, let him be directed to stand by his bedside, supported by an assistant, so as to bear his weight upon the sound limb. Immediately he does this the surgeon observes most distinctly the shortened state of the injured leg, the toes resting on the ground, but the heel not reaching it, the everted foot and knee, and the diminished prominence of the hip." (*Surgical Essays,* part ii. p. 34.) The lessened projection of the trochanter major arises from its not being supported by the neck of the bone, as it always is in the natural state of the parts. A swelling is observable at the upper and front part of the thigh, always proportioned to the retraction, of which it appears to be an effect.

The projection of the great trochanter is almost effaced. Directed upwards and backwards, this eminence becomes approximated to the crest of the ilium; but, if pushed in the opposite direction, it readily yields; and when it has arrived at its natural level, the patient becomes capable of moving his thigh.

The knee is a little bent. Abduction of the limb always occasions acute pain, and it is noticed by Sir A. Cooper, that the rotation inwards is particularly painful, because the broken extremity of the bone then rubs against the capsular ligament. (Vol. cit. p. 33.) If, while the hand is placed on the great trochanter, the limb is rotated on its axis, this bony projection may be felt revolving on itself, as on a pivot, instead of describing, as in the natural state, the segment of a circle, of which the neck of the femur is the radius. This symptom, which was first particularly noticed by Desault, is very manifest when the fracture is situated at the base of the neck; less so when at its middle; and it is not very perceptible when the breach is near the head of the bone. In the rotatory motions, the lower fragment rubbing against the upper one, produces a distinct crepitus, which, however, is not an invariable symptom. In fact, as Sir A. Cooper has explained, it is not discoverable while the patient is lying upon his back with the limb shortened; but if the leg be drawn down so as to bring the limbs to the same length, and rotation be then performed, especially inwards, the crepitus is sometimes observed, in consequence of the broken ends of the bone being thus brought into contact. (*On Dislocations*, &c. p. 121.)

It appears to Mr. Amesbury that the head of the bone moves so readily in the acetabulum, "that the least impetus, even through the periosteum and reflected membrane (supposing them to be entire) will cause it to move simultaneously with the shaft; and, if it should do so in the same relative proportion, crepitus cannot be felt. If crepitus be not elicited by bending the limb upon the pelvis, the surgeon may try to produce it by causing the limb to be *gently rotated* while he endeavours to fix the head of the bone by pressing it with his fingers back against the acetabulum." (*On Fractures of the Upper Third of the Thigh-bone*, p. 15.) [It should be remembered, however, that mischief may arise from too great anxiety to obtain the evidence of crepitus, for the fibrous reduplications which are reflected upon the neck of the bone from the insertion of the capsular ligament, and which sometimes remain entire, and are of great service in preventing displacement, may be ruptured by the attempts to communicate rotatory movements to the limb.]

The toes are usually turned outward; a position which Sabatier considers as the inevitable effect of the fracture, though Paré and Petit noticed that it did not constantly occur. Two cases adduced by these illustrious surgeons were not credited by M. Louis; but the experience of Desault fully confirmed the possibility of inversion of the limb. As Sir A. Cooper has remarked, three or four hours generally elapse before the turning of the limb outward is rendered most obvious by the fixed contraction of the muscles. (*Surgical Essays*, part ii. p. 32.) The inversion of the limb, however, in fractures of the neck of the femur, is rare; Dupuytren, in his immense practice, never having seen it but once or twice. (*Clin. Chir.* t. ii. p. 105.) Mr. R. W. Smith has met with three cases, in one of which the injury was within the capsule. (*Dub. Journ. of Med. Science*, vol. vi. p. 215.)

Mr. Langstaff dissected a case in which the great toe was in the first instance everted, but subsequently turned inwards when the patient began to use the limb. The preparation shows the fracture to have been within the capsular ligament, close to the head of the bone, and gives a decided refutation to the opinion of the length of the broken portion attached to the trochanter being the cause of the inversion, inasmuch as this part has been removed by absorption. The point of the foot was everted, whilst it retained its proper length, and only became inverted by a wise provision of nature to assist progression after it had begun to be shortened. This circumstance was illustrated in the person of Henry West, a boy from whom Mr. White, of the Westminster Hospital, removed the head, neck, and part of the trochanter of the left thigh-bone, in consequence of scrofulous disease of the hip-joint, attended by abscess. He recovered after the removal of the bone. The thigh was three inches and a half shorter than the other, and the toes turned inwards, not only in walking, but when he lay on his back in a quiescent posture, or prepared for sleep. (*Guthrie, Med. Chir. Trans.* vol. xiii. p. 109.) The possibility of the foot being turned inwards directly after the accident, is the subject that now more immediately interests us. Of this occurrence an example is reported by Mr. Stanley. "A middle-aged man fell in the street, and his hip struck the curb-stone. The immediate consequences were, that the limb was inverted and shortened to the extent of an inch, and no crepitus could be discovered. It was presumed that a dislocation had occurred, and accordingly an extension of the limb was made; and so great was the constitutional irritation occasioned by the repeated trials to reduce the supposed dislocation, that the man died about five months from the time of the accident. In the dissection of the hip a fracture was found, extending obliquely through the middle of the neck of the femur, but *entirely within the capsule.* A portion of fibrous and synovial membrane on the anterior side of the neck of the bone had escaped laceration."—"In a male subject that had been brought for dissection, it was observed that the left lower extremity was turned inwards and considerably shortened. On examining the hip a fracture was found extending through the neck and shaft of the femur. The neck had been broken at its junction with the shaft, and a fracture had extended from the upper part of the trochanter major downwards at the posterior side of the femur, a little below the trochanter minor. The upper part of the shaft was thus split into two portions, one of which was of sufficient magnitude to include the trochanter minor and nearly the whole of the trochanter major.

"In the two last cases, it may be asked, to what cause the inversion of the limb should be attributed? Whether to the direction of the fracture? If not, whether there be any other circumstance adequate to its explanation? In the instance of fracture within the capsule, the portion of the synovial and fibrous membrane which had escaped laceration on the anterior side of the neck of the bone might probably prevent the limb from being turned outwards; but (says Mr. Stanley) why it should have been turned inwards, I confess myself unable to explain. In the instance of fracture without the capsule, by considering the direction of the fracture, in reference to the attachments of the muscles, we obtain an explanation of both points. For, as nearly the whole of the muscles that rotate the thigh outwards were connected with the separated portion of bone, they must have ceased to influence the limb in one direction, and of course have left their antagonists at liberty to turn it in the other; and the fractured surfaces being permitted to unite, without any change in the position of the limb, the inversion would become permanent." (*Med. Chir. Trans.* vol. xiii. p. 508.) Respecting one part of this statement, I think with Mr. Smith (*Dub. Journ. &c.* vol. vi. p. 215), that the circumstance of the fibrous membrane remaining entire upon the front of the neck of the bone, would scarcely account for the limb not being everted. Another explanation of the cause of the inversion of the foot in certain fractures on the outside of the capsular ligament has been given by Mr. Guthrie. "When (says he) the fracture has taken place in such a manner as to be external to the insertion of these rotators outwards, yet sufficiently within the insertion of the glutæus medius and minimus, so as not to deprive them of their due action, the toe will be turned inwards, and must always be so; or remain without any alteration of position, according to certain variations in the inclination of the fracture, affecting the power of these muscles." In the instance recorded by Mr. Guthrie, the little trochanter was broken off; but whether it be an essential complication, he conceives, must be determined by future observation. (Vol. cit. p. 112.) The principles on which this gentleman founds his explanation have since been corroborated by the particulars of a case that was examined by Mr. Syme. (See *Edin. Med. Journ.* April 1826.) The reason of the foot being occasionally inverted, even when the fracture is quite within the capsular ligament, still remains, however, a point in surgery requiring explanation. The eversion or inversion of the limb, Dupuytren ascribes to the obliquity of the fragments. If the internal fragment is carried backward, and the external one forward, then, says he, eversion will take place; but on the contrary, if the fracture be oblique in the inverse direction, there will be inversion of the limb. (*Clin. Chir.* t. ii. p. 109.)

[Mr. R. W. Smith is of opinion that the occasional occurrence of inversion should be ascribed rather to the relative position of the fragments than to the action of those muscles which rotate inwards; for the rotators outwards, whose influence the fracture does not affect, still preponderate over their antagonists. In every case of fracture, accompanied by inversion of the foot, which he has had an opportunity of examining after death, *the inferior has been placed in front of the superior fragment.* Cruveilhier also has recorded a case of fracture with inversion, in which, after death, this relative position of the fragments was found. This is in contradiction to the opinion of Dupuytren above quoted; but, as Mr. Smith explains, it is probable that this surgeon's views have been misstated by the editors of the *Leçons Orales,* and that his real opinion was, as stated by Sanson, that inversion of the foot occurred when the lower fragment was placed in front of the superior. Inversion of the foot has been noticed both in the intra-capsular and in the extra-capsular fracture, but it appears to be most frequent in the latter variety. Mr. R. W. Smith states that he has met with seven examples of inversion, and in five of these the fracture was external to the capsular ligament.]

Mr. Porter had an opportunity of dissecting the hip-joint, in a case where the patient, an old female, died the day after the accident. When first brought to the hospital, she could bend the knee and draw up the foot by the action of the muscles of the limb alone. Afterwards she lost this power. The limb was not shorter than the other; neither was the toe everted. At the post-mortem examination the limb was from a quarter to half an inch shorter than the other, and "the foot was in a state of semi-eversion." The capsule was found perfect, and, on dividing it posteriorly, a transverse fracture of the neck of the femur was detected close to the head of the bone, and, of course, entirely within the capsule. The fragments were but little displaced, *being held together by the synovial membrane and periosteum.* These latter were partially detached, and a portion of the lower surface of the neck of the bone denuded; but the fibres, removed from the bone, were gathered together into a bundle, forming a kind of ligament of a triangular shape; the base being at the edge of the head, the apex at the point of reflexion of the synovial membrane on the capsule. *This appeared to be very tense and strong, and made considerable resistance to a separation of the fragments.* "This case is interesting, as proving that in fractures completely within the capsule the limb is not at all, or but slightly, shortened; and that the chief obstacle to such shortening is the periosteum of the neck, and the reflected synovial membrane." (*W. H. Porter*, in *Dub. Journ. of Med. Science,* vol. x. p. 243.)

The dislocation upon the dorsum of the ilium, that into the sciatic notch, and fracture of the neck of the femur, *attended with inversion of the foot,* are to be distinguished from each other, according to Mr. Guthrie, by comparison, or a due estimate of the degree of inversion. In the first case the inversion is complete, the great toe resting against the instep of the opposite foot; in the second, it is less complete, the great toe resting against the ball of the corresponding toe of the opposite foot; and in the third, it is still less complete. And, as Mr. R. W. Smith justly observes, the nature of the injury is rendered still more evident by observing the facility with which, in the case of fracture, the foot may be everted, the thigh flexed upon the abdomen, and the limb restored to its natural length by extension; and comparing its free, loose, powerless condition with its almost immovably fixed state in dislocation. (See *Dub. Journ. of Med. Science,* vol. vi. p. 218.) [The accident most liable to be confounded with dislocation upon the dorsum ilii, is fracture of the neck of the femur, with inversion of the foot, especially if it is combined with fracture of the trochanters, which is almost invariably the case in the extracapsular variety. A direct source of mistake may then arise from the positive resemblance of the fractured portion of the trochanter to the head of the femur, the former occupying the same place as the latter would do in dislocation. (*R. W. Smith, On Dislocations, &c.* p. 23.)]

The ordinary position of the toes outward is commonly, and I believe correctly, imputed to the action of the rotator muscles, and the adductors. Bichat conceived, however, that if this doctrine were true, such position ought always to exist; and he reminds us that all the muscles which proceed from the pelvis to the trochanter and upper part of the outer fragment, are, with the exception of the quadratus, in a state of relaxation, by the approximation of the femur to their point of insertion; and that the contracted muscles would not allow the foot to be so easily turned inward again. Hence Bichat thought it probable that the weight of the foot itself might pull the limb into the position in which it is commonly found. On the other hand, it is remarked by Sir A. Cooper that any one may satisfy himself that the rotation of the limb outwards is in part owing to the muscles, by feeling the resistance which is made to rotation inwards, which resistance, however, he thinks may in some measure depend upon the length of the portion of the neck of the femur, which remains attached to the trochanter major, and rests against the ilium. (*Surgical Essays*, part ii. p. 32.)

In addition to the foregoing observations respecting the diagnosis, it is to be remembered, that a fracture within the capsular ligament seldom happens but at an advanced period of life, and is much more frequent in women than men. (*Sir A. Cooper, On Dislocations, &c.* p. 123.)

The observations of Boyer, R. W. Smith, Porter, and others, prove that a fracture of the neck of the thigh-bone, on the outside of the capsular ligament, is attended with a greater shortening of the limb than a fracture within it. A fracture on the outside of the capsule is frequently met with in persons under fifty, though it may and often does occur in older subjects. Also, while the fracture within the capsule takes place from very slight causes, this is generally the result of great violence, severe blows, falls, and the passage of heavy carriages over the pelvis. The crepitus can be easily felt, without previously drawing down the limb, and the case is characterised by greater suffering than what is usually noticed when the fracture is within the capsule. But the most important circumstance in which a fracture on the outside of the capsule differs from one within it, is in its readily admitting of bony union, which it is much more difficult to accomplish in the latter case. (See *Sir A. Cooper, On Dislocations, &c.* p. 185, &c.)

Many years ago it was supposed that fractures of the neck of the thigh-bone could not be cured without some shortening of the limb, and lameness. Ludwig, Sabatier, and Louis, broached this doctrine, and imputed the circumstance to the destruction of the neck of the bone. That this commonly happens, has been well ascertained. In several specimens which Mr. Crosse examined in different museums at Paris, whether imperfect union, or no union at all, had followed the fracture, this absorption of the neck of the bone had taken place to a great extent, and in some to so great an extent, that the articulating surface of the bone which plays in the acetabulum, rested between the trochanters consolidated to the body of the bone by ligamentous union, and the thickening of the surrounding parts, whilst all the intervening neck of the bone was absorbed. (See *Sketches of the Medical Schools of Paris, by J. G. Crosse*, p. 90.) M. Roux has also nearly always found the neck of the femur shortened and deformed after its reunion. (*Parallèle de la Chir. Angloise avec la Chir. Françoise*, p. 178.) The specimens in the museum of University College exhibit the usual disappearance of more or less of the same part. Desault, however, in his practice, is said to have rarely met with instances of lameness from such a cause.

A question formerly much agitated (see *Earle's Practical Obs. in Surgery*, Lond. 1823; and *Amesbury's Obs. on the Nature and Treatment of Fractures of the Upper Third of the Thigh-bone, &c.* Lond. 1829, ed. 2) was, whether reunion by bone ever follows *cases in which the fracture is entirely within the capsule*, and the head of the bone insulated, except at its attachment to the acetabulum by the round ligament? Many years ago the decision of the French surgeons was in the affirmative, and they believed the fact to be actually demonstrated by preparations in their museums. M. Roux sent a specimen to Sir A. Cooper, with the hope of producing conviction; but this eminent surgeon was not satisfied with the evidence, because the traces of reunion in that preparation appeared to him to indicate a sort of fracture, where the internal fragment still retained some connexion with the capsular ligament. (*Roux, Parallèle de la Chirurgie Angloise, &c.* p. 179, 180.) In fact, it was a case in which the fracture happened at the junction of the cervix with the trochanter. Sir A. Cooper never denied the possibility of what M. Roux and others alleged, but only stated, that in all the examinations which he had then made of *transverse fractures of the cervix femoris, within the capsular ligament, he had never met with a bony union, or with any which did not admit of motion of one bone upon the other.* (*Surgical Essays*, part ii. p. 39.) Since that period, however, Sir Astley Cooper has satisfied himself that osseous union sometimes takes place, and he has in his own collection a most unequivocal specimen of it, which he was kind enough to show to me about two years ago. The possibility of bony union is now universally acknowledged; but the cure in this way is far less frequent than that by means of a ligamentous connexion. Sir Astley Cooper ascribes the common want of bony union to the fragments not being in contact, and duly pressed against each other, and to the little action in the head of the bone separated from the cervix, "its life being supported solely by the ligamentum teres, which has some few vessels ramifying from it to the head of the bone." These vessels, though neither large nor numerous, may yet, according to Amesbury and Dupuytren, be adequate to the nutrition of the upper fragment. Besides, it is observed by Dupuytren that the synovial membrane, which invests the cartilage, forms a little cul-de-sac at its base, and is distinctly covered by portions of reddish cellular tissue, in which there are many vessels. (See *Clin. Chir.* t. ii. p. 118.) Mr. Mayo gives two cases exemplifying the appearances usually found on dissection; and observes, "there are features in them which make it sufficiently clear that the absence of bony union does not result from imperfect nutrition, or inadequate supply of blood to the separated portion." (*Outlines of Human Pathology*, p. 9.) This gentleman concurs with Dupuytren, Cruveilhier, and others, that in the union of the shafts of long bones, the surrounding tissues take a prominent part in the act of reparation. But in the fracture of the neck of the thigh-bone within the capsule, these tissues are excluded by the untorn synovial and capsular membranes from communicating with the fracture. "They are sometimes, indeed, seen to make the ordinary effort towards reparation of the adjacent fracture. Thus, a portion of an ossified provisional callus is often met with external to the attachment of the capsular membrane to the neck of the femur. But the effort is ineffectual; the callus cannot reach the fracture, whether it remains entirely disunited or is glued together by an exudation from the ends of the broken bone. In the cases in which union takes place (continues Mr. Mayo), I believe the process of ossification to be extremely slow. Such instances occur in those only who are not greatly advanced in life at the time of the fracture; and in whom, through the care with which the joint is kept at rest, direct union by soft substance takes place between the separated portions." (*Mayo*, ib.) [The impossibility of keeping the part at rest has probably much more to do with causing the non-union than the exclusion of the surrounding tissues. If the ends of the fracture could be maintained in continued and immoveable contact, they would, except in the very old and feeble, possess in themselves sufficient vitality for their re-union; and probably the only cases in which union has been effected, are those in which this contact has been secured, either by impaction or by the non-laceration of the fibrous covering of the neck.] For the particular appearances found in the dissection of many of these cases, I must refer to the statements of Dr. Colles (*Dublin Hospital Reports*, vol. ii.), and to Sir Astley Cooper's own account, from which it seems that in most instances "where no ossific union is produced, nature makes slight attempts for its production upon the neck of the bone, and upon the trochanter major, but scarcely any upon the head of the bone; and that, if any union is produced, it is by ligament only." (Vol. cit. p. 46. Also, *Mayo's Outlines of Human Pathology*, p. 9.) Mr. Wilson's observations are all in support of the same explanation (*On the Skeleton*, p. 247); and he adverts to two preparations in the museum of the College of Surgeons, which were supposed to be proofs of a bony reunion of the neck of the femur, subsequently to a fracture within the capsular ligament; but (says Mr. Wilson) "I have very attentively examined these two preparations, and cannot perceive one decisive proof in either of the bone having been actually fractured." One of these cases was published by Mr. Liston, in the *Edin. Med. and Surgical Journ.* Lastly, Dr. Colles of Dublin dissected several cases in which the neck of the femur had been broken: in one, where the injury was within the capsular ligament, "no effort of nature had been made to create a reunion between the two pieces of the fracture, and *the stability of the limb had depended upon the strength of those ligamentous bands by which each piece was connected with the capsular ligament of the joint, aided, no doubt, by the extraordinary thickness which the capsular ligament had acquired.*" (*Dublin Hospital Reports*, vol. ii. p. 336.) In the two first instances reported by this author, "The broken surfaces moved on each other, and were converted into a state approaching to ivory. No attempt had been made to reunite the fracture, and the pieces of bone were held in apposition only by new ligamentous productions from the capsular ligament, which were inserted into the external surfaces of each piece. In No. 3 there had been a slight attempt made at reunion. In Nos. 7, 8, and 9 we observed *a phenomenon, which*, I believe, *is now for the first time mentioned, a fracture of only part of the bone.* No. 6 presented us with that mode of reunion, which some have supposed the most perfect of which this fracture is susceptible; while Nos. 10 and 11 exhibit a mode of reunion very little inferior to callus in point of firmness, but very different in its nature, and which, I conceive, is peculiar to the fracture of the neck of the femur." Dr. Colles also found that in all these cases (except, perhaps, No. 5) the *capsular ligament was not lacerated.* In every instance, however, there was an *increased thickness of the capsule*, and *a removal of all*, or *the greater part, of the neck of the bone.* "Although the ligamentous bands seem, in a majority of instances, to have proceeded from the capsular ligament, yet it is evident from No. 6 that these may arise merely from the broken surfaces of the bone; for in this case not a single fibre was attached to the capsular ligament, the new bond of union being covered by the reflected portion of the synovial membrane or periosteum of the neck. We have an illustration of this in Ruysch, tab. 1. Thes. 9." In Nos. 10 and 11 the fragments were united by a cartilaginous substance. In Nos. 7, 8, and 9 the unbroken portion of the neck was so softened, that it more resembled cartilage than bone, and in this state "it was laid down upon the fractured surface, and united to it." (*Dr. Colles*, in *Dublin Hospital Reports*, vol. ii. p. 353—355.) In the museums at Paris are some preparations which the professors used to exhibit at their lectures, in order to prove that bony union may succeed a fracture within the capsule. These specimens were carefully examined by Mr. Crosse, but none of them proved to him that bony union ever follows where the head of the bone becomes insulated, excepting at its attachment to the pelvis by the ligamentum teres. (*Sketches of the Medical Schools at Paris*, p. 93.) On the other hand, Boyer observes, that experience fully proves the possibility of uniting such fractures of the neck of the thigh-bone as are situated within the capsular ligament; but he acknowledges that there are certain circumstances which may prevent this desirable event. "From all that has been hitherto said on the prognosis of a fracture of the neck of the femur, we may conclude (says Boyer) that this fracture is more serious than that of any other part of the same bone, because the difficulty of keeping it reduced is greater: that it may in general be reunited, especially in young healthy subjects (in whom, however, be it observed, the accident hardly ever occurs); but more easily when it is situated near the base of the neck than near the head of the bone: that the languid vitality of one of the fragments, and the impossibility of ascertaining whether the coaptation be exact, make the cure slow, and the time necessary for their consolidation uncertain: that the neglect of means adapted to maintaining the limb in its proper length and natural straightness, and the fragments sufficiently motionless, may cause them to unite by an intermediate substance. Lastly, that the situation of the fracture near the head of the femur; *the complete laceration of the elongation of the capsule investing the neck of the bone;* the great age of the patient; and, particularly, the constitution labouring under some diathesis which affects the osseous system; may render the cure absolutely impossible; *that in this circumstance one of the fragments is more or less destroyed by the friction of the other against it*, and in the joint a disease is formed, which tends to carry off the patient." (*Mal. Chir.* t. iii. p. 284.) Boyer lays much stress on the complete laceration of the continuation of the capsule over the neck of the bone, as an occurrence preventive of union. But he thinks it does not frequently happen, because the capsular ligament hinders much displacement of the fragment. (Op. cit. p. 278.) As for Baron Larrey, he entertains no doubt of the possibility of uniting fractures of the neck of the femur within the capsular ligament, and concludes his tract on this subject with the case of General Fririon, who was perfectly cured after an injury of this description. (See *Journ. Complém.* t. viii. p. 148.)

After the very numerous and careful dissections performed by Sir A. Cooper and Dr. Colles, with the view of ascertaining the state of the joint after fractures of the neck of the thigh-bone, little doubt can be entertained that where the fracture is *transverse*, and *within the capsular ligament, a bony reunion, though not impossible, is at least so rare an occurrence as not to be calculated upon.* Those who look upon it as a thing more frequent and easy of accomplishment, have probably not duly discriminated from the foregoing kind of case either fractures extending more or less in the direction of the axis of the neck of the bone, or other fractures external to the capsular ligament. How much, however, the safety of a practitioner's reputation will depend upon the prognosis which is given, must be quite evident; for in *the transverse fracture within the capsule, lameness is almost sure to follow, though its degree cannot at first be exactly estimated.* (*Sir A. Cooper*, *Surgical Essays*, part ii. p. 51.)

So far as I am able to judge, Sir Astley Cooper has been the means of introducing a great deal of discrimination into this subject, and, without his able exertions, the important differences in the nature, symptoms, and curableness of the various kinds of fractures of the neck and upper part of the thigh-bone, depending upon their exact situation and direction, might yet have continued very imperfectly comprehended. This remark is made without any intention of deducting from the merits of Desault, Platner, and Mr. John Bell, all of whom long ago expressed their opinion, which, as we know, extends rather beyond the bounds of accuracy, that a fracture within the capsular ligament would not admit of union by callus. (*C. Bell*, *On Injuries of the Spine and Thigh-Bone*, 4to. Lond. 1824, p. 52, &c.)

Mr. Amesbury believes that all fractures of the neck of the thigh-bone admit of union, whether they be situated quite within the capsular ligament or not, and whether the reflected portion of that ligament be ruptured or not; and he ascribes the usual want of success, not to the nature of the injury, nor to the insufficient circulation in the pelvic portion of the bone, but to the imperfection of the mechanical means employed in the treatment. As, however, the important point under consideration, namely, whether transverse fractures of the neck of the femur, situated entirely within the capsular ligament, admit of bony union, is one that can only be determined by experience, Mr. Amesbury follows up his arguments by a reference to several cases.

The first case adduced was under the care of Mr. Cribbe of Holborn, and is described by Mr. Langstaff, who has the preparation: "The woman was about fifty years of age when the accident occurred. The foot was everted, and there was shortening of the limb at this time; and, after death, it was shorter than the other full two inches and a half. She was confined to bed nearly twelve months: during the remainder of her life, which was ten years, she walked with crutches. This (says Mr. Langstaff, alluding to the preparation) is a specimen of fracture of the neck of the thigh-bone within the capsular ligament: the principal part of the neck is absorbed; the head and remaining portion of the neck were united principally by bone, and partly by a cartilaginous substance. The capsular ligament was immensely thickened, and embraced the joint very closely. The cartilaginous covering of the head of the bone and acetabulum had suffered partial absorption; the internal surface of the capsular ligament was coated with lymph. On making a section of the bone, it was evident that there had been *a fracture of the neck within the capsular ligament, and that union had taken place by osseous and cartilaginous media.*" (See *Med. Chir. Trans.* vol. xiii.) Mr. Amesbury then adverts to Dr. Brulatour's case, reported in the same volume of the latter work. The patient, Dr. James, died about nine months after the injury. The following appearances presented themselves. 1. The capsule a little thickened. 2. The cotyloid cavity sound. 3. The interarticular ligament in a natural state. 4. The neck of the femur shortened: from the bottom of the head to the top of the great trochanter was only four lines, and from the same point to the top of the small trochanter six lines. 5. An unequal line surrounded the neck, denoting the direction of the fracture. 6. At the bottom of the head of the femur, and at the external and posterior part, a considerable bony deposit had taken place. A section of the bone was made in a line drawn from the centre of the head of the femur to the bottom of the great trochanter, so as perfectly to expose the callus. The line of bone, indicated by the callus, was smooth and polished as ivory. The line of callus denoted also that the bottom of the head of the femur had been broken at its superior and posterior parts.

In another example, communicated to Mr. Amesbury by Mr. Chorley of Leeds, a gentleman died twelve months after the accident, and, on examining the hip, the synovial covering was found united with the shortened neck of the bone nearly at the head. Here nature had also thrown out broad ligamentous bands, one on each side of the joint. They were firmly united to the head of the bone. When the soft parts had been removed, the head of the bone was seen depressed in a line with the shaft. The fracture was slightly oblique, commencing at the upper part close against the cartilaginous covering of the head of the bone, and extending downward and outward, so as to terminate in a point at the lower surface of the neck, one inch from the cartilaginous covering of the head. The posterior surface of the shell of the neck had the appearance of having been splintered, so as to make a part of the fractured end of the pelvic portion extend in one situation a little on the outside of the capsular ligament, and where no union had taken place.

In a fourth instance, where the necks of both thigh-bones had been broken at different periods, the parts were examined after the patient's decease. On the right side, the fracture extended through the neck of the bone, in a direction downward and outward. In one part a portion of the reflected membrane remained entire; but was separated from the neck of the bone in such a manner as not to prevent the retraction of the limb. The head of the bone was somewhat excavated; and that portion of the neck attached to the trochanter was partially absorbed. There was no soft substance between the surfaces of the fracture. A bond of union, however, consisting of fibrinous matter, adhered to the sides of the ends of the fracture, and in one part it was strong. No surgical attempt had been made to unite the fracture on the right side. On the left, the neck of the bone had been broken within the capsule, and was firmly united. The cervix was nearly absorbed; and the head was depressed, so as to come within about two lines of the trochanter minor, to which it was united at its base by a small short process of bone. Strong bands of ligament were seen connecting the pelvic portion of bone to the capsule, which had become thickened, and much smaller than natural. There had been a longitudinal fracture of the trochanter major, but quite independent of the injury of the cervix. The fracture of the latter part was united with the head, about two inches and a half below its natural situation; which leads Mr. Amesbury to believe, that what he terms the close coverings of the neck of the bone had been nearly or quite divided. A longitudinal section of the head and neck of the bone showed that the fracture had taken place close to the head. The uniting callus had become cancellated; but he says that the direction of the fracture could be seen "by the situation of the trochanteral portion of the neck, when examined in different parts of its circumference." (See *Amesbury, On Fractures, &c.* p. 43, &c.)

These, and other cases and dissections, sufficiently establish the possibility of bony union in fractures entirely within the capsular ligament. But this is not the ordinary mode of union; and no doubt is now entertained about many preparations, exhibited as specimens of it, not being good and authentic ones. The rapidity with which absorption proceeds in the head and neck of the thigh-bone after fractures, brings about such changes as must soon greatly obscure the exact original situation and direction of the injury, and particularly the question, whether the injury reached also to the outside of the capsular ligament. That fractures extending beyond the capsular ligament may be united by bone, is admitted by all parties, as well as the fact that those entirely within the capsule are often united with the intervention of fibrous or ligamentous bands. In confirmation of this circumstance, I have already cited the dissections performed by Dr. Colles of Dublin; and, in further proof of it, I refer to the preparations in the museum of the College of Surgeons at Edinburgh, as specified by Mr. B. Bell of that city. (*On Diseases of the Bones*, p. 205, &c. 1828.)

[For an interesting account of several cases of real or supposed osseous union of intra-capsular fractures occurring in the practice of American surgeons, with an impartial discussion of the merits of each example, see *Treatise on Fractures and Dislocations, by Dr. F. H. Hamilton of Buffalo.* Philadelphia. 1860.

The union of fractures external to the capsule is usually attended with very abundant and irregular osseous deposits. These deposits encircle the neck of the femur to a variable extent, but are usually found in greatest quantity along the posterior inter-trochanteric line, though sometimes they are also deposited freely along the anterior line. Mr. R. W. Smith believes the object of their formation is the union of the fracture traversing the inter-trochanteric space, and he states that they are usually proportionate to the amount of injury which the trochanters have suffered. When the trochanter major is merely split or fissured, its fibrous coverings remaining entire, the quantity of new bone is exceedingly small; while it is abundant when a large proportion of the trochanters is broken off and displaced, in consequence of the laceration of the fibrous tissues which invest this region; and it is especially exuberant when the trochanters are comminuted and the fragments displaced, both from the shaft and from each other. The consolidation between the opposed surfaces of the impacted cervix and of the shaft, does not take place so readily or at so early a period as that of the fracture through the trochanter. Mr. Smith states that he has frequently found the latter firmly united by bone, while the neck of the femur has, after maceration, become loose in the cavity which it had formed for itself between the trochanters. In these cases the bond of union is generally a cartilaginous and fibro-cartilaginous structure of extreme density and great strength, and which, along with the mechanical support resulting from the impaction, enables the patient to bear his weight upon the limb before the *osseous* union of the cervix with the shaft has been accomplished. (Op. cit. p. 36.)

In those rare cases of intra-capsular fracture in which union by bone has taken place, it is highly probable, either that the fibrous covering of the neck has remained wholly or partially uninjured, or that the fragments have been impacted or interlocked in the manner described by Mr. R. W. Smith. In either event the fractured surfaces are retained steadily in their position, and are never completely removed from contact with each other. These are precisely the cases, unfortunately, in which the symptoms of the accident are most obscure, and in which the chance of union may be, and probably often is, destroyed or diminished by the too great eagerness on the part of the surgeon to obtain conclusive evidence of the existence of fracture. On the other hand, it is not impossible that union by bone may sometimes have taken place, when the patient has been kept quiet for some time after the accident, in cases where fracture was not suspected, but where the injury has been set down as merely a contusion.

The diagnosis in these cases is often most difficult, for when the muscles around the hip have suffered a violent contusion, the patient is often unable, by a voluntary effort, to raise the injured limb; the inclination of the pelvis produces an *apparent* shortening, and the foot lies everted; there is swelling around the joint, and every motion is attended with pain. Nor does the subsequent progress of the case always tend to remove the uncertainty, for these cases of contusion of the hip are not unfrequently followed, especially in old people, at a period remote from the receipt of the injury, by a *real* shortening of the limb and eversion of the foot—circumstances well calculated to confirm the belief of a fracture of the neck of the femur having been the original injury; whereas these subsequent changes are the result of a slow and mild inflammatory action excited by the contusion in the cancellated tissue of the head and neck of the femur. (*R. W. Smith*, op. cit. p. 30, 31.)

The appearances, occasioned by the alterations which the head and neck of the femur undergo in the disease described by Mr. R. Adams as chronic rheumatic arthritis, present many points of resemblance to fracture of the neck of the femur, and if a patient suffering from this disease should meet with a contusion of the hip, a mistake is especially likely to occur. On the subject of chronic rheumatic arthritis of the hip joint, see *R. Adams, On Abnormal Conditions of the Hip Joint, Cyclop. of Anat. and Physiol.* vol. ii. p. 789; and *R. W. Smith, On Fractures, &c.* p. 113; and JOINTS, DISEASES OF.]

Having spoken of the nature of fractures of the neck of the thigh-bone within and without the capsular ligament, I come next to the consideration of the proper practice to be adopted. In the first description of the injury, as osseous union is rare, ought we to endeavour to keep the fragments as nearly in a state of apposition as possible, and subject the patient to rest and confinement, with the view of promoting the other modes of union, so well pointed out in Dr. Colles's paper? Or should we, as Sir A. Cooper does, avoid confining the patient to any long or continued extension, "as being likely to be productive of ill health, without the probability of producing union?" Yet, it appears both from this gentleman's own statements, and from those of Dr. Colles, Mr. Langstaff, Mr. B. Bell, and others, that though a bony union cannot always be effected, other connecting means may be established; and the more perfect these are, the less will be the subsequent lameness. So long, therefore, as these facts are incontrovertible, I should be disposed to recommend surgeons to do everything in their power to keep the limb quiet, and in a desirable posture for a due length of time. On this point all surgeons must, on reflection, be unanimous. It is one that I have always insisted upon in my surgical writings, and it is one that is very properly defended by Mr. Amesbury. For this purpose, sometimes Desault's or Boyer's apparatus, with the limb in the straight posture; sometimes the double inclined plane, with the limb in the bent position, and the patient on his back; and sometimes, in America, Hagedorn's ingenious plan of using the sound limb as the part to which the long splint and footboard, with numerous perforations, should be attached, in order that the length of the injured limb, and the right position of it and the foot, may be effectually maintained; are preferred. Sir A. Cooper merely places one pillow under the whole length of the limb, and puts another transversely under the patient's knee, so as to keep the limb in an easy bent position. In a fortnight or three weeks the patient is allowed to sit upon a high chair, and in a few more days he begins to take exercise upon crutches. After a time these are laid aside, a stick substituted for them, and in a few months this assistance may be dispensed with. At the end of the treatment a shoe must be worn with a sole of equal thickness to the diminished length of the limb. (*Surgical Essays*, part ii. p. 50.) On this plan, of course, no bony union can be expected, and I prefer the doctrine of Dupuytren and Langstaff, that full time should be afforded for the chance of osseous union being completed, and efficient means adopted to keep the limb quiet and in the best position. From one hundred to one hundred and forty days are specified by Dupuytren as necessary for the consolidation. (*Clin. Chir.* t. ii. p. 99.)

In the treatment of such fractures of the neck of the femur as are situated on the outside of the capsular ligament, Sir A. Cooper prefers the position in which the patient lies on his back, with the injured limb in a bent posture, supported on what is termed the double inclined plane. When the limb has been placed over this machine in an easy bent position, a long splint, reaching above the trochanter major, is applied to the outer side of the thigh, and fastened to the pelvis with a strong leathern strap, so as to press one portion of bone towards the other. The lower part of the splint is also fastened to the outside of the knee with a strap. The limb is to be kept as quiet as possible for eight weeks, at the end of which time the patient may leave his bed, if the attempt should not cause too much pain; but the splint is to be continued another fortnight. (*Surgical Essays*, part ii. p. 59.)

Dupuytren laid the patient on his back; bent the thigh on the pelvis, and the leg on the thigh. He then reduced the displaced outer fragment. He disapproved of continued and forcible extension; and preferred a double inclined plane, composed of several pillows rolled firmly up into the form of bolsters, placed one above the other, and secured together by stitching. Along this double plane he placed another pillow lengthwise, extending from the hip to the heel. The leg and thigh were retained in their places by sheets folded round the limb after the manner of a cravat, and fastened to the bedposts. When consolidation had taken place, the double inclined plane was gradually lowered.

In University College Hospital I have, in many cases, successfully employed the double inclined plane with a pelvis strap; but have latterly tried still more extensively the straight position and long splints with equal success, and perhaps more comfort to the patient.

Pott's method of treatment, with reference to these cases, is now entirely renounced. The bad effects and painful consequences of having the whole weight of the trunk operating upon the fractured ends of the bone, which are often not properly in contact, are too obvious to need any comment. Yet this injudicious pressure was made in the position recommended by Pott, which also forbids the use of long effective splints, and all assistance from moderate continued extension.

A fracture of the neck of the thigh-bone may be complicated with a dislocation of the head of the bone. (See *J. G. Haase, De Fracturâ Colli Ossis Femoris, cum Luxatione Capitis ejusdem Ossis conjuncta.* Lips. 1798.)

[*Oblique fracture through the trochanter major, without injury to the neck of the bone.*—In this somewhat rare form of injury the fracture has an oblique direction downwards and inwards, so as to separate the upper part of the trochanter major, together with the head and neck, from the shaft of the femur. Sir Astley Cooper has given several examples of this fracture; in one of which the nature of the injury was verified by post-mortem examination. Another instance, similarly confirmed, has been related by Mr. Stanley. (See *Med. Chir. Trans.* vol. xiii.)]

In this fracture, according to Sir A. Cooper, the leg is very little, and sometimes not at all, shortened; the foot is benumbed; the patient cannot turn in bed without great difficulty and pain; in some cases the detached portion of the trochanter is drawn forwards towards the ilium; in others, it falls towards the tuberosity of the ischium; but, in general, it is widely separated from that portion which remains connected with the neck of the bone, so that the finger may be placed between the fractured portions. The foot is considerably turned outwards, and crepitus is with difficulty discovered if the trochanter is either much fallen or much drawn forwards. This fracture unites very firmly and more quickly than when the cervix is broken at the root of the trochanter, and the patient recovers with a very good use of his limb. (*On Dislocations, B. Cooper's ed.* p. 175.) [Usually there is little or no diminution in the length of the limb; but, says Sir A. Cooper, when the fracture happens below the insertion of the principal rotatory muscles, the lower portion of bone is much raised by the action of the glutæus maximus, and the limb becomes very much shortened and deformed at the place of union by exuberant callus. This allusion to the rotator muscles is not very intelligible; the presence or absence of shortening is much more likely to depend upon the direction of the line of fracture. If this is very oblique *downwards*, the glutæus maximus may readily draw upwards the shaft of the bone, while if it passes more *inwards*, or at all approaches to the horizontal line, it will be very difficult for the fractured surfaces to become clear of each other, so as to allow shortening to take place. The case recorded by Mr. Stanley is interesting, from its presenting some striking points of resemblance to a dislocation of the hip. The limb was shortened three-quarters of an inch and slightly everted. The extremity of the shaft of the femur was in its natural situation, but behind it, and a little distance from it, *a bony prominence was discovered resting on the ilium, towards the great ischiatic notch, strongly resembling the head of the femur.* This prominence, as was proved at the post-mortem examination, was occasioned by the posterior and larger portion of the trochanter, which was drawn backwards towards the ischiatic notch. (*Med. Chir. Trans.* vol. xiii.

The *treatment* of the fracture through the trochanters may be conducted on the same principles as that of fracture of the neck of the femur. Most surgeons would probably prefer moderate continued extension by means of the long straight splint, while the fracture may be steadied by a broad belt buckled round the pelvis. If the upper part of the trochanter should be inclined backwards, which appears to be frequently the case, an attempt should be made to remedy the displacement by pressing it forwards, if possible, with the fingers, and then supporting it by placing a thick pad behind it, underneath the pelvic band.

Fracture of the trochanter major, by which this process is broken off without further injury to the neck or shaft, occasionally occurs. Sir A. Cooper relates a case, the particulars of which were sent to him by Mr. Aston Key, occurring in a girl æt. sixteen, in which this process was broken off at the point at which it is naturally united as an epiphysis. The patient had fallen in crossing the street, and struck her trochanter violently against the curb stone. She arose and walked home without much pain or difficulty; but four days afterwards, in consequence of the increase of pain she experienced, she applied for admission to Guy's Hospital. The injured limb was considerably everted, and apparently about half an inch longer than the other. It admitted of passive motion in all directions, but in abduction gave her considerable pain. She had perfect command over all the muscles except the rotators inwards. No crepitus or displacement of bone could be detected. She died of fever a few days afterwards, and the examination of the part showed a fracture which had detached the trochanter from the head and neck of the bone, but without tearing through the tendons attached to the outer side of the process. The tendons, those of the two smaller glutæi, so effectually prevented all motion of the fractured portion, that when dissected from the body not the least motion could be produced except in one direction—upwards and downwards.

Another case in which this injury was presumed to have occurred, is related by Mr. Bransby Cooper. The patient was thrown out of his gig, and fell upon the trochanter major. He was unable to walk, but could bear his own weight on the limb of the injured side. The trochanter major was not perceptible in its usual position, and pressure in this situation was extremely painful to the patient. By bending the pelvis towards the injured side, and at the same time abducting the limb to its fullest extent, and pressing down the glutæi muscles, the detached portion of bone could be depressed, and crepitus was produced. Mr. Cooper endeavoured to keep the fractured portions of bone in apposition, by applying bandages and compresses upon the upper portion of the trochanter, so as to draw it downwards and fix it in its place, and he was kept in bed in this position for more than six weeks. Two years afterwards he was seen by Mr. Cooper, and there was then some degree of lameness remaining, but he was capable of performing most of the functions of the injured hip, even to slight feats of agility, though with a halt. (See *Sir A. Cooper, On Dislocations, edited by B. Cooper*, p. 185.) Another instance is mentioned by Mr. Stanley, and two others by Dr. Hamilton, in which this fracture is supposed to have occurred, although he thinks it not improbable that they may have been examples of impacted fracture of the neck. (See his *Treatise on Fractures and Dislocations*, p. 390, Philadelphia, 1860.)

In the treatment of such cases, says Sir A. Cooper, there must always be great difficulty in producing and maintaining coaptation of the parts; and the prognosis of perfect recovery must be unfavourable, for the fractured portion of the trochanter being covered by the tendons of the glutæi muscles, and by the synovial lining of a bursa, and invested with tendons and not with periosteum, and being separated from its right position by the muscles, is placed under circumstances similar to the patella, olecranon, and os calcis, and, like these bones, when entirely severed by fracture, cannot be capable of reparation by ossific union.]

For further information, the following authors may be consulted. *C. G. Ludwig*, de Collo Femoris ejusque Fractura Programma. Lips. 1755. *Bellocq*, in Mém. de l'Acad. de Chir. t. iii. *Aitken's* and *Gooch's* Machines are described in *B. Bell's* Surgery, vol. iv. *Sabatier*, in Mém. de l'Acad. de Chir. t. iv. *Duverney*, Mal. des Os, t. i. *Unger*, in *Richter's* Bibl. b. vi. p. 520. *Theden*, Neue Bemerkungen, &c. th. 2. *Brunninghausen*, über den Bruch des Schenkelbeinhalses, &c. Wurzb. 1789. *Van Gescher*, über die Entstellungen des Rückgrats, und über der Verrenkungen und Bruche des Schenkelbeins. aus d. Holland. *Hedenus*, in *Bernstein's* Darstellung des Chir. Verbandes, tab. xlii. fig. 82 and 83. *M. Hagedorn*, über der Bruch des Schenkelbeinhalses, &c. Leipz. 1808. *J. N. Sauter*, Anweisung die Beinbrüche der Gliedmassen, vorzüglich die complicierten, und den Schenkelbeinhalsbruch nach einer neuen, &c. Methode, sicher zu heilen, 8vo. Konstanz. 1812. *J. Wilson*, on the Structure and Physiology of the Skeleton, &c. p. 243, &c. 8vo. Lond. 1820. *Dr. Colles*, in Dublin Hospital Reports, vol. ii. *Sir A. Cooper*, Surgical Essays, part ii.; and on Dislocations, &c. 4to. 1822, with Appendix, 1823. *H. Earle*, Practical Obs. on Surgery, 1823. *Boyer*, Mal. Chir. t. iii. *John Bell*, Principles of Surgery, 4to. 1801. p. 549, &c. *Sir C. Bell*, on Injuries of the Spine and Thigh-bone, 4to. 1824. *Baron Larrey*, in Journ. Complém. t. viii. p. 116. *G. Langstaff*, Cases of Fractured Neck of the Thigh-Bone within the Capsular Ligament, with the Dissections and Obs. in Med. Chir. Trans. vol. xiii. *E. Stanley*, Cases of Injuries of the Hip-Joint, op. et vol. cit. *G. J. Guthrie*, on the Diagnosis and on the Inversion of the Foot in Fracture of the Neck, &c. of the Thigh-Bone, vol. cit. p. 103. *John Howship*, op. cit. vol. xix. *Syme*, in Edin. Med. Journ. April, 1826. *B. Bell*, on Diseases of the Bone, 1828. *J. Amesbury*, Obs. on Fractures of the Upper Third of the Thigh-Bone, &c. 2nd ed. 1829. *R. W. Smith*, on the Diagnosis of Fractures of the Neck of the Femur; Dubl. Journ. of Med. Science, vol. vi. p. 205. *W. H. Porter*, op. cit. vol. x. p. 243. *M. le Baron Dupuytren*, Leçons Orales de Clinique Chir. t. ii. art. 2, 8vo. Paris, 1832. *Herbert Mayo*, Outlines of Human Pathology, chap. i. 8vo. Lond. 1835. [*R. W. Smith*, on Fractures and Dislocations, Dublin, 1847. *Malgaigne*, Traité des Fractures, &c. t. i. Paris, 1847. *Hamilton*, Practical Treatise on Fractures and Dislocations, Philadelphia, 1860.]

Fractures of the Shaft of the Femur.

The shaft of the thigh-bone is liable to be broken at any point; but it is in the middle third of this extent that fractures mostly occur, which are sometimes transverse, but more frequently oblique. The latter direction of the injury makes a serious difference in the difficulty of curing the case without future deformity or lameness. Sometimes the fracture is comminuted, the bone being broken in more places than one; and sometimes the case is attended with a wound, communicating with the fracture, and making it what is termed *compound.* As Petit remarks, however, the thigh-bone is less seldom broken into several pieces than other bones more superficially situated. [Fractures of the femur are not unfrequent in children, in whom they are more common than fractures of the leg, whereas the reverse is the case in the adult.]

A fractured thigh is attended with the following symptoms: acute pain at the instant of the accident; a sudden inability to move the limb; a preternatural mobility of one portion of the bone; a distinct crepitus, if the two ends of the fracture rub against each other; deformity, in regard to the length, thickness, and direction of the limb. The latter change, viz. the deformity, ought to be accurately understood; for, having a continual tendency to recur, especially in oblique fractures, the chief difficulty in the treatment is to prevent it. (*Desault, par Bichat,* t. i. p. 181.)

Almost all fractures of the thigh are attended with deformity. When this is considered, in relation to length, it appears that, in oblique fractures, the broken limb is always shorter than the opposite one; a circumstance denoting that the ends of the fracture ride over each other. We may also easily convince ourselves, by examination, that the deformity is owing to the lower end of the fracture having ascended above the upper one, which remains stationary.

For the purpose of exemplifying the power of the muscles to displace the ends of the fracture, mention is made, in Desault's works, of a carpenter who fell from a scaffold and broke his thigh. The limb, the next day, was as long as the other; but the man had a complete palsy of his lower extremities, and could not discharge his urine. The moxa was applied, the muscles soon regained their power, and then the shortening of the limb began to make its appearance.

Besides the action of muscles, there is another cause of displacement. However firm the bed may be on which the patient is laid, the buttocks, more prominent than the rest of the body, soon form a depression in the bedding, and thence follows an inclination in the plane on which the trunk lies, which, gliding from above downward, pushes before it the upper end of the fracture, and makes it ride over the lower one. The muscles, irritated by the points of bone, increase their contraction, and draw upward the lower part of the bone; and from this double motion of the two ends of the fracture in opposite directions, their riding over each other results.

Transverse fractures are less liable to be displaced in the longitudinal direction of the bone, because, when once in contact, the ends of the fracture form a mutual resistance to each other; the lower end, drawn upward by the muscles, meets with resistance from the upper one, which being itself inclined downward by the weight of the trunk, pushes the former before it, and thus both retain their position in relation to each other.

The deformity of a fractured thigh, in the transverse direction, always accompanies that which is longitudinal; but sometimes it exists alone. This is the case when, in a transverse fracture, one end of the bone is carried outward, the other inward; or one remains in its place, while the other is separated. The upper end of the fracture is not now, as in the foregoing instance, motionless in regard to the muscular action; for the contraction of the pectineus, psoas, iliacus internus, and upper part of the triceps, draws it from its natural direction, and contributes to displace it.

The deformity of the limb, in regard to its direction, is either the consequence of the blow which produced the fracture, or, what is more common, of the ill-directed exertions of persons who carry the patient. Thus, an injudicious posture will bend the bone so as to make an angle.

Whatever may be the kind of deformity, the lower end of the fracture may retain the natural position in which it is placed, or else undergo a rotatory motion on its axis outward, which is very common, or inward, which is more unusual. This rotation always aggravates the displaced state of the fracture, and should be attended to in the reduction. (*Desault,* t. i. p. 180, 185.)

[*Fractures in the upper third of the shaft,* or just below the trochanter minor, are especially subject to distortion. According to Sir A. Cooper, the upper end of the broken bone is drawn forwards and upwards, so as to form nearly a right angle with the body, and the cause of this position is evidently the contraction of the iliacus internus and psoas muscles, assisted by the pectineus, and perhaps by the first head of the triceps. (*On Dislocations, &c. B. Cooper's edition,* p. 190.) M. Malgaigne has questioned the correctness of Sir A. Cooper's statement. According to him, it is an angular displacement *outwards* rather than forwards which really takes place: and he attributes it to the action of the powerful muscles on the internal part of the thigh, which represent the cord of an arc formed by the neck and shaft of the femur. When the arc is broken, these muscles act so as to approximate the extremities without encountering any resistance. On the contrary, the muscles which are inserted into the great trochanter only favour the movement of abduction which carries the superior fragment outwards.—He has never seen the displacement forwards carried to the extent indicated by Sir A. Cooper and Boyer, and believes that it is often absent altogether, or that when present it is only slightly marked, and in combination with the displacement outwards.

Fracture just above the condyles of the femur sometimes happens, and, according to Sir A. Cooper, is usually oblique from behind downwards and forwards. The appearances produced by it are that the lower and broken extremity of the shaft of the bone projects, and forms a sharp point just above the patella, which pierces the vasti muscles and threatens to tear the skin, and sometimes does so; whilst the patella, tibia, and condyles of the femur sink into the ham, and are drawn upwards behind the broken extremity of the shaft of the os femoris. The accident is likely to happen when a person falls from a considerable height upon his feet, or is thrown upon the condyles of the os femoris with the knee bent. (*On Dislocations*, *B. Cooper's edit.* p. 244.) M. Malgaigne has more frequently found fracture in this situation caused by direct violence, and taking a transverse instead of an oblique direction, though he admits that when it is caused indirectly, in the way Sir A. Cooper describes, it is more frequently oblique. In young persons a separation of the epiphysis may take place. In a case of this kind in a child eleven years old, mentioned by Malgaigne, the superior fragment was carried backwards, and after amputation it was found that the condyles were placed in front of the shaft of the bone, and turned so that their articular surface looked forwards.]

Treatment.—Three very different methods of treating fractured thighs are followed. In one, which was recommended by Hippocrates, and is preferred by a vast number of surgeons, the limb is kept in the straight or extended position. In another, the limb is laid upon its side, with the knee bent; a mode which was extolled by Pott, and has had many partisans in this country. To these two positions for fractured thighs is to be added that in which the patient lies upon his back, with his thigh and leg in the bent position, supported on two oblique planes, or surfaces, the apex or angle of which is beneath the ham.

That Pott lost sight of certain advantages of the straight position; that he was blind to the imperfections of the bent posture; and that he exaggerated the power, which we have, of relaxing all the muscles of a limb by position; few reflecting surgeons of the present day will be inclined to deny. Were we to believe the literal sense of several passages in Pott's Remarks upon Fractures, we should suppose it practicable to relax at once, by a certain posture of the limb, every muscle connected with a fractured bone. In the first vol. of his works, page 389, edit. 1783, he observes, in speaking of what must best answer the purpose of incapacitating the muscles from displacing the fracture: "Is it not obvious that putting the limb into such position as shall relax the whole set of muscles belonging to, or in connexion with, the broken bone, must best answer such purpose?" and, in the next page, "What is the reason why no man, however superficially acquainted with his art, ever finds much trouble in setting a fractured os humeri? is it not because both patient and surgeon concur in putting the arm into a state of flexion, that is, into such a state as relaxes all the muscles surrounding the broken bone?" Also, in page 393, he continues, "Change of posture must be the remedy, or rather, the placing the limb in such manner as to relax all its muscles." Putting out of present consideration the disputed point, whether the relaxed state of a muscle is really the most efficient for the prevention of those spasms which displace a fracture, and occasion vast suffering (see *J. Houston*, in *Dublin Journ. of Med. Science*, vol. viii. p. 459), the possibility of perfectly relaxing all the muscles of the limb by any position, so long as different muscles have different uses, different situations, and different attachments to the bones, every one must grant to be only a visionary project. For instance, do not the patient and surgeon, in the case of fractured os humeri, adverted to above, concur in putting the fibres of the triceps and anconeus into a state of tension, at the same moment that they relax the biceps and brachialis anticus.

The position of the fractured os femoris, says Pott, should be on its outside, resting on the great trochanter; the patient's whole body should be inclined to the same side; the knee should be in a middle state between perfect flexion and extension, or half-bent; the leg and foot, lying on their outside also, should be well supported by smooth pillows, and should be rather higher in their level than the thigh; one very broad splint of deal, hollowed out and well covered with wool, rag, or tow, should be placed under the thigh, from above the trochanter, quite below the knee; and another, somewhat shorter, should extend from the groin to below the knee on the inside, or rather in this posture on the upper side. The bandage should be of the eighteen-tail kind; and when the bone has been set, and the thigh well placed on the pillow, it should not, without necessity (which necessity in this method will seldom occur), be ever moved from it again until the fracture is united; and this union will always be accomplished in more or less time, in proportion as the limb shall have been more or less disturbed.

Here only two splints are mentioned; but the few surgeons who still adopt this method usually employ four. After placing the patient in the above position, the necessary extension is to be made. Then the under splint, having upon it a broad soft pad, and an eighteen-tailed bandage, is to be laid under the thigh, from the great trochanter to the outer condyle. The surgeon, before laying down the tails of the bandage, and putting on the other three splints, is to take care that the fracture lies as evenly as possible.

In the foregoing observations, we find Pott directing the leg and foot to be rather higher in their level than the thigh; with what particular design, I have not myself been able to make out. Whoever meditates upon the consequence of elevating the leg and foot above the level of the thigh, in the bent position, will know that it is to twist the condyles of the os femoris more outward than is natural. When a patient is placed, according to Pott's direction, upon a common bed, the middle soon sinks so much that the leg becomes situated considerably higher than the thigh, and I am disposed to think that this is one cause why so many broken thighs were formerly united with the foot permanently distorted outward. Fractured thighs should always be laid upon beds not likely to sink much. When this happens, no rational dependence can be put in the efficacy of the bent position, and, as Desault has explained, the same thing is hurtful also in the straight posture.

Pott's position certainly leaves the leg and foot too movable and unsupported, and, though it may relax the muscles which have the greatest power to disturb the coaptation of a fractured thigh, it leaves a mass of muscle unrelaxed, quite sufficient to displace the ends of the bone. Hence, practitioners should endeavour to improve the apparatus employed, so that it may make a permanent resistance to the action of the muscles, and in the straight position such resistance may undoubtedly be made to operate with most effect and convenience.

In the early editions of this Dictionary, I expressed a preference to Pott's method of treating broken thighs. More experience, however, made me a convert to the sentiments of Desault on this subject. The terrible compound fractured thighs which I had under my care in the campaign in

Holland in the year 1814, could not have been at all retained by any apparatus put merely upon the thigh itself. The superiority of long splints, extending the whole length of the limb, was in these cases particularly manifest. With such splints, which maintain steady the fracture itself, the knee, leg, ankle, and foot, the patient may, in fact, even be removed upon an emergency from one place to another, without any considerable disturbance of the broken part. But how could this be done in Pott's position, with short splints, merely applied to the thigh, affording no support to the leg, and not confining the motions of the knee and foot?

It was observed by Desault, that, if we compare the natural powers of displacement with the artificial resistance of almost every apparatus, we shall find that the disproportion between such forces is too great to let the former yield to the latter. The action of the muscles, however, which is always at first very strong, he conceived might afterwards be gradually overcome by extension being kept up.

A power incessantly operating can effect what another greater power, temporarily applied, cannot at once accomplish, and the compression of circular bandages tends also to lessen the force of the muscles.

Desault cured an immense number of fractured thighs without any kind of deformity. This success was chiefly ascribed to the well-combined employment of extension and compression of the muscles. The advantage of keeping the muscles a long while extended, in order to diminish their power, seemed to him particularly evident in the reduction of certain dislocations, as those of the shoulder, in which we often cannot succeed till the muscles have been kept on the stretch for a greater or lesser time. The fracture of the patella and olecranon equally demonstrates the utility of compression for the same purpose; as, when the muscles are not steadily compressed by the bandage, they draw upward the fragment of bone with double or triple force.

To the treatment of fractured thighs in the bent posture, Desault entertained the following objections: the difficulty of making the extension and counter-extension when the limb is so placed; the necessity of then applying them to the fractured bone itself, instead of a situation remote from the fracture, as, for example, the lower part of the leg; the impossibility of comparing with precision the broken thigh with the sound one, in order to judge of the regularity of its shape; the irksomeness of this position long continued, though it may at first seem most natural; the inconvenient and painful pressure of a part of the trunk on the great trochanter of the affected side; the derangement to which the limb is exposed when the patient has a motion; the difficulty of fixing the leg firmly enough to prevent the effect of its motion on the thigh-bone; the manifest impossibility of adopting this method when both thighs are fractured; the unfavourable results of the trials of such posture made in France; and, what is gained by the relaxation of some muscles, is lost by the tension of others.

According to Desault, an apparatus which does not execute permanent extension may suffice for transverse fractures; but is always ineffectual when the division is oblique, because it does not fulfil the twofold indication of drawing downward the lower end of the fracture, and keeping the other one upward. He inculcated that the object particularly to be aimed at was such a disposition that the foot, leg, thigh, and pelvis should constitute but one whole; so that, though the different parts thereof might be drawn in different directions, yet they would still, with respect to one another, preserve the same mutual relation; and he invented the following apparatus to answer these purposes. A strong splint, long enough to extend from the crista of the os ilium to a certain length beyond the sole of the foot, and rather more than two inches and a half broad, with each of its extremities pierced in the form of a mortise, and terminating in a semicircular niche, is a principal part of Desault's apparatus. It is applied to the exterior side of the thigh, by means of two strong linen rollers, each more than a yard long. The middle part of one roller is applied to the inside of the thigh at its upper part; its ends are brought to the exterior side of the thigh, passed through the mortise, and knotted on the semicircular niche. Pads are to be previously placed under its middle part, in order to prevent any disagreeable pressure; as well as on the tuberosity of the ischium, which Desault considered as the principal point of action of this band. The inferior part of the leg is next covered with pads, on which the middle part of the second roller is placed, the extremities of which cross on the instep and upper part of the foot, then on the sole; after which they are conveyed outward, and one end passed through the mortise, and knotted with the other on the niche, with such a degree of force as to pull the inferior portion of the femur downward, and push the splint upward, and by this means, the pelvis, and superior portion of the fractured bone. On the internal side of the limb is placed a second splint, which extends from the superior part of the thigh to a certain distance beyond the foot. A third is placed on the anterior part of the limb, from the abdomen to the knee. The superior extremities of the anterior and exterior splints are fixed by means of a bandage passed round the pelvis. A roller, the middle part of which is placed under the sole of the foot, and the extremities crossed on its superior surface, and fastened to the splints, operates with them in preventing the foot from moving.

Before applying the apparatus, Desault covered the whole limb with linen, wetted with a solution of the acetate of lead. Over these, Scultetus's bandage was put, and a roller round the foot, all wetted with the same lotion. (See *Parisian Chir. Journal*, vol. i. *Œuvres Chir. de Desault par Bichat*, t. i. *Rosalino Giardina, Memoria sulla Fratture, con alcune Modificazione all' Apparato di Desault.* 8vo. Palermo, 1814. *Boyer, Maladies Chir.* t. iii.)

In University College Hospital, Desault's method somewhat modified, and in particular without the employment of the wetted many-tailed bandage, is commonly preferred. Dr. Houston, who is an advocate for the same practice, has lately published some interesting cases and observations relative to the treatment of fractures generally, and in particular to the question concerning the advantages of one kind of posture over another. Dr. Houston conceives that they will tend to settle what is the best mode of preventing early spasms, pain, and fever, and of securing for the patient, after the cure, the most seemly and useful condition of the limb; whether that of leaving the broken bone, during the first day, in the predicament in which it has been thrown by the accident, or that of bringing about, and securing, by artificial means, the proper apposition of the fragments, is the more likely to accomplish these objects. He believes also, that they will enable us to draw a comparison between the advantages of the flexed and straight postures. It appears to him that no advantage whatever is gained by leaving the ends of a broken bone in any manner out of place. The excuse for this practice, founded on the doctrine of relaxing the muscles to prevent or relieve spasms, he regards as completely erroneous; and he insists upon the fact, that relaxation of the muscles which have a tendency to spasmodic contraction, excites and promotes it; whilst, on the other hand, extension, or stretching of the same muscles, is the most likely means of averting or subduing the spasm. In the spasmodic action of the gastrocnemius, which follows over-exertion of it, he observes, relief is sought in an attempt at elongating the muscular fibres by stretching out the heel. A person in bed seized with such cramps, will press the heel of the affected limb against the footboard, or get out of bed, in order to accomplish more effectually the same object, by standing with the heel on the ground. In this case, says Dr. Houston, it is obvious that the relaxation of the muscle is favourable to the occurrence of spasm, and that extension constitutes a means of relief. The primary cause of spasms of the muscles in fractures he conceives to be the loosening of one or other of their fixed points of attachment; and he thinks it not likely that by leaving them in the loosened state, or by giving one set of muscles a greater degree of relaxation than another, a check will be given to irregularity in their movements. On the contrary, it appears to Dr. Houston, both from an examination into the laws of muscular contraction, and from observations of the phenomena which occur in other cases of disease, as well as in fractures, that the more completely the muscles are extended in length, and secured by their extremities to unyielding points, the less will be their disposition to spasmodic action. The practice of placing a broken limb in the bent posture does not appear to Dr. Houston the most calculated to avert or check spasms; for, by such posture, the most powerful set of muscles, the flexors, seem to him to be brought into a condition "favouring the energy of their contraction;" whilst the influence of the extensors, in counteracting the effects of such contraction, is weakened nearly in the same degree.

Moderate soft pressure on the surface of a fractured limb, appears to Dr. Houston to assist in the prevention of cramps in the long muscles, "on the same principle, that proper fixtures for the attachment of their distal extremities contributes to that effect. Such pressure may exert its beneficial influence in controlling any irregular action in the muscles by numbing their sensibility, and producing in them a certain amount of fatigue which weakens their powers of contraction, as well as by propping together, and keeping steady the broken fragments of the bone." (See *Dublin Journ. of Med. Science*, vol. viii. art. 19.)

Dr. Houston's views of the physiology of muscular action, with reference to fractures of the extremities, make him an advocate for the extended posture, accompanied, if necessary, with extension. The cases which he has published are brought forward to prove the efficacy of this practice in preventing the occurrence of spasms, inflammation, and fever; and some of them to exemplify its utility even when circumstances have prevented its adoption until after the coming on of these symptoms. Dr. Houston finds that the patient "becomes sooner reconciled to the bed in this posture, than in the flexed one; he can be shifted more readily, so as to vary the points of contact between his body and the bed, and thereby save himself from excoriations, or sloughing of any part; and he can assume the sitting posture, and maintain it with less fatigue, for a considerable time. A better judgment may be formed of the length and shape of the broken limb, by its admitting of a comparison with the sound one; the limb can be kept more steady; and extension, if necessary, can be more readily and effectually practised." (*Houston*, vol. cit. p. 489.)

The *double-inclined plane* does not appear to Dr. Houston exempted, in any considerable degree, from the ordinary inconveniences attendant on any other plan of treatment, which has for its object the principle of relaxation, or flexure of the limb; "whilst it is almost totally useless, as a means either of effecting elongation of a shortened bone, or of giving, in many cases, steady support to the member. Besides, it throws the weight of the body so completely on one part of the buttock, and by its bulk and shape so deprives the patient of the means of relieving himself from such injurious pressure, that excoriation and sloughing of the hips are frequent consequences of its use." (p. 490.)

Dr. Houston also objects to the double-inclined plane for fractures of the thigh, because it has no provision "by which the upper fragment may be steadied against the lower, especially in cases where the lesion in the bone has taken place near the trochanters. The lower piece, together with the knee and leg, are immoveably fixed, whilst the upper is left in such a predicament that the least movement of the buttocks bends it from side to side, and rubs and twists its broken surface against that from which it has been detached. There is no provision in the inclined plane by which the upper part of the thigh, when bent upon the pelvis, can be secured against the motions communicated to it by that part, such as may be effected in the extended posture by long splints and pads passing up on the inside close to the perineum, and on the outside, as far along the body as may be thought necessary, securing thereby all the parts, so that, in any movement which is made, all must go together, as if they were one solid piece." (Vol. cit. p. 492.)

The usual objections to the straight posture in fractures just below the trochanters, on account of the tendency of the upper fragment to be pulled forwards by the psoas and iliacus muscles, were not exemplified in one of the cases of this description, the particulars of which are given by Dr Houston. "The projection forwards of the upper piece, so remarkable in the first days after the accident, gradually subsided, under gentle pressure on the forepart of the thigh, and the bones finally assumed their natural points of connexion with each other. By the adoption of the extended posture, with the aid of extension, that deformity, so common in fractures of the thigh, permanent eversion of the toes, and I believe also that of shortening of the limb, will be more probably averted than can be done under the best directed efforts of the double-inclined plane." By the same plan, likewise, Dr. Houston observes that pain and excoriation of the heel may be easily prevented if a narrow pad be laid between the limb and bed, a little above the heel. The apparatus which this gentleman employs for fractures of the lower extremities, is a modification of that recommended by Desault, and consists of a tailed bandage, two long lateral splints, and splint-cloth, two calico bags containing bran, and broad straps with buckles, together with a footboard, and if necessary, lacs of calico for the purposes of extension. "The tails of the bandage may be two inches and a half broad, and about two feet long. They should be applied neatly around the limb, with due regard to lightness. The application of this bandage tends to steady and support the muscles, and, if much inflammation be present, it may, when very lightly applied, be of use in conveying discutient washes. In a case of compound fracture, the bandage may be left out to facilitate the discharge of matter, and to permit the application of poultices or dressings, without disturbing the other parts of the apparatus. The splints may be made of deal, of sufficient thickness to prevent their bending, and from 2½ to 3½ inches in breadth, according to the thickness of the limb to which they are to be applied. They should be of equal breadth, as otherwise the limb will turn to the side of the narrow one. In case of necessity for permanent extension, the external splint should be made, as directed by Desault, with a hole and notch at either end, by which to fasten the lac; and it will be advantageous here to have this splint of sufficient length to mount well up along the side of the abdomen, as the higher the point to which the lac is fastened the more effectually will the extension be exerted in the axis of the limb." Dr. Houston prefers pads of linen, or calico, filled with bran, and about one-third broader than the splints. If permanent extension be necessary, the upper lac, or band for counter-extension, he recommends to be filled in a baglike form with bran, in order to prevent excoriation of the groin. The ends of this lac should be long enough to be carried round the abdomen, after being fastened to the top of the splint, by which means the splint will be effectually secured to the side. In order that the extension of the lower end may be made as much as possible in the line of the axis of the limb, Dr. Houston deems it advantageous to draw the lac through a hole or slit in the centre of the footboard, which will thereby serve as a pulley to give the lac a perpendicular direction, before it is turned towards the extremity of the outer splint, to which it is to be fastened. A piece of leather, introduced between the ankle and the lac, will save the skin from the injurious effects of pressure. The lac may consist of a long strip of calico, doubled up several times into a breadth of about an inch and a half, and smoothed so as to make it lie flatly. The mode of its application may be that usually practised for the reduction of dislocations, by which extension is made equally from both sides of the limb. For other particulars, the reader is referred to Dr. Houston's paper. (See *Dublin Journ. of Med. Science*, vol. viii. art. 19.)

Thus we find that Dr. Houston's principles and practice, in relation to fractures of the thigh, are as opposite as possible to those of Pott, and coincide very closely with those of Desault. As no posture will hinder the muscles from displacing the ends of the fracture, I have always recommended that to be generally preferred in which the most efficient mechanical aid can be employed. The position chosen by Pott I have therefore long abandoned, and tried sometimes a slightly flexed position, on a well-made double-inclined plane, with footboard, and pelvis, and thigh-straps; but of late still more frequently the straight position. During the first year after the opening of University College Hospital, I tried both plans promiscuously, and nearly every case terminated without deformity; but as the patients in the straight position appeared to suffer least inconvenience, I have since commonly preferred it. With regard to Dr. Houston's observation, that the double-inclined plane cannot be made to "bind the pelvis and broken fragments together as one piece, only moveable together," it cannot apply to one of proper construction, like that of Amesbury, with a pelvis and thigh strap. I have now a woman under my care in University College Hospital, whose thigh-bone is broken close below the trochanter minor. The extended position was tried for the first few days; but as the upper fragment continued to project considerably forwards, the slightly flexed posture, on a double-inclined plane, with a pelvis strap, was adopted; and the ends of the fracture were then kept together without difficulty; and the union of them has taken place very favourably.

Fractures of the femur, near the knee, are recommended by Sir Astley Cooper to be treated in the extended position, with lateral splints.

Instead of the position advised by Pott, or that recommended by Desault and Boyer, some surgeons prefer the posture in which the patient lies upon his back, with the limb supported in the bent attitude by means of a wooden frame. This machine, in its most simple form, consists merely of boards, ten or eleven inches in breadth, one reaching from the heel to the ham, the other from the ham to the tuberosity of the ischium. Under the knee-joint they are united at an angle, while a horizontal board connects their lower ends together. Thus they form two sloping surfaces, to which cushions are adapted, and over which the limb can be placed in an easy bent position. Near the edge of the inclined boards holes are made, furnished with pegs. After the bone has been set a long splint is applied from the hip to the side of the knee, and another along the inside of the thigh. (See *Sir Charles Bell's Operative Surgery*, vol. ii. p. 189.) The foregoing apparatus does not sufficiently secure the leg and foot from motion, though, with the aid of a roller and a footboard, this advantage might easily be obtained. At present, therefore, the oblique planes of Amesbury and M'Intyre are generally preferred, which are more complete, admit of being placed at any angle, and fulfil their purpose with greater efficiency, particularly when the pelvis and thigh straps are employed. Indeed, whatever apparatus be applied, or whatever posture be chosen, the pelvis strap is a most important thing if the fracture be high up; and without its assistance, as Dupuytren justly remarks, the patient cannot be cured without deformity. (*Clin. Chir.* t. i. p. 333.) The fracture bed, devised by my friend Mr. Earle, is excellently calculated for this mode of treatment, and has a contrivance by which the patient is enabled to have stools without moving himself or changing his posture in the slightest degree. (See *Earle's Practical Obs. in Surgery*, p. 125, &c. 8vo. Lond. 1823.)

[For a detailed account of the various modifications which have been devised in the long splint, and also in the double inclined plane, see *Dr. Hamilton*, *Treatise on Fractures, &c.*

The long splint is employed very generally in this country, both in hospital and private practice. Mr. Erichsen, however, states that he has treated many fractured thighs, both in adults and children, by means of the starched bandage, without confinement to bed for more than three or four days, and without the slightest shortening or deformity being left. The following is the plan which he recommends :—A dry roller should be applied to the whole of the limb evenly and neatly, which must then be covered with a thick layer of wadding; a long piece of strong pasteboard, about four inches wide, soaked in starch, must next be applied to the posterior part of the limb, from the nates to the heel. If the patient is very muscular, and the thigh large, this must be strengthened, especially at its upper part, by having slips of bandage pasted upon it. Two narrower strips of pasteboard are now placed along either side of the limb, from the hip to the ankle, and another shorter piece on the fore part of the thigh. A double layer of starched bandage should now be applied over the whole, with a strong and well-starched spica. It should be cut up and trimmed on the second or third day, and then re-applied in the usual way. The points to be especially attended to are that the back pasteboard splint be very strong, at the upper part especially, and that the spica be well and firmly applied, so that the hip and the whole of the pelvis be immoveably fixed. (*Science and Art of Surgery*, *ed.* 3, 1861. p. 247.) Most surgeons will, we think, be reluctant to trust to the starched apparatus, to retain the fracture in apposition from so early a period, though it may be used with advantage after a lapse of three or four weeks. When the fracture is oblique, which in the adult is most frequently the case, it is very difficult, even with the advantage of permanent extension carefully and systematically kept up, to prevent some over-riding of the fractured ends, and consequent shortening of the limb. M. Malgaigne is of opinion that, unless the fracture is transverse, and the displaced fragments can be brought together end to end, so as to oppose themselves to the action of the muscles, it is impossible to preserve to the limb its normal length, whatever apparatus or method may be applied. (*Traité des Fract. &c.* t. i. p. 723.) Many other surgeons of experience have expressed a similar opinion. Dr. Mason Warren, of Boston, U.S., says : "I have never yet seen an oblique fracture of the thigh in a patient over seventeen years of age, in which there was not some shortening. I have had cases shown to me, in which it was averred that the limb was not shortened, but on measuring myself I have found the fact otherwise." In children, however, he believes that union without shortening may be accomplished. According to Dr. Buck, of seventy-four cases of fractured femur of all ages, occurring in the New York Hospital, only nineteen resulted without any shortening, a proportion of about one-fourth. The average shortening of the remaining fifty-five fractures was a fraction less than three-fourths of an inch. (See *Hamilton, On Fract.* p. 400.)

In treating a fractured thigh, with the long splint or any of its various modifications, great care and attention is requisite, from day to day, to see that no slipping or relaxation of the bandages has taken place. In the application of the bandages it is necessary to protect, with layers of cotton wool, those points on which the extending force must principally operate. From inattention to these points, patients often endure much unnecessary suffering from excoriation or even sloughs on the instep and ankle, and on the heel, if the weight of the limb be allowed to rest upon this part. The perinæum also requires to be well protected by cotton wool or soft pads, from the pressure of the counter extending force. If the case is properly looked after, it is quite possible to continue the apparatus for five or six weeks, without any excoriation or even soreness of the parts mentioned. Mr. Butcher's modification of the long splint is well calculated to keep the limb steady, and to prevent inversion or eversion of the foot, and also to protect the heel from pressure. (See *Dublin Journal of Med. Science*, vol. xxv. 1858, p. 271.)]

Fractures of the Condyles of the Femur.

[Oblique fracture of the external or internal condyle of the femur into the knee joint occasionally happens, but it is a rare form of injury. M. Malgaigne states that he has seen three cases of this nature, but he could only meet with three other recorded examples. Of these six, three were fractures of the internal, and three of the external condyle. Three others, two of the external and one of the internal condyle, are mentioned by Dr. Hamilton in his work *On Fractures and Dislocations.* They may be caused by a fall on the knee, or a direct blow, such as the kick of a horse, or a heavy weight falling upon the condyles. In one case, mentioned by Dr. Hamilton, the patient, a young man, æt. twenty-one, suddenly twisted his knee while undressing himself to bathe, and a fracture of the external condyle was produced. Six months afterwards the separated fragment, comprising a considerable portion of the articular surface, was removed through an incision below the condyle, and the patient recovered.

The symptoms are severe pain and great swelling of the joint. If the swelling be not too great on examination of the lower end of the femur, the fractured portion may perhaps be felt separated from the rest of the bone, and on pressing the surfaces together crepitus will be elicited. M. Malgaigne states that in general the fractured condyle has a tendency to ascend above the level of the other, and to draw the tibia with it. The leg is therefore abducted upon the thigh in fractures of the external, and adducted in fractures of the internal condyle ; or if it does not assume one of these positions spontaneously, movements in one or other of the directions indicated may readily be communicated to it to an abnormal extent.]

In these cases, Sir A. Cooper prefers the straight position, because the tibia presses the extremity of the broken condyle into a line with that which is not injured. The limb is to be put in the extended posture upon a pillow, and evaporating lotions and leeches are to be used for the removal of the swelling and inflammation. "When this object has been effected, a roller is to be applied around the knee, and a piece of stiff pasteboard, about sixteen inches long, and sufficiently wide to extend entirely under the joint, and to pass on each side of it, so as to reach to the edge of the patella, is to be dipped in warm water, and applied under the knee, and confined by a roller. When this is dry, it has exactly adapted itself to the form of the joint, and this form it afterwards retains, so as best to confine the bones. Splints of wood or tin may be used on each side of the joint; but they are apt to make uneasy pressure. In five weeks, passive motion of the limb may be gently begun, to prevent ankylosis." (*Surgical Essays*, part ii. p. 101; also *Treatise*, p. 221.)

[M. Malgaigne prefers a slightly flexed position of the knee, as less likely to be followed by the articular rigidity, which is especially to be feared as the result of these fractures. The tendency to adduction or abduction of the knee must be guarded against if necessary, by the employment of straight lateral splints.

Sometimes there is a fracture in an oblique or vertical direction, separating the condyles from each other, and communicating above with a transverse fracture of the lower end of the shaft of the femur. When this is the case there is greater mobility than in the fracture last described, and sometimes shortening of the limb from the descent of the shaft of the femur in front of the condyles. The fracture above the condyles has usually an oblique direction downwards and forwards, which favors this species of displacement. The vertical fracture may separate the condyles into equal or unequal portions. Mr. Erichsen mentions a case in which the condyles of *both* femora were splintered into a number of fragments, amongst which the shafts were *impacted.* Excellent union, however, took place, the skin having been uninjured. (*Science and Art of Surg.* ed. 3, p. 249.)

The treatment should be conducted on the same principle as in the oblique fracture of a single condyle, excepting that some degree of extension may be necessary to correct the overlapping of the fragments. If this tendency to shortening should be very great, permanent extension with the long splint may be employed, and when the inflammatory swelling has subsided, the broken condyles may be steadied and maintained in contact with each other by a circular bandage round the knee.

Fractures of this description when compound will, in the majority of cases, call for amputation. Sir A. Cooper, however, mentions the case of a boy under the care of Mr. Travers, in St. Thomas's Hospital, in which the external condyle, which protruded, was, after a time, removed, and the patient recovered so favorably that five months after the accident he had free use of the joint, and was able to walk without any support. (*On Dislocations, &c. ed. by B. Cooper*, p. 241.)]

Fractures of the Patella

May be produced either by external violence, or by the action of the extensor muscles. They may be either transverse or longitudinal in their direction.—When the patella is broken longitudinally the cause is always outward violence; but when the fracture is transverse, though it also may originate from a blow or fall on the part, it is in all common cases, the result of the violent action of the extensor muscles of the leg. In the latter case, which is by far the most common, the fall is subsequent to the fracture, and, as Camper has remarked, it is mostly only an effect of it. For instance, the line of gravity of the body is, by some cause or another, inclined backward; the muscles in front contract to bring it forward again; the extensors act on the patella; this breaks, and the fall ensues. That it is the action of the muscles, and not the fall, which usually breaks the knee-pan, is well ascertained. Sometimes the fracture occurs, though the patient completely succeeds in preventing himself from falling backward, as we find exemplified in two cases reported by Sir A. Cooper. (*Surgical Essays*, part ii. p. 85.) A soldier broke the patella in endeavouring to kick his serjeant; the olecranon has been broken in throwing a stone. In the operating theatre of the Hôtel-Dieu, both the knee-pans of a patient were broken by the violent spasms of the muscles, which followed an operation for the stone. It is only of late years, however, that the true mode, in which the bone is usually broken, has been understood. For the production of a transverse fracture of the knee-pan, the extensor muscles of the leg need not act with a convulsive force, their ordinary action being strong enough to produce the effect in question, when the body is inclined backward, and the patient is in danger of falling upon his occiput. In this state, the thigh being bent, the extensor muscles of the leg contract powerfully, in order to bring the body forwards, and prevent the fall backwards; and the patella, whose posterior surface then rests only by a point against the fore part of the condyles of the femur, is placed between the resistance of the ligament binding it to the tibia, and the action of the extensor muscles. A fracture now happens the more easily, because, by the flexion of the knee, the line of the extensor muscles, and that of the ligament of the patella, are rendered oblique, with respect to the vertical axis of this bone, which is bent backwards at the point where it rests upon the condyles. (See *Boyer, Mal. Chir.* t. iii. p. 322: *C. Bell's Operative Surgery*, vol. ii. p. 201, 8vo. Lond. 1809; *A. Cooper's Surgical Essays*, part ii. p. 86.) By violent spasmodic action of the extensor muscles, however, the patella may be broken transversely, while the limb is perfectly straight. The force of the muscles occasionally ruptures the common tendon of the extensor muscles, or what is more frequent, the ligament of the patella. Of these cases, Petit, Desault, and Sabatier, met with examples. [Chelius mentions five cases in which rupture of this ligament took place. See *Transl. by South*, vol. i. p. 580.]

In transverse fractures, there is a considerable separation between the two fragments of the bone, very perceptible to the finger, when the hand is placed on the knee. This separation is not occasioned equally by both portions; the upper one, embraced by the extensor muscles, is drawn upward very forcibly by them, the patella no longer resisting, while the inferior portion, being merely connected with the ligament below, is not moved by any muscle, and can only be displaced by the motions of the leg, to which it is attached. Hence, the separation is least when the limb is extended, being then only produced by the upper fragment; greatest, when the limb is bent, because both pieces contribute to it; and it may be increased or diminished, by bending the knee more or less.

[M. Malgaigne has shown that the separation is not, after a time, occasioned solely by the ascent of the upper fragment, but that it depends partly upon the descent of the lower portion, in consequence of the gradual contraction which the ligamentum patellæ undergoes. In one case he found this ligament shortened more than an inch, and it was not more than half the length of the ligament on the uninjured side. The retraction of the ligament had in this instance produced a greater effect even than the contraction of the muscles. But, besides being separated from each other, the fractured portions of bone undergo a displacement of another kind; they are tilted forwards, so that the anterior edges of the fractured surfaces are more widely separated than the posterior. This obliquity does not affect both pieces to the same extent, but is much more marked in the lower than in the upper. M. Malgaigne believes this is principally due to the slow contraction of the ligamentum patellæ, the anterior fibres of which, being longer than the others, undergo a greater amount of shortening, and draw downwards the anterior surface of the lower fragment to which they adhere. The movement is increased by any apparatus which aims at the approximation of the fragments by means of circular constriction above and below the patella. (See *Malgaigne*, *Traité des Fract.* t. i. p. 755.)]

As Boyer has particularly noticed, the laceration, or not, of the tendinous expansion, upon the front of the patella, makes a material difference in these cases, because it is a part of great importance in the cure. According to this author, a portion of it, in simple fractures of the patella, generally escapes laceration, and the separation of the fragments is then not very considerable; but the violent action of the extensor muscles, a fall subsequent to the fracture, or the bending of the knee too much, may separate the pieces of bone far from each other, and rupture the tendinous expansion. (*Mal. Chir.* t. iii. p. 328.) According to Sir A. Cooper, "when the ligament is but little torn, the separation will be but half an inch; but under great extent of injury, the bone may be drawn five inches upwards, the capsular ligament, and tendinous aponeurosis covering it, being then greatly lacerated." (*Surgical Essays*, part ii. p. 84.)

The upper portion of bone may be moved transversely, and pain is thus excited, but no crepitus can be felt, as the two pieces of bone are not sufficiently near each other. When the swelling of the knee, consequent on fractures of the patella, is great, the symptoms of the injury may be more or less obscure. However, in consequence of the inability of the extensor muscles to move the leg, except in a few cases where the fracture is very low, the patient cannot stand without difficulty, and is unable to walk.

The broken patella commonly unites by means of a ligamentous substance, instead of bone. However, that an osseous union may follow a transverse fracture of the patella, and still more frequently a perpendicular one, is a fact of which there is not now the slightest doubt. Thus, Lallement has published an unequivocal specimen of a transverse fracture united by bone, with the history of the case, and the appearances after the death of the patient from some other affection. (*Boyer, Mal. Chir.* t. iii. p. 355, &c.) In the collection of Dr. William Hunter, there is one well-marked instance of the bony union of a transverse fracture of the patella, and other examples have been seen in the dead subject by Mr. Wilson. (*On the Structure, Physiology, &c. of the Skeleton*, p. 240.) In Sir Charles Bell's museum were likewise similar specimens, one or two of which are now in the museum of University College. (*On Injuries of the Spine and Thigh-bone*, pp. 57, 58.) The reason why transverse fractures of the patella do not commonly unite by callus, is not owing to the want of power in this bone to produce an osseous connecting substance; for, as Larrey has several times noticed, if the fragments are kept in perfect contact by means of a suitable apparatus, their bony reunion becomes so complete, that scarcely any vestige of the injury can afterwards be traced. (*Journ. Complém.* t. viii. p. 114.) And what must add strength to the purport of the foregoing remarks, is the consideration, that perpendicular or longitudinal fractures of the patella, which are not liable to any displacement from the action of the extensor muscles of the leg, readily admit of bony union. (*Wilson*, *On the Structure and Physiology, &c. of the Skeleton*, p. 239.) This is a statement which, I think, could not be rendered doubtful by any experiments made on animals, without the advantages of quietude and proper treatment. Yet there are other facts related, which prove that, both in longitudinal and transverse fractures, a ligamentous union is generally produced, when the fragments are separated; but, if these are not drawn asunder, an osseous union takes place. Thus, in one case, reported by Sir A. Cooper, one third of the patella was separated from the rest of this bone, and had united by ligament, a free motion being left between the fragments. (*Surgical Essays*, part ii. p. 94.) The same gentleman divided the patella longitudinally in a dog, without extending the division into the tendon above, or the ligament below, so that the fragments could not be separated. In three weeks, a close bony union was the result. (p. 95.) A case is also related, in which a gentleman fractured the patella transversely, and the lower portion likewise perpendicularly. The transverse fracture united as usual, by ligament; the perpendicular one, by bone. (p. 96.)

Pott and some others thought that an interspace between the two pieces of the patella, with a certain length of the connecting substance, might be advantageous in the motion of the joint; but Desault, Boyer, Sir A. Cooper, Sir J. Earle, and others, have always found that the greater the distance between the two pieces of the bone, the greater is the difficulty afterwards in walking up a rising or over an unequal ground.

[Much separation of the fragments must also, as Sir A. Cooper has remarked, produce weakness in the limb in consequence of the shortening of the extensor muscles, for the shortening will necessarily be attended with a proportionate diminution of their power. This weakness of action will also in process of time cause atrophy and degeneration in the muscular structure. (See *Malgaigne*, vol. i. p. 454.)

According to the researches of Mr. W. Adams, it appears that it is only when the fragments are separated by a short interval that their fractured surfaces become firmly united by a new fibrous or ligamentous material; when the separation exceeds an inch or an inch and a half, the bond of union consists merely of a thickening of the aponeurotic structures which pass over the front of the patella, and not of any new plastic material that has been effused between the fragments.

A second fracture in the same patella, or rather—according to the observation of most surgeons—a rupture of the ligamentous union, is by no means a rare occurrence ; it has been known to happen for the third and even for the fourth time in the same limb. The second injury, however, is not always rupture of the ligament, though probably this is most frequent; Mr. Erichsen states that in all the cases which he has seen, it has been a real fracture and not a rupture of the ligament—the second fracture having been always situated just above the line of the original one.

It has also been repeatedly noticed that persons who have broken one patella will, at some subsequent period, suffer from a similar injury on the opposite side. The weakness of the injured limb probably induces the patient to rely more for support on the sound limb, and especially so in any sudden emergency, till at last, during some effort more violent than usual, this in its turn snaps across.]

A very singular case is mentioned by Sir A. Cooper, where a patella, which had been formerly broken, and united by ligament, was again divided into two portions, in consequence of the destruction of the uniting medium by ulceration. (Vol. cit. p. 100.) A case is also on record where the ligamentous uniting substance was so incorporated with the skin that, when the latter happened to be lacerated, the knee-joint was laid open, and amputation became necessary. (*C. Bell*, *Op. Surgery*, vol. ii. p. 204.)

Treatment.—The chief indications are to overcome the action of the extensor muscles of the leg, and to keep the fragments as near each other as possible, partly by a judicious position of the limb, and partly by mechanical means. The first indication is fulfilled by relaxing the abovementioned muscles : 1st, by extending the leg ; 2ndly, by bending the thigh on the pelvis, or, in other words, raising the femur so that the distance between the knee and anterior inferior spinous process of the ilium, and brim of the acetabulum, may be as little as possible ; which object, however, will also require the body to be raised, and the pelvis somewhat inclined forwards, so that the rectus may be perfectly relaxed. In short, as Richter long ago advised, the patient should be almost in a sitting posture, the trunk forming a right angle with the thigh. (*Bibl. Chir.* b. vi. p. 611. Göttingen, 1782.) 3rdly, the muscles are to be compressed with a roller. The second indication, or that of placing and maintaining the fragments in contact, or as nearly so as circumstances will allow, is in a great measure already answered by the above-recommended position of the limb and trunk ; but it is not perfectly fulfilled unless the upper portion of the bone be also pressed towards the lower fragment, and mechanically held in this situation by the pressure of an apparatus or bandage. And, in pushing the upper fragment towards the lower one, the surgeon should always be careful that the skin be not depressed and pinched between them.

After putting the patient to bed upon a mattress, and in the desirable posture, with the limb confined, supported, and raised, as above directed, upon a well-padded hollow splint, Sir A. Cooper applies at first no bandage to the knee, but covers it with linen wet with a lotion, composed of liq. plumbi acet. dilut. ℥ v. and spir. vin. ℥ j. If, on the succeeding day or two, there be much tension, or ecchymosis, leeches should be applied, and the lotion continued ; but the employment of a bandage is not to commence until the tension has subsided ; for Sir A. Cooper assures us that he has seen the greatest suffering, and such swelling as threatened gangrene, produced in these cases by the too early use of a roller. Instead of a circular bandage, placed above and below the broken bone, and drawn together with tape, &c. so as to bring the upper fragment towards the lower one, this experienced surgeon prefers the following method:—A leathern strap is buckled round the thigh, above the broken and elevated portion of bone, and from this circular piece of leather, another strap passes under the middle of the foot, the leg being extended and the foot considerably raised. This strap is brought up to each side of the patella, and buckled to the leathern band already applied to the lower part of the thigh. It may also be fastened to the foot, or any part of the leg, with tapes. The limb is to be confined in this position five weeks if the patient be an adult, and six if advanced in years. Then a slight passive motion is to be begun, and to be gently increased, from day to day, until the flexion of the knee is complete. (*Surgical Essays*, part ii. p. 91.) But, although the impropriety of making any constriction of the knee with a bandage, while the skin is swelled and inflamed, must be obvious, the surgeon ought to be apprised that such swelling and inflammation ought not to occasion the least delay in placing the limb in the right posture, and pressing the upper fragment towards the lower one. Mohrenheim ascribes the lameness formerly so frequent after this fracture, partly to the custom of not thinking of bringing the pieces of bone together until the swelling had subsided, and partly to the fashion of bending the joint too soon, with the view of preserving its motion. But, says he, nothing can be clearer than that it is most advantageous to attend to the union of the fracture first, and to the flexibility of the joint afterwards. (*Beobachtungen*, b. ii. 8vo. 1783.) Boyer has likewise remarked that the uniting substance is apt to yield and become lengthened by bending the knee too early, and he therefore never allows this motion to be performed before the end of two months. When the ligamentous substance is long, and the patient very slow in regaining the use of the extensor muscles, he should sit every day on a table and endeavour to bring them into action ; and as this increases, a weight may be affixed to the foot, as Hunter, Sheldon, &c. recommend.

Nothing keeps the leg more surely extended than a long, broad, excavated splint, with a suitable pad applied to the posterior part of the thigh and leg, and fixed there with a roller, while the thigh itself is to be bent by raising the whole limb from the heel to the top of the thigh, with pillows, which, of course, must form a gradual ascent from the tuberosity of the ischium to the foot.

[M. Malgaigne objects to the various methods which have been recommended for the purpose of approximating the fragments, and which act by circular compression of the limb, not only on account of their inefficiency, but because they depress the tendon of the extensor muscles on the one side, and the ligamentum patellæ on the other, in such a manner as to tilt the fragments forward, and to separate the fractured surfaces in front.

Contact may, indeed, be obtained; but it is limited to the posterior border of the fracture, while there remains a wide interval in front. He has, therefore, devised an instrument to act upon the pieces of bone themselves, without taking its bearings upon either the integument or tendons. The instrument terminates above and below in two curved sharp-pointed hooks, which he passes through the skin and firmly implants in the upper and lower borders of the bone. The apparatus is so contrived as to admit of its ends being approximated by means of a screw; and in this way the fragments can be drawn together. Osseous union was thus obtained in two cases which he relates, and in another the separation was not more than a quarter of an inch. A firm hold was readily obtained by the lower hooks, which were inserted beneath the thin lower border of the bone, so as to embrace it in their concavity; but there was more difficulty with the upper ones, which, being inserted upon the sloping upper surface of the patella, were found to have a tendency after a time to slip downwards. It was necessary to insert these very deeply, or they only took hold of the tendinous structures on the front of the bone, and they required to be held very firmly in their place until the screw was tightened. The apparatus was retained from three to four weeks, and in one instance as long as forty-one days. The irritation produced was very trifling, and the punctures healed in two or three days after the hooks were removed. (See *Traité des Fract.* t. i. p. 771.)]

In the treatment of a *longitudinal* or *perpendicular* fracture of the patella, the leg should be kept extended, leeches used, and a cold lotion applied. After a few days a roller is to be put round the limb, and then a laced knee-cap, with straps buckled round the limb above and below the patella, and a pad on each side to bring its parts as nearly as possible into contact. (*Sir A. Cooper*, vol. cit. p. 96.) The experience of Dupuytren confirms the fact that a longitudinal fracture of the patella is soon firmly consolidated. (*Annuaire Méd. Chir. de Paris*, p. 94. 4to. Paris, 1819.)

[Dupuytren thought that the action of the muscles had no tendency to displace the fragments in a longitudinal fracture. Sir A. Cooper even believed that it would approximate them. M. Malgaigne has, however, well explained that these views were erroneous; and that on the one hand the fibres of the vastus externus which pass obliquely forwards to be inserted into the external angle of the patella, and on the other those of the vastus internus, which are attached along the whole length of the internal border of the bone, must necessarily tend to draw the fragments apart. The separation is greater when the knee is flexed, because this position puts the extensor muscles on the stretch, but it is still present when the knee is extended, unless the preservation of the fibrous tissues should obviate the effect of the muscular contraction. The interval is greater at the upper than at the lower end of the bone. The knee should be kept in the extended position; but there is no necessity to flex the thigh upon the pelvis, since the rectus muscle has no influence in causing the separation. Compresses should be carefully fixed on each side of the bone, to insure the contact of the fractured surfaces.]

Compound fractures of the patella frequently terminate in the death of the patient, unless amputation be performed early. The injury, however, does not invariably lead either to the loss of life or limb. I saw a case in St. Bartholomew's Hospital, in the year 1820, under Mr. Vincent, where the patella was broken to pieces, and the opening so extensive that the fingers readily passed into the joint; yet, after a tedious confinement, the formation of abscesses, and the separation of several fragments of bone, the patient recovered with a stiff joint. In general, however, I believe, with Sir A. Cooper, that in compound fractures of the patella, if the laceration be extensive, or the contusion very considerable, amputation will be required; but, if the wound be small, the patient not irritable, and no sloughing of the integuments, or ligament, likely to occur, it will be best to try to save the limb. (Vol. cit. p. 99.) The wound should be re-united as speedily as possible, and advantage taken of evaporating lotions, perfect rest in a desirable posture, a very low regimen, leeches, venesection, and saline opening medicines. Since the above remarks were first drawn up, I saw another case of bad compound fracture of the patella in St. Bartholomew's Hospital, where it had been about a month. No fragments of bone had then been removed, but a good deal of matter issued daily from the wound, and the patient was in considerable danger of losing his limb, or even his life.

FRACTURES OF THE LEG.

[Fractures of the leg are among the most frequent of all fractures. In 1101 cases of fracture occurring at the Middlesex Hospital, and recorded by Mr. Lonsdale, 289 were fractures of the leg; in 226 fractures occurring at Guy's Hospital, and recorded by Dr. Wilkinson King, 66 were of the leg; and in 946 fractures occurring at the Pennsylvania Hospital, and recorded by Dr. G. W. Norris, 293 were of the leg. (*Pirrie's Surgery*, p. 201.) Thus, in a total of 2267 cases of fracture, 638, or nearly 1 in 3½, were fractures of the leg. This proportion corresponds almost exactly with the statistics collected by M. Malgaigne from the records of the Hôtel-Dieu, for in a total of 2328 fractures he found 652 were of the leg, being as nearly as possible in the same proportion.

Fractures of the leg, like those of the fore-arm, may be divided into three classes, viz.:—1. Fractures of both bones. 2. Fractures of the tibia. 3. Fractures of the fibula. Of these varieties the first is by far the most frequent: in Mr. Lonsdale's table, of 289 fractures of the leg, 197 were of both bones, 41 of the tibia singly, and 51 of the fibula; and in that of M. Malgaigne, out of 652, 515 were of both bones, 29 only of the tibia, and 108 of the fibula.]

In a review of the position and strength of the two bones of the leg, it will appear that the tibia supports alone the whole weight of the body, as well as every shock directed in the axis of the limb, and many kinds of force applied also in the transverse direction, without operating upon any particular point. Hence the frequency of fractures of the tibia; and, if the fibula is generally broken likewise, the latter injury is subsequent to the other, and takes place because this slender bone is not capable of bearing the weight of the body, the impulse of external violence, or even the action of the muscles, after the tibia has given way. (*Dupuytren, Annuaire Méd. Chir. des Hôpitaux de Paris*, p. 15. 4to. Paris, 1819.) On the other hand, as the same distinguished surgeon remarks, the fibula being principally designed as a support for the outside of the foot, it is particularly when this function is to be executed and its lower end has to make resistance to efforts made in that direction, that it is fractured; and, if the lower part of the tibia be also sometimes broken by the same force, it is almost always consecutively, and not by the effect of a direct and simultaneous action upon the two bones. (p. 17.) The fibula may, however, like the tibia, be broken by direct violence.

Fractures of both Bones of the Leg.

[Fractures of both bones may be caused either by direct or indirect violence. In the former case, as, for instance, when the wheel of a carriage passes over the limb, when it is kicked by a horse, or when a heavy substance such as a paving-stone falls against it, both bones are usually broken at the same level, and the fracture takes place at that part of the limb to which the force is applied; but in the fracture from indirect violence, as when a person falls from a height and the sole of the foot is the first part to reach the ground, the tibia usually gives way in its lower third, which is its weakest part, and the fibula, being unable to sustain the weight of the body thus suddenly thrown upon it, gives way consecutively, not always or necessarily at the same level, but in most cases several inches higher up. Sometimes, as M. Nélaton has remarked, one bone is broken by direct and the other by indirect violence, as when the tibia is fractured by a blow, and the fibula is broken secondarily, on account of its not being able by itself to support the weight of the body. This is especially likely to happen if, after the fracture of the tibia, the patient makes an effort to walk, or struggles to prevent himself from falling.]

The usual symptoms denoting a fracture of both bones of the leg, are a change in the direction and shape of the limb, pain, and incapability of walking, or bearing upon the limb, mobility of the fractured pieces, and a distinct crepitus.

The fracture may be transverse or oblique. The first case is most common in children, and in adults, who meet with fracture of the tibia above the lower fourth of the bone. (See *Sanson, in Dict. de Méd. et de Chir. Pratiques*, t. viii. p. 557.)

In transverse fractures a longitudinal displacement cannot easily take place, on account of the considerable extent of the surfaces of bone; but, in oblique fractures, the inferior fragments are almost always drawn upwards by the action of the posterior muscles of the leg.

The direction of the obliquity is in the majority of cases from above downwards, and from without inwards, the end of the upper fragment mostly projecting and presenting itself under the skin at the front and inner part of the leg. Sometimes, however, when the solution of continuity is obliquely downward and outward, the anterior projection will be produced by the lower piece. In both kinds of displacement, the pointed ends of the bones may tear and penetrate the integuments, and cause a compound fracture.

An angular displacement may be produced either by the action of the posterior muscles of the leg, or the weight of the foot, and, in both cases, the angle projects forwards. But it may be directed posteriorly if the heel be too much raised. A rotatory displacement, most commonly happening in the direction outwards, is produced by the inclination of the foot; but, if this be turned too much inwards, the rotatory displacement will be in that direction.

Fractures near the knee are not very subject to displacement, on account of the thickness of the tibia at that part. When displacement does occur, the upper piece is usually tilted forwards, under the influence of the extensor muscles of the knee-joint. Fractures near the knee are more dangerous than those of the middle of the bone, because often followed by inflammation of the knee-joint. Fractures close to the ankle are also severe accidents. Oblique fractures are more difficult of management than transverse, and, when the displacement is considerable, the integuments are in danger of being torn by the projecting points of the superior portion of the tibia.

To bad compound fractures of the leg most of the observations already delivered on compound fractures in general, are applicable.

Treatment of Fractures of both Bones of the Leg.—As in cases of fractured thighs, the practitioner may adopt either a bent or a straight position of the limb: in this country, surgeons mostly follow Pott's advice, and select the first one. A few, however, are advocates for the extended position, and amongst them Dr. Houston deserves to be particularly noticed, on account of the ingenuity of his arguments, the novelty of his views respecting the causes of spasmodic action of the muscles in these cases, and the facts which he brings forward. (See *Dublin Journ. of Med. Science*, vol. viii.) But, notwithstanding his objections to the bent position, experience has taught me that it is, generally speaking, the most advantageous for a broken leg. The strong muscles of the calf are the powers which tend to displace the ends of the fracture, and their relaxation is a thing of the first importance. It is quite different in the thigh, where the muscles are so numerous that the attempt to relax, by any position of the limb, all such as have the power of displacing the fragments, would be in vain. I am ready to acknowledge, however, that, in Pott's method, the apparatus is defective, inasmuch as it does not keep the knee-joint from moving; yet it is certain that such motion has not so injurious an effect upon fractures of the leg as it has upon those of the thigh. When the case is complicated with a wound, which cannot be dressed in the bent posture of the limb without great disturbance of the fracture, the straight position ought unquestionably to be preferred. With respect to one of Pott's objections to this position, viz. that it makes the knee stiff for a long while afterwards, I suspect that we should not lay much stress upon the circumstance, because, as Boyer has correctly observed, it is always the joint situated below the fracture that is thus affected.

In the fracture of both tibia and fibula (says Pott) the patient should lie on the injured side with his knee moderately bent; the thigh, body, and leg being in the same position as in the broken thigh. If common splints be used, one should be placed underneath the leg, extending from above the knee to below the ankle, the foot being properly supported by pillows, bolsters, &c.; and another splint of the same length should be placed on the upper side, comprehending both joints in the same manner.

The strong muscles of the leg being relaxed, the surgeon is to make such extension as seems requisite for bringing the ends of the fracture into even apposition. Then he is carefully to raise the leg a little way from the surface of the bed by taking firm hold of the limb above and below the fracture, and elevating the broken bones together, in such a way as shall keep both the upper and lower portions as nearly as possible on the same level. At this moment an assistant should put exactly beneath the leg the under splint, which has been previously made ready by covering it with a soft pad, and laying over this an eighteen-tailed bandage. The limb is now to be gently depressed till it rests on the apparatus. The surgeon, before proceeding further, must once more observe that the ends of the bones are evenly in contact. Being assured of this important point, he is to apply a piece of soap-plaster, and lay down the tails of the bandage. Another soft pad, well filled with tow, is next to be put over the upper surface of the leg, and over that the other splint, and then the straps are to be fastened.

This mode of treatment, as preferred by Pott and his followers, is seldom adopted at the present time. The disadvantage of leaving the limb, and especially the knee, movable, must be self-evident; and whoever has had the opportunity of observing the treatment of fractures of the leg in a slightly flexed position, on M'Intyre's double inclined plane, with the patient on his back, must be fully convinced of its superiority and greater simplicity. No eighteen-tailed bandage is required. The whole limb, including knee and foot, is kept perfectly steady. A circular hole, as advised by Mr. Liston, is made in the apparatus under the heel, so as to lessen the pressure in that situation, and the chance of ulceration, or sloughing. The apparatus, lined by proper pads, receives the limb; the foot is supported upon the foot-piece, with the intervention of soft materials; and the limb, from the lower part of the thigh down to the toes, is then encircled, together with the double inclined plane and its foot-piece, with common rollers. Of these we generally employ three: one for the thigh, knee, and upper part of the leg; a second for the foot and the leg; and a third for the central part of the leg, and place of the fracture, which is put on last. One great advantage of this method is, that the central piece of the roller may be removed as often as the surgeon pleases, and the fracture examined, or if a compound one the wound cleaned and dressed, without the slightest disturbance of the fracture itself, or any motion of the limb.

[It is an advantage to have the foot-piece fixed in such a manner as to admit of lateral movements, so that the toes may be directed outwards or inwards, by which means any tendency to displacement of the foot in either of these directions may be effectually counteracted.

Side splints, with foot-pieces, are often employed for the treatment of fractures of the leg, and in ordinary cases they answer sufficiently well; but they do not afford the same steadiness and security against displacement, especially in the antero-posterior direction, as the apparatus last described, nor are they so comfortable to the patient.

Another excellent mode of treating fractures of the leg is by the swing apparatus introduced by Mr. Luke, and in common use at the London Hospital. The fracture is first properly adjusted and placed in a kind of fracture box, well furnished with cushions; and the whole is then placed in the interior of an arched cradle, from the upper bar of which it is suspended by straps. A modification of Mr. Luke's apparatus, with some additions, has been devised by Mr. James Salter, of King's College, and a drawing of it is given by Mr. Fergusson. (See *Pract. Surg.* ed. 3. p. 404.) By this method of swinging the limb the fracture is less likely to be disturbed by slight movements of the patient than when the apparatus rests immovably upon his bed. After the lapse of a fortnight or three weeks, if the case progresses favourably, the starched bandage, strengthened with pasteboard, may be substituted for these more cumbrous appliances, and the patient may be allowed to walk about on crutches, with his foot supported by a strap which is buckled over his shoulders. Many continental surgeons and some in this country recommend the starched bandage from the first, and allow the patient to move about a day or two after the accident. The more common practice in England is, however, to use it more as an auxiliary to the other methods, and after the lapse of time above mentioned. (See *ante*, p. 688.)

In some cases it becomes necessary to employ a certain amount of permanent extension to prevent the tendency to retraction and overlapping of the fragments, and for this purpose Desault's long splint or some modification of it may be employed. Mr. Fergusson has contrived a very convenient and simple splint suitable for cases of this kind, and also for fractures of the thigh. It consists of a light iron bar to represent the long splint, with a movable foot-piece attached by which the toes can be pointed in either direction, while the whole is supported upon the bed by a sort of cross bar attached to its lower end. By having the apparatus thus supported and steadied, the troublesome tendency so often noticed with the long splint of the foot to turn out, or of the splint to turn forwards, is prevented. For a drawing and description of this splint, see *Fergusson*, *Pract. Surg. ed.* 3. p. 401.

In some cases of oblique fracture, the upper fragment has a strong tendency to project forwards under the influence, as is usually believed, of the extensors of the knee-joint, and obstinately resists all efforts to keep it in its place either by position or pressure. For cases of this kind, M. Malgaigne has devised an ingenious plan of treatment, by which *direct pressure* is made upon the displaced portion of bone itself. The limb is placed on a double inclined plane, well padded, with the foot supported against a foot-piece. His apparatus consists of an arched plate of iron, intended to surround the anterior three-fourths of the leg, at about a finger's-breadth distance from it; at each end of this plate is an aperture through which a strap and buckle may be passed, by means of which the plate can be fixed firmly to the inclined plane a little distance above the seat of the fracture. There is an aperture in the centre of the arched iron plate, grooved for a screw; the screw which passes through this opening ends in a sharp point, which is intended to be inserted through the skin into the projecting portion of bone.

This having been done, by a few turns of the screw the bone is effectually pressed down into its place. If the patient remains quiet, the point may be maintained in its place for twenty or thirty days without producing suppuration or inflammation, or even redness, and if it has not slipped in consequence of having been inserted too obliquely upon the internal surface of the tibia, the small wound which it leaves will very rapidly cicatrise. M. Malgaigne states that in the majority of cases in which this instrument was employed, not the slightest projection remained on the surface of the bone. (*Traité des Fract.* t. i. p. 795.)]

Fractures of the Tibia.

Fracture of the tibia alone is much less frequent than fracture of both bones; indeed, when the size of the tibia is compared with that of the fibula, and the close connection of these bones to each other is remembered, an opinion might be formed that the first could never be broken without the second. Experience, however, proves the contrary; and reasons for this fact may be deduced from the consideration, that the tibia is the bone which supports the weight of the body, and that it is situated at the fore part of the limb, simply covered by the skin, and much exposed to the effects of direct violence. (See *Boyer, Mal. Chir.* t. iii. p. 373.)

Fractures at any point of the two upper thirds of the tibia can scarcely happen, except from direct violence, as that from a gunshot wound, a blow, or the passage of a heavy body over the leg. But the lower fourth is exposed both to the action of direct causes, and to fractures by *contre-coup*, as they are termed, like those which happen from a fall on the sole of the foot from a considerable height. Fractures of the lower end of the tibia alone are not common; the fibula being almost always broken at the same time. (*Sanson, Dict. de Med. et de Chir. Pratiques,* t. viii. p. 557.) When the tibia alone is broken, the fracture is frequently transverse. When the injury happens near the knee, the great extent of the fractured surfaces prevents any considerable displacement of the fragments; and the fibula, acting as a support on the external side, contributes also to this effect. Boyer, however, saw one instance in which the tibia had been broken by the kick of a horse, and the fragments displaced in the direction of the axis of the bone, which displacement could not be rectified, and the bone remained permanently arched.

[Sometimes there may be a fracture of the upper extremity of the tibia above the tibio-fibular articulation. Sir A. Cooper speaks of an oblique fracture of the upper extremity of the tibia, sometimes extending into the knee-joint and sometimes not. When the fracture is just below the joint, but not extending into it, the lower portion has a tendency to be drawn upwards on one side or other of the knee-joint, according as the obliquity takes a direction inwards or outwards. (See *Sir A. Cooper, On Dislocations, &c. B. Cooper's ed.* p. 250.) When there is an oblique fracture of the upper end of the tibia into the knee-joint, the smaller detached fragment is usually not much displaced, but it may be felt to be movable upon the rest of the bone, and by moving it crepitus may be readily obtained. As in the fracture of the condyles of the femur into the joint, great swelling and inflammation of the knee rapidly supervene, and permanent stiffness is very likely to result.]

The absence of displacement sometimes obscures the diagnosis of fractures of the tibia, and the difficulty is further increased by the little pain and inconvenience occasionally attending such a fracture, with which the patient has been known even to walk.

Whenever there is reason to suspect the accident in consequence of a blow or a fall on the leg, the part should be minutely examined. The fingers are to be moved along the anterior surface and sharp edge of the tibia, the slightest inequality in which may be easily perceived, on account of their being covered only by the skin; and the motion of the pieces may be distinguished, by grasping the opposite ends of the bone, and pushing them in contrary directions. However, this motion, and the crepitus, are not always very plain, on account of the fibula not allowing the fractured portions to be sufficiently moved on one another.

Treatment.—[The treatment of a fracture of the tibia alone should be conducted in the same manner as a fracture of both bones; but there is usually not much tendency to displacement, and the case is therefore more easily manageable. Lateral splints may be used, or Liston's modification of M'Intyre's apparatus; the latter will probably be found more comfortable to the patient. After a few days, when the inflammation has subsided, the starch bandage may be substituted for the splints, and the patient may be allowed to move about on crutches.]

In an oblique fracture of the head of the tibia, extending into the knee-joint, Sir A. Cooper recommends the straight position, because the femur preserves the proper adaptation of the fractured tibia by serving as a splint to its upper portion, and keeping the articular surfaces in apposition. [Probably a slightly flexed position would answer equally well, and be less likely to be followed by permanent stiffness of the joint.] A roller is to be used for pressing one fragment towards the other; a pasteboard splint is also to be applied with the same view; and early passive motion of the joint is to be practised, in order to prevent ankylosis. When the fracture is oblique, but does not reach into the joint, he prefers placing the limb on the double inclined plane, for, the cause of the deformity being the elevation of the lower portion of the tibia, the weight of the leg keeps the limb constantly extended as it hangs over the angle of the inclined plane, and thus the bone is brought into as accurate apposition as the nature of the fracture permits. (*On Dislocations, &c. B. Cooper's ed.* p. 250.)

Fractures of the Fibula.

Fractures of the fibula are divided by Dupuytren, Boyer, and all the best writers on this subject, into two kinds: first, those in which the force is applied directly to the bone itself; secondly, the more frequent and important cases, in which the force operates upon the fibula, through the medium of the foot. In the first kind the fracture may happen at any part of the bone; in the second variety it is very rarely more than three inches above the extremity of the malleolus externus. Dupuytren states that of 207 fractures of the fibula observed by him, seven-tenths of them happened to the right leg; only one-tenth were caused by direct violence, such as a blow or the passage of some heavy body over the limb; the remaining nine-tenths were produced by indirect force applied to the foot either in the direction of adduction or abduction, six-tenths being caused by violent adductive motions of the foot, three-tenths by similar abductive movements. With respect to the seat of the fracture of the fibula, in five-tenths it was two inches from the lowermost point of the external malleolus; in three-tenths, below this point; and in two above it. Cases, within two inches of the external malleolus, were often complicated with displacement of the foot; the others but rarely. (See *Dupuytren*, in *Annuaire Méd. Chir. des Hôpitaux de Paris*, 4to. Paris, 1819; also, in *Leçons Orales de Clin. Chir.* t. i. art. 10, p. 189.)

With respect to the first class of cases, *i. e.* those arising from *direct* causes, the situation of the fibula on the outer side of the leg, a situation which would seem to expose it much to external violence; its slenderness; the interspace left between it and the tibia, at the middle part of the leg; and the way in which each end of it rests upon the latter bone, would lead one to expect that its middle portion must often be broken; yet the case is less frequent than might be apprehended. And, as Dupuytren observes, there are two reasons for this fact; viz. the protection which the fibula receives from the peronæi muscles, and the rarity of circumstances capable of producing a fracture by a direct cause. These fractures, which are not usually attended with deformity, and, in some cases, even do not hinder the patient from bearing upon the foot, cannot for the most part be ascertained, unless attention be paid to the manner in which the accident was produced, and to the presence of ecchymosis, and of more or less pain in the part which has been struck or pressed upon; together with a degree of irregularity of the fibula, perceptible by the fingers, and a more or less distinct mobility and crepitus of the ends of the fracture.

The usual causes of this sort of fracture are blows on the fibula, gunshot wounds, the fall of heavy bodies on the outside of the leg, or the passage of them over the same part. The foot may be slightly twisted, either inwards or outwards, but in most instances the accident is not accompanied by any of the symptoms so often complicating other fractures of the fibula, produced by distortion of the foot, and is easily cured by means of rest. A striking analogy may be remarked between fractures of the central part of the fibula, and those of the corresponding portion of the ulna, and this in respect to causes, symptoms, treatment, and consequences. Fractures of the middle of the ulna, like those of the body of the fibula, are always occasioned by blows or falls on the fractured part, or by violence applied directly to the bone. Such fractures are scarcely ever attended with any deformity in the limb, incapacity of moving it, or displacement of the fragments; and just as some individuals are able to walk with a broken fibula, others, notwithstanding a fracture of the ulna, are found capable of using their fore-arm nearly as well as if it were free from injury. The latter case, like that of a fracture of the fibula, can only be known by the recollection of the way in which the hurt was received, the pain, ecchymosis, irregularities, motion, and crepitus, which last effects are also not very obvious so high up the bone. Like fractures of the body of the fibula, those of the body of the ulna only require rest and discutient applications, and very seldom the bandages, &c. necessary in the treatment of fractures of both bones of the fore-arm, or of the radius alone. (Vol. cit. p. 50.)

Fractures of the fibula from an *indirect* cause may happen from the foot being violently twisted either inwards or outwards. In both instances, the cause of the fracture is a change in the direction of the line in which the weight of the body is transmitted. In the first case, the said line, instead of following, as it commonly does, the axis of the tibia and falling upon the astragalus, crosses the lower end of the tibia and the ankle-joint obliquely from within outwards, and, after passing across the malleolus externus, extends to the outside of the member. The parts then supporting the weight of the body are the malleolus externus, and the lower end of the tibia; besides which state of parts, the same malleolus is subjected to the traction of the external lateral ligaments, which operate with great force, in consequence of those ligaments being now nearly at a right angle with the lower end of the fibula. The ligaments pull upon the lower border of the malleolus, while its upper part is pressed upon by the astragalus, which is propelled from within outwards by the tibia. The result is a fracture of the fibula an inch or an inch and a half above the extremity of the malleolus, and nearly opposite the lower edge of the tibia. The latter bone, being thicker and stronger than the fibula, generally resists, and, if the malleolus internus sometimes happens to break, it is secondarily, as an effect of the displacement of the foot inwards.

In the other example, where the foot is twisted outwards, the centre of gravity of the body, instead of following its usual course, obliquely crosses the lower end of the fibula, the ankle-joint, and the malleolus internus, and falls on the ground at a greater or lesser distance from the inner edge of the foot. On the one side, the internal lateral ligaments and malleolus, and on the other the lower end of the fibula, are then the parts which have to bear the weight of the whole body, and the force of the muscles; and they are also the parts which are torn and fractured,—first, the internal lateral ligaments, or the malleolus; and, secondly, the lower portion of the fibula. (*Annuaire Méd. Chir. de Paris*, 1819, pp. 66, 67.) Some of the symptoms of a fracture of the fibula, from an *indirect* cause, depend upon the fracture of that bone, and others upon the dislocation of the foot. They are divided by Dupuytren into two kinds; viz. *presumptive*, and *characteristic*. The first are, the way in which the patient received his hurt; a noise or sort of crack heard by him at the instant of the injury; a fixed pain at the lower part of the fibula; a difficulty or inability of walking; more or less swelling round the ankle, especially about the malleolus externus and lower portion of the fibula. The *characteristic symptoms* are, an irregularity and unnatural mobility of some point of the lower end of the fibula; a crepitus, which can be more or less distinctly felt by pressing upon and moving the part; mobility of the whole foot transversely, or horizontally; a facility of bringing the lower end of the fibula towards the tibia by pressure; a change in the point of incidence of the axis of the limb upon the foot; distortion of the foot outwards, and sometimes backwards; rotation of the same part upon its axis from within outwards; an angular depression, more or less manifest, at the outer and lower part of the leg; projection of the internal malleolus; disappearance of almost all these symptoms, as soon as reduction is effected by a force applied to the foot; and their immediate recurrence when such force is discontinued, particularly if the limb be in the extended posture. (Vol. cit. p. 68.)

[The different modes in which the indirect fracture of the fibula may be produced have been the subject of much discussion. Dupuytren stated that in his 207 cases of fracture of the fibula (after setting apart one-tenth produced by direct violence), six-tenths arose from violent adductive movements of the foot, and three-tenths from similar abductive movements. This is not the opinion of surgeons generally in this country, who believe that the fracture from eversion is more frequent than that from inversion of the foot. Certainly the displacement of the foot which often accompanies or follows fracture of the fibula is much more frequent in the direction *outwards*, as described by Mr. Pott, than in the direction *inwards*, and it is impossible to understand how the foot can be displaced *outwards*, by violence which operates in such a direction as to *invert* it. Neither are we disposed to agree with Dupuytren, that the fracture of the fibula from *eversion* of the foot is always preceded by rupture of the internal lateral ligament or fracture of the internal malleolus; on the contrary, it is found that in many cases of simple fracture a little above the ankle attributed to eversion, and attended with little or no displacement of the foot, the symptoms are confined to the region of the fibula, and there is no evidence of injury in the neighbourhood of the internal lateral ligament or internal malleolus, which would necessarily be the case if the injury to these parts always preceded the fracture of the fibula. It is more reasonable to suppose that the twist of the foot first occasions the fracture of the fibula, and often stops short at this point; but if it continues to operate, or if, after the fracture, the patient should bear his weight on the injured limb, which has then lost its accustomed support on the outer side, the internal lateral ligament, or the internal malleolus, may give way, and the dislocation of the tibia inwards (or of the foot outwards) may be produced.

But although fracture of the fibula from eversion of the foot is probably the most frequent, there is little doubt that a twist of the foot *inwards* may also fracture the bone near its lower extremity. Dupuytren speaks of the fracture from inversion as often producing the same displacement of the foot which has just been described. It is difficult, however, to understand how this could occur. The explanation of such cases given by M. Malgaigne is more satisfactory: he believes that the inversion has first caused the fracture of the fibula, and that, the patients having attempted to bear their weight upon the injured limb, the dislocation of the foot outwards has been subsequently produced.

It is as well to remark that the words outwards and inwards, applied to these displacements of the foot, are here used in their most obvious sense, and not in the sense in which Dupuytren employed them; what is here spoken of as displacement *inwards*, he was in the habit of describing as displacement *outwards*. (On this point, see *Dislocations of the Ankle-joint*, *ante*, p. 571.)

M. Maisonneuve rejects the fracture by abduction. According to him it is not abduction, but a rotation of the point of the foot outwards, which, in the majority of cases, is the cause of the fracture.

M. Malgaigne says that, judging from the statements of patients, the majority of fractures of the fibula take place from a movement of forced adduction of the foot, that is to say, from the effect of a fall or of a false step, in which the weight of the body falls upon the external border of the foot. He thinks it difficult to explain the mechanism of the accident, but remarks that the movement of adduction is usually accompanied by an inclination of the point of the foot inwards. Others are attributed by the patients to a fall or a false step in which the weight of the body falls upon the internal border of the foot, which is consequently carried in the direction of abduction; but he thinks that the abduction is almost necessarily associated with the rotation of the point of the foot outwards, as explained by M. Maisonneuve. His experience is that, whatever may be the cause of the fracture, its seat is usually from two and a half to three inches above the point of the malleolus, and rarely higher or lower than this.—*Traité des Fract.*, t. i. p. 808.]

In considering the varieties of simple fracture of the fibula with reference to the part of the bone fractured, the *first* to which Dupuytren adverts is that in which the bone is broken *more than three inches above the extremity of the malleolus externus; a case neither accompanied nor followed by any displacement of the foot*, and almost always produced by the direct application of violence to the broken part of the bone. The *second* variety is when the bone has been broken, either by direct or indirect force, *within three inches from the end of the malleolus externus, and when the foot is not displaced, though much displacement is possible*, and indeed often arises from the slightest effort or movement made by the patient after the injury. The most frequent point of fracture is about two inches and a half above the extremity of the outer malleolus. This is generally the place of a fracture caused by a twist of the foot outwards; but the accident may happen lower down, as is commonly seen when the fracture is occasioned by a twist of the foot inwards.

[It is doubtful whether the opinion of Dupuytren, which has been acquiesced in by most subsequent writers, that the fracture from inversion is situated nearer the malleolus than that from eversion, is really correct. As has been already mentioned, M. Malgaigne's opinion is, that whichever be the direction of the foot at the time of the injury, the fracture is in the great majority of cases situated from two and a half to three inches above the malleolus.]

These fractures of the fibula, abstractedly viewed, are not of much importance in themselves; but with reference to the manner in which they facilitate the dislocation of the foot, they are very serious.

Amongst the most frequent complications of fractures of the fibula, are the rupture of the internal lateral ligament, the detachment of the point of the inner malleolus, and fracture of the lower part of the tibia.

[These conditions, accompanied by dislocation of the foot outwards, constitute the injury known as Pott's fracture, or Pott's dislocation.]

Besides distortion of the foot outwards or inwards, as attending certain fractures of the fibula, another complication may be dislocation of the foot backwards, produced by the action of the muscles of the calf, and not by the same causes which broke the bone. However, whenever the malleolus internus has not given way, the dislocation is incomplete, and the foot is inclined outwards as well as backwards. (See *Dislocations of the Ankle-joint.*)

Although fractures of the middle and upper parts of the fibula are often overlooked and neglected, there is no displacement, and no ill consequences ensue ; but things are different with regard to fractures of the lower end of the bone. In an example of fracture of the lower end of the fibula, that was mistaken for a sprain, the patient was permitted to walk about before union had taken place. The consequences were a distortion of the foot, and a tendency to a dislocation of it inwards, followed by such severe symptoms as nearly led to amputation. After a confinement of eight months, the limb was saved; but the ankle continued stiff, and of course the patient was yet a cripple. (See *J. Cloquet, Pathologie Chir.* p. 45.) Some interesting particulars of the dissection of a case of dislocation of the ankle, and fracture of the fibula, which had been neglected for three or four weeks, the limb being in continued exertion all this time, were published by Mr. Lawrence. (See *Med.-Chir. Trans.* vol. xvii. p. 58.)

[According to M. Malgaigne, an easy and sure means to distinguish between a sprain and a fracture of the fibula unattended with displacement, is to make pressure successively upon the lateral ligaments and upon the outer side of the fibula, from one to three inches above the malleolus: pain produced by pressure upon the ligaments indicates a sprain; pain confined to a limited portion of the fibula belongs almost exclusively to a dislocation. (t. i. p. 812.)]

Treatment of Fractures of the Fibula.—Pott's method of treating fractures of the fibula, complicated with luxation of the tibia, is described in the article DISLOCATIONS. I consider it a very inferior plan to that followed in University College Hospital with M'Intyre's apparatus. I would make the same observation with respect to Dupuytren's mode, ingenious and scientific as it is. Pott's method of treatment is not calculated to prevent the falling-in of the lower extremity of the fibula towards the tibia. In a fracture of the lower end of the fibula, when the foot is brought into the state of extreme adduction, it draws by means of the lateral ligaments the point of the outer malleolus in an inward direction, and, consequently, the fractured portion corresponding to it is drawn outwards from the tibia. It is on this principle that Dupuytren's mode of treating this accident is founded. In all cases, then, a fracture of the fibula, accompanied with distortion of the foot outwards, requires an apparatus which maintains the foot turned inwards, and the inferior fragment of the fibula raised from the tibia, and in the direction of the superior fragment. The simple apparatus recommended by Dupuytren is as follows : a cushion, a splint, and two bandages are the whole of it. The cushion, made of linen, and stuffed two-thirds full of hair-balls, or chaff enclosed in bags in the usual manner, should be two feet and a half in length, four or five inches in breadth, and three or four inches in thickness. The splint is to be from twenty to twenty-three inches in length, and three inches broad. Lastly, the two rollers should each be from four to five yards in length. The cushion, doubled in the form of a wedge, should be applied on the internal side of the fractured limb, its base below, and resting on the internal malleolus, without passing beyond it ; its summit above on the internal condyle of the femur. The limb is thus protected from the splint, which derives from the pad a support that keeps it at the distance of several inches from the internal margin of the foot, and at the same time tends to throw the tibia outward. The splint, applied along the cushion, should extend six or seven inches below it, which will be about four inches below the internal margin of the foot. These parts of the apparatus being thus disposed, should then be fixed by one of the bandages passed round the limb below the knee, when the portion of the splint extending below the cushion will leave between itself and the foot an interval of several inches, and furnish a *point d'appui* to which the foot may be drawn from without inwards. In order to effect this purpose, the second bandage should be drawn from this point over the instep and heel, alternately embracing the splint and the parts of the limb just indicated, in circles gradually lessening, and forming the figure of the cipher 8 with the crossing part on the splint. Thus the apparatus acts on the principle of a lever of the *first kind*, in which the *point d'appui* is the base of the cushion, a little above the malleolus internus, and in which the resistance, as well as the power acting on the fracture, are in the extremities of the foot. The foot thus drawn must yield to the action of the lower bandage, while the tibia, pressed by the base of the cushion, must be propelled outwards with the astragalus. Lastly, it is evident that as the lower fragment of the fibula is drawn downwards by the external lateral ligaments of the ankle, a tilting movement must be produced on the external surface of the astragalus, contrary to that which displaced it. With the view of obtaining a complete reduction, Dupuytren says that the surgeon must not confine himself to drawing the foot in a perpendicular line under the limb; it must be brought as much inwards as it had been turned outwards by the peronæal muscles.

After the foot has been retained a good while in this forced state of adduction, if it should not return to its ordinary position, the defect may be easily remedied by applying the preceding apparatus to the outer surface of the leg and foot.

When, with a fracture of the fibula, the foot is drawn backwards and upwards, Dupuytren applies the splint and cushion to the back part of the leg down to the heel. One roller is applied below the knee, and a second round the lower end of the tibia and splint. A square pad should always be put between the lower bandage and the tibia. Of 207 cases of fracture of the fibula, comprising all the varieties of this accident treated in the above way by Dupuytren, 202 were cured ; the remaining five died, three of them from the consequences of the injury itself, or from complications independent of it.

[In a fracture without displacement of the foot or at the seat of fracture, it matters little what apparatus is employed; lateral splints or M'Intyre's apparatus, succeeded in a few days by the starch bandage, will answer every indication. Indeed, in all cases, whether with or without displacement, M'Intyre's splint, or Liston's modification, is as convenient and effectual an apparatus as can be desired. (See *Dislocations of the Ankle-joint.*)]

[FRACTURES OF THE ASTRAGALUS.]

[A fall from a height upon the foot occasionally produces a fracture of this bone, but it is a rare form of accident. In a simple fracture, the fragments are not usually displaced, and, beyond a general swelling of the ankle, there is no evidence externally of the nature of the injury, which is likely to be mistaken for a sprain. Mr. Lonsdale mentions a case in which the bone was broken into several pieces, and the patient was treated for a severe sprain, there being no reason to suspect a fracture, which was only discovered after the death of the patient, which took place on the twelfth day, from the severity of the symptoms which ensued. (*Treatise on Fract.* p. 531.) The fracture may take various directions. M. Malgaigne met with a case in which it was transverse, the bone being divided into an anterior and posterior half. He also mentions a case under M. Tavignot where the fracture was in the antero-posterior direction, with incomplete fracture of the neck of the bone. Sir A. Cooper mentions one in which the bone was broken almost horizontally into an upper and lower portion. This was a compound dislocation, and the lower ends of the tibia and fibula, with the upper division of the astragalus, protruded through the skin at the outer side of the ankle. It was found necessary to remove this part of the bone before the dislocation could be reduced, but the patient ultimately did well; an artificial joint was formed, and he recovered with a very good use of his foot. (See *Sir A. Cooper*, *On Dislocations*, *&c. ed. by B. Cooper*, p. 290.) A case has been already referred to (see art. DISLOCATIONS, *ante*, p. 582), in which the body of the astragalus was separated by fracture from the head and neck, and was dislocated forwards upon the tarsus. The dislocated portion, which was loose, was removed through the wound on the dorsum of the foot, and the patient recovered the almost perfect use of his foot.]

[FRACTURES OF THE OS CALCIS.]

[Fractures of the os calcis may be produced in two ways,—by muscular action, and by direct violence, such as a fall on the heel.

Of the *fracture by muscular action*, two cases are mentioned by Sir A. Cooper. The first was that of a lady who when walking in a field stumbled and fell, and was for some time unable to rise. The os calcis was found to be fractured, and its posterior part was drawn up by the action of the gastrocnemius to three inches from its situation. She was very unruly, and would not submit to the appropriate treatment; the bone therefore remained in this position, and the interspace was filled up by ligamentous substance. By wearing a high-heeled shoe, and with the aid of a stick, she was, however, able to bend and extend the foot, and to walk tolerably well. The second case was that of a lady unde the care of Mr. Green, who fractured the bone by the violent action into which the muscles of the leg were thrown in her efforts to preserve herself from falling downstairs. A high-heeled shoe was used for the purpose of keeping the tendo Achillis in its most complete state of relaxation, but ligamentous union only could be effected. (See *Sir A. Cooper*, *On Dislocations*, *&c. ed. by B. Cooper*, p. 339.)

In these, and in most other cases which have been recorded, the situation of the fracture is not sufficiently explained; it does not appear whether any considerable portion of the bone was detached, or whether merely the surface into which the tendon is inserted was torn off. There will not be much difficulty in ascertaining the nature of the injury; the separated portion will be readily felt, drawn up by the muscles of the calf to a greater or less extent. Ligamentous union was the result in the two cases which have been mentioned, but in others which have been recorded osseous union was obtained, and there appears to be no difficulty in the consolidation, if the fragments can be maintained in contact or nearly so. The treatment consists in relaxing as much as possible the muscles of the calf, and to effect this the leg must be bent on the thigh, and the foot be extended on the leg. A convenient apparatus for the purpose consists of a slipper, to the posterior part of which a strap is attached, which is passed up behind the leg and fastened to a broad leather belt which is buckled round the lower part of the thigh. The resulting inconvenience does not appear to be great, even if osseous consolidation is not obtained, but the patients are able to walk with the aid of a high-heeled shoe, and sometimes even without this assistance, nearly as well as before.

In the fracture from *direct violence*, the bone is usually more or less comminuted, and M. Malgaigne, who was the first to call attention to this form of injury, speaks of it as the "*fracture par écrasement.*" It is more frequent, he thinks, than the fracture by muscular action. It is almost always produced by a fall on the heel, and the bone is broken into several pieces, which may be impacted into each other, so that the breadth of the bone is increased, but its height is diminished. This fracture is situated chiefly in the sub-astragaloid portion of the bone, while the fracture by muscular action always occupies that part which is posterior to the astragalus. The symptoms, as described by M. Malgaigne, are a severe pain in the part, and a swelling which is rapidly developed around the two malleoli, the instep, part of the dorsum of the foot, the two sides of the foot beneath the malleoli, and part of the sole, while, singularly enough, the heel and the region of the tendo Achillis are exempt from it. This swelling masks the deformity of the parts, but on examination it may be felt to be soft opposite the malleoli, while under the malleolus internus the finger rests upon an abnormal projection formed by the lesser process of the os calcis. Crepitus is obscure and sometimes absent; the best way to obtain it is by lateral or twisting movements of the os calcis. The characteristic deformity is an increased breadth of the os calcis, a diminution of the arch of the foot, and in some cases an increased prominence of the heel. The fracture is usually confined to the os calcis, and rarely if ever complicated with fracture of the astragalus or malleoli. M. Malgaigne mentions two cases in which both calcanea were simultaneously fractured. (See *Traité des Fract.* t. i. p. 831.) A case of fracture of the os calcis from a fall on the heel, which was under the care of Mr. Ure at St. Mary's Hospital, has been recorded by Mr. Gascoyen, then one of the house-surgeons. The fracture was situated beneath the astragalus, at about the junction of the posterior two-thirds with the anterior third of the bone. There was unnatural mobility of the heel, and crepitus was obtained by moving it laterally, and also by holding the heel and flexing the ankle. The parts were kept steady by pasteboard splints, but he was unable to walk at all till more than six weeks after the accident, and it was not till the end of three months that the splints could be dispensed with. At that time firm union was found to have taken place, with a great deposit of callus below and in front of the malleoli, which somewhat interfered with the movements of the joint. Mr. Gascoyen mentions two other cases of fracture of the os calcis from falls on the heel treated at St. Mary's Hospital; in one the fracture was situated at the junction of the posterior two-thirds with the anterior third of the bone, in the other the posterior and upper extremity was separated from the rest of the bone. (See *Med.-Chir. Trans.* vol. xxxix. p. 282, 1856.)

In this form of fracture, the heel is not usually displaced by the action of the muscles of the calf; the apparatus, therefore, which has been recommended for the fracture by muscular action, is not required. It is sufficient to keep the foot quiet by means of lateral splints, or on a M'Intyre's apparatus, till the inflammation has subsided, and then to encase it in pasteboard until consolidation has taken place. Some stiffness of the neighbouring joints will remain for a longer or shorter period.]

[FRACTURES OF THE METATARSAL BONES, AND OF THE PHALANGES OF THE TOES.]

[Fractures of the metatarsal bones are rare; they are usually produced by direct violence applied to the dorsum of the foot. They are often compound and comminuted, and the injury of the bones and soft parts may be such as to necessitate amputation. There may be little or no displacement, especially if only one or two of the central bones are broken; but when it does take place the anterior fragments are usually depressed towards the sole of the foot.

The foot should be kept at rest, and steadied by a splint of pasteboard or gutta-percha; if the displacement just alluded to should be present, an attempt may be made to remedy it by making pressure with a compress on the sole of the foot.

Fractures of the phalanges of the toes are usually compound or comminuted, and require amputation. In a simple fracture, a narrow bandage stiffened with starch will answer every purpose. In a compound fracture, when there is hope of saving the toe, it should be fixed upon a narrow splint of pasteboard or wood placed under its plantar surface. Several writers have remarked that fractures of the great toe are often followed by symptoms disproportionately severe, such as swelling of the foot and leg, inflammation of the absorbents, the formation of abscesses, &c.]

James R. Lane.

For *Fractures of the Cranium*, see HEAD, *Injuries of.*

For information on fractures generally, consult *J. L. Petit*, Traité des Maladies des Os, 8vo. Paris, 1723, et nouv. ed. par *M. Louis*, 2 t. 12mo. 1767. *Duverney*, Traité des Maladies des Os, 8vo. Paris, 1751. *Jonathan Wathen*, The Conductor and Containing Splints; or, a Description of two new-invented Instruments, for the more safe Conveyance, as well as the more easy and perfect Cure, of Fractures of the Leg, 2d ed. 8vo. Lond. 1767. *W. Sharp*, in vol. lvii. of the Philosophical Trans. part ii. 1767. *Pott*, On Fractures and Dislocations, 2d ed. 1773. *T. Kirkland*, Obs. upon Pott's General Remarks on Fractures, &c. 8vo. Lond. 1770; also, Appendix to the same, 8vo. Lond. 1771. Cases in Surgery, by *C. White*, edit. 1770. *J. Aitken*, Essays on several Important Subjects in Surgery, chiefly on the Nature of Fractures of the Long Bones of the Extremities, 8vo. 1771. *Boyer*, Traité des Mal. Chir. t. iii. Œuvres Chir. de *Desault*, par *Bichat*, t. i. Parts of the Parisian Chir. Journal. *Sir J. Earle*, Obs. on Fractures of the Lower Limbs; to which is added an Account of a Contrivance to administer Cleanliness and Comfort to the Bed-ridden, or Persons confined to Bed by Age, Accident, Sickness, or other Infirmity, 8vo. Lond. 1807. *Assalini*, Manuale di Chirurgia, parte prima, Milano, 1812. *M. le Baron Dupuytren*, Des Fractures ou Courbures des Os des Enfans, in Bulletin de la Faculté de Méd. Paris, 1811. *Idem*, Sur la Fracture de l'Extrémité inférieure du Péroné, les Luxations, et les Accidens qui en sont la suite, in Annuaire Méd. Chir. de Paris, 4to. Paris, 1819. Also, On Fractures of Various Bones, in Leçons Orales de Clin. 4 tomes, 8vo. Paris, 1832—1834. *M. Roux*, Relation d'un Voyage fait à Londres en 1814, ou Parallèle de la Chir. Angloise avec la Chir. Françoise, p. 173, &c. Paris, 1815. Med. Chir. Trans. vol. ii. p. 47, &c.; vol. v. p. 358, &c.; vol. vii. p. 103. Sketches of the Medical Schools of Paris, by *J. G. Crosse*, p. 87, &c. *Sir Astley Cooper*, On Dislocations and Fractures of the Joints, 4to. Lond. 1822; and Obs. on Fractures of the Neck of the Thigh-bone, 1823. *H. Earle*, Practical Obs. in Surgery, 8vo. 1823. *W. Gibson's* Institutes and Practice of Surgery, 8vo. vol. i. Philadelphia, 1824. *Sir C. Bell*, On Injuries of the Spine and Thigh-bone, 4to. Lond. 1824. *J. Amesbury*, On Fractures of the Upper Third of the Thigh-bone, and Fractures of long standing, ed. 2. 8vo. Lond. 1829. *G. W. Hind*, a Series of Plates, illustrating the Causes of Displacement in the Various Fractures of the Bones of the Extremities, fol. 1835. [*Edward F. Lonsdale*, Practical Treatise on Fractures, Lond. 1838. *J. F. Malgaigne*, Traité des Fractures et des Luxations, t. i. 1847, and t. ii. 1855, avec un Atlas de xxx. Planches. *Chelius*, System of Surgery, translated by *J. F. South*, Lond. 1847. *R. W. Smith*, On Fractures and Dislocations, Dublin, 1847. *F. H. Hamilton*, Practical Treatise on Fractures and Dislocations, Philadelphia, 1860.]

FRÆNUM LINGUÆ. In infants, the tongue is sometimes too closely tied down, by reason of the frænum being extremely short, or continued too far forwards. In the latter case, the child will not be able to use its tongue with sufficient ease in the actions of sucking, swallowing, &c., in consequence of its point being confined at the bottom of the mouth. Though this affection is not unfrequent, it is less common than is generally supposed by parents and nurses. When the child is small, and the nurse's nipple large, it is common for her to suppose the child to be tongue-tied, when, in fact, it is only the smallness of the child's tongue that prevents it from surrounding the nipple, so as to enable it to suck with facility. Mothers also commonly suspect the existence of such an erroneous formation whenever the child is long in beginning to talk.

The reality of the case may always be easily ascertained by examining the child's mouth. In the natural state, the point of the tongue is always capable of being turned upward towards the palate, as the frænum does not reach within a quarter of an inch of the lower part of the tongue from the apex. But, in tongue-tied children, by looking upon one side, we may see the frænum extending from the back part to the very point, so that the whole length of the tongue is tied down, and unnaturally confined.

The plan of cure is to divide as much of the frænum as seems proper for setting the tongue at liberty. The surgeon presses up the tongue against the palate with his left thumb and fore-finger. The incision should be directed downwards, away from the tongue, and not be carried upward or backward, lest the raninal veins or arteries be cut; an accident that has been known to prove fatal. For the same reason, the scissors used for this operation should be blunt-pointed. If the fore-finger and thumb prevent the parts from being seen, the tongue must be pressed up with a spatula, or a director, that has a slit in which the frænum may be placed, as long ago preferred by J. L. Petit. (See *M. Velpeau*, in *Nouv. Elém. de Méd.* op. t. ii. p. 67, 8vo. Paris, 1832; and *M. Malgaigne, Manuel de Méd. Opér.* p. 465, ed. 2. 12mo. Paris, 1837.)

I think the following piece of advice, offered by a modern author, may be of service to practitioners who ever find it necessary to divide the frænum linguæ: "It is not the relations of the trunk of the lingual artery alone, which the student ought to make himself acquainted with. He will do well to study the position of the arteria ranina in respect to the frænum linguæ. This information will teach him the impropriety of pointing the scissors upward and backward when snipping the frænum; an operation, by the by, oftener performed than needed. He will learn that the ranular artery lies just above the attachment of the frænum; so that, if he would avoid it he must turn the points of the scissors rather downward; if he do not, the artery will probably suffer." (*A. Burns, Surgical Anatomy of the Head and Neck*, p. 239.)

When an infant has the power of sucking, this proceeding should never be resorted to, even though the frænum may have the appearance of being too short, or extending too far forwards. (*Fab. Hildanus*, centur. iii. obs. 28. *Petit, Mal. Chir.* t. iii. p. 265. edit. 1774.)

Although the operation of dividing the frænum linguæ is, for the most part, done without any bad consequences, surgeons should remember well that it is liable to dangers, especially when performed either unnecessarily or unskilfully. Besides the fatal events which have occasionally resulted from wounding the raninal arteries, the records of surgery furnish us with proofs that the mere bleeding from the raninal veins, and the small vessels of the frænum, may continue so long in consequence of the infant's incessantly sucking, as to produce death. In such cases the child swallows the blood as fast as it issues from the vessels, so that the cause of death may even escape observation. But if the body be opened, the stomach and intestines will be found to contain large quantities of blood. (See *Dionis, Cours d'Opérations de Chirurgie*, 7e Démonstration. *Petit, Maladies Chir.* t. iii. p. 282, &c.)

Another accident, sometimes following an unnecessary or too extensive division of the frænum, consists in the tongue being thrown backward over the glottis into the pharynx, where it lies fixed, and causes suffocation. The observations of Petit on this subject are highly interesting. (See Op. cit. t. iii. p. 267, &c.)

Lastly, it should be known that an infant's inability to move its tongue, or suck, is not always owing to a malformation of the frænum. Sometimes the tongue is applied and glued, as it were, to the roof of the mouth, by a kind of mucous substance; and in this case it should be separated with the handle of a spatula. By this means infants have been saved which were unable to suck during several days, and were in imminent danger of perishing from want of nourishment. (See *Mém. de l'Acad. de Chir.* t. iii. p. 16. ed. 4to.)

See particularly *Petit*, Traité de Maladies Chir. t. iii. p. 260, &c. *Dionis*, Cours d'Opérations, 7e Démonstr. *Sabatier*, Médecine Op. t. iii. p. 132, &c. *Lassus*, Pathologie Chir. t. ii. p. 454. *Richter*, Anfangsgr. der Wundarzn. b. iv. kap. ii. p. 11. ed. 1800. Also. *A. L. M. Velpeau*, Nouv. Elém. de Méd. Op. t. ii. p. 65. 8vo. Paris. 1832. *J. F. Malgaigne*, Manuel de Méd. Op. p. 464. 12mo. ed. 2. Paris, 1837.

FRAGILITAS OSSIUM. A morbid brittleness of the bones. Although it may take place at different periods of life, it is remarked to be more common in childhood and in persons of advanced age. (See *B. Bell*, *On Diseases of the Bones*, p. 74.)

Boyer imputes *mollities ossium* to a deficiency of lime in their structure; *fragilitas ossium* to a deficiency of the soft matter naturally entering into their texture. This is not the view usually adopted. One modern writer considers preternatural brittleness and flexibleness of the bones as the results of different degrees of the same cause. One degree produces brittleness; a greater degree flexibleness, with greater brittleness; the most aggravated form, mollities ossium. (See *Mayo's Human Pathology*, p. 19.) The diseases termed *rickets* and *mollities*, however, as we shall find by a reference to those articles, are at all events combined with other pathological changes and circumstances. Boyer states that a certain degree of fragilitas ossium necessarily occurs in old age, because the proportion of lime in the bones naturally increases as we grow old, while that of the organised part diminishes. Hence the bones of old persons more easily break than those of young subjects, and are longer in uniting again. In old age the cortex of the bones is thinner, and both in it and the cancelli the quantity of phosphate of lime diminished. This is one cause of the frequency of fracture of the neck of the thigh-bone in elderly persons. (See *Mayo*, op. cit. p. 17.) As Mr. Wilson observes, however, they never are found so friable and fragile as to crumble like a calcined bone, but, on the contrary, they contain a large quantity of oil; a fact particularly noticed by Saillant (see *Hist. de la Société de Méd.* 1776, p. 316); and when dried after death, they are so greasy as to be unfit to be preserved as preparations. Their organised vascular part is diminished, but their oily animal matter is increased. (*Wilson*, *On the Skeleton and Diseases of Bones*, p. 258.)

In persons who have been long afflicted with cancerous diseases, the bones sometimes become as brittle as if they had been calcined. Saviard and Louis relate cases of this description. (*Obs. Chir. et Journ. des Savans*, 1691. *Obs. et Remarques sur les Effets du Virus Cancereux.* Paris, 1750. *Pouteau, Œuvres Posthumes*, t. i.) Two remarkable instances of this kind were published by Mr. Salter of Poole. In the first, the patient, a female aged 82, felt the right thigh suddenly break as she was standing at her drawers. For several months previous to the accident she had had constant and very severe pain in the part of the bone which was broken, and she had been long afflicted with a cancerous ulceration of the mamma. After death the bone was so flexible that no bony union could have taken place. A regular dissection of the limb was not allowed. In Mr. Salter's second case, the patient was also a female, 56 years of age, and, for five months preceding the accident, had laboured under violent pain of the right thigh, and a thickening of the periosteum a little above the patella. As her friends were putting her into a cart, the bone snapped about three inches below the trochanter. For several years she had had a scirrhus of the left breast. This had been removed and the wound healed, but afterwards broke out in the form of cancerous ulceration. In this stage the fracture took place, and was followed in about three months by her death. Mr. Salter removed the thigh-bone, and brought it home for examination; but previously to its removal, the affected limb was observed to be considerably shorter than the other, and flexible at its middle, and a good deal deformed by a projection just below the trochanter major. The muscles of the thigh were pale and shrunk; a bloody fluid escaped from the capsular ligament of the knee-joint, and two or three clots of pure blood were in the articular cavity. On removing the patella, a small ulcer was discovered in the upper and external part of its articular surface. The thigh-bone was remarkably soft throughout its whole length, and the knife could be pushed through it at any part, but at its middle it was most conspicuously deficient in earthy matter. At about three inches from either extremity it could be bent in any direction; and it was on the upper part of this portion that the fracture had taken place; but the precise situation of it was not distinctly visible, and Mr. Salter conceives that there had been no complete separation, like what occurs in common fractures. The distortion did not arise from any overlapping, but from a bending of the bone. The muscles about the upper part of the limb were confounded together into an uniform mass of a pale red colour, firm and cartilaginous, with bony spicula thickly dispersed through them, and puriform matter slightly tinged with blood issuing from the cut surfaces. The integuments had suffered no change. In the situation of the swelling noticed above the patella, the tendon of the cruralis was much thickened and altered in texture, and a considerable quantity of pus came from under it; the subjacent periosteum was also much thickened, and readily detached. The parietes of the bone were here nearly absorbed, and the medullary cavity was filled with a bloody pultaceous substance. (See *Med. Chir. Trans.* vol. xv. p. 186.) It is justly inferred by Mr. Salter, that, as these cases correspond in so many points, the predisposing cause of fracture was probably the same in both. Both the patients laboured under cancer of the breast; and both suffered much from previous pain and lameness. These cases, it is to be remarked, were rather specimens of mollities ossium, or preternatural flexibility of the bones affected; and seem to have differed from some examples of fragility on record, not only in their cause, but in the circumstance of no attempt at ossification having taken place in the broken or flexible parts. They resemble in some respects Mr. Howship's case; yet differ in the affection being restricted to one bone, and being the sequel of a cancerous disease of the breast. In University College Hospital, I remember a woman who had long laboured under cancer of the breast, and in whom several spontaneous fractures had occurred at different periods. She was treated in this hospital, first for a fracture of the humerus, and afterwards for one of the clavicle. In this case every fracture ultimately united.

M. Louis mentions a nun who broke her arm by merely leaning on a servant; and in the *London Medical Journal* an account is given of a person who could not even turn in bed without breaking some of his bones. One of Professor Gibson's patients, residing near Trenton in the United States, has a son, 19 years of age, who from infancy has been subject to fractures from the slightest causes, owing to an extraordinary brittleness of the bones. "The bones of the arm, fore-arm, thigh, and leg, have all been broken repeatedly, even from so trivial an accident as catching the foot in a fold of carpet whilst walking across the room. The clavicles have suffered more than any other bone, having been fractured eight times. What is remarkable, the boy has always enjoyed excellent health, and the bones have united without difficulty or much deformity." (*Institutes, &c. of Surgery*, vol. i. p. 370.)

Similar cases are mentioned by Mr. B. Bell. A child, he observes, fractures a limb. The fracture unites, and is consolidated perhaps in less than the usual period. Some time afterwards, on lifting a moderate weight, or on giving the limb a slight twist, it is again broken, and again unites. Mr. Bell saw this occur three times in different parts of the right humerus of a child five years of age, within the short period of eighteen months. "Several similar cases," he says, "have been under my care: in all of them the patients seemed to enjoy robust health, were apparently untainted by scrofula, and their fragile bones united in a shorter space of time than I have generally observed to be the case in individuals whose bones were tougher." (*On Diseases of Bones*, p. 71.) The same author has been able to discern in only two cases of fragility a palpable deviation from the healthy structure of the bones affected. The subject of one case was a gentleman at the middle period of life, who fractured his humerus in unscrewing a music-stool. The fracture was comminuted, and did not unite. The arm was at length amputated by Mr. George Bell at the shoulder. On examining the limb, the muscles around the fractured bone were found in a pulpy state. The bone, surrounded with blood, partly fluid and partly coagulated, was almost friable, and its whole surface perforated by innumerable small, irregularly shaped holes, giving it a reticulated appearance. (Op. cit. p. 72.)

In the latter stages of syphilis the bones sometimes become remarkably brittle. (*Ephem. Nat. Cur.* dec. ii. ann. iii. obs. 112. *Walther*, *Museum Anat.* t. ii. p. 29.)

In bad cases of scurvy the bones are occasionally so brittle, that they are broken by the slightest cause, and do not grow together again. (*Bottcher* *von den Krankh. der Knochen*, p. 68.) In the museum of University College is a specimen of fragility from scrofula; the humerus having broken in two places from merely shampooing the limb.

Dr. Good was once present at a church in which a lady, nearly seventy-two years old, broke both the thigh-bones by merely kneeling down; and, on being taken hold of to be carried away, had an os humeri also broken, without any violence, and with little pain. Hardly any constitutional disturbance ensued, and in a few weeks the bones united. (*Study of Medicine*, vol. v. p. 332. ed. 3.)

The fragilitas ossium of old age is incurable; but, in children, the tendency depends on some other constitutional disease, and can only be cured by a removal of the latter. (See *Boyer*, *On Diseases of the Bones*, vol. ii.)

For additional remarks on brittleness of bones, see FRACTURE.

Consult *Waldshmidt*, Dis. de Fracturâ Ossium sine Causâ violentâ externâ. Kilon. 1721. *Acrel*, Chir. Vorfälle, b. ii. p. 136. *Courtial*, Nouvelles Obs. Anat. sur les Os, p. 64, 12mo. Paris, 1705. *Marcellus Donatus*, lib. v. c. i. p. 528. *Walther*, Museum Anat. vol. ii. p. 29. *Schmucker*, Vermischte Schriften, b. i. p. 385. *Kentish*, in Edin. Med. Comment. vol. i. Hist. de l'Acad. des Sciences, 1765. p. 65. Hist. de la Soc. Royale de Médecine, 1777 and 1778. p. 224. Journ. de Méd. t. lxxvii. p. 267.; t. lxxxiv. p. 216. *Isenflamm*, Pract. Bemerk. über Knochen, pp. 368. 415. 466. *Fabricinus Hildanus*, cent. ii. obs. 66, 67, 68.; cent. v. obs. 89. *D'Aubenton*, Description du Cabinet du Roi, t. iii. *Meckren*, Obs. Med. Chir. p. 341. Amst. 1682. *Weidmann*, de Necrosi Ossium, p. 2. Francofurti, 1793.; and the writings of *Duverney*, *Petit*, and *Pringle*. *Gooch*'s Obs. Appendix. *J. Wilson*, on the Skeleton, &c. p. 258. 8vo. Lond. 1820. *Gibson's* Institutes of Surgery, vol. i. p. 370.; and vol. ii. p. 70. Philadelphia, 1825. *B. Bell*, on Diseases of the Bones, p. 71. Edin. 1828. *Salter*, in Med. Chir. Trans. vol. xv. *Howship*, in Edin. Med. Chir. Trans. vol. ii. *Herbert Mayo*, outlines of Human Pathology, p. 18. 8vo. Lond. 1835.

FUNGUS. Any sponge-like excrescence. Granulations are often called *fungous*, when they are too high, large, and unhealthy.

FUNGUS HÆMATODES. (From *fungus*, and αἷμα, blood.) So named by Hey. *Milklike Tumour;* Monro. *Spongoid Inflammation;* Burns. *Soft Cancer;* Auct. Var. *Medullary Sarcoma;* Abernethy. *Fungoid Disease;* Sir A. Cooper. *Matière Encéphaloide*, ou *Cérébriforme;* Laennec. *Fungus Medullaris;* Maunoir. *Cephaloma;* Carswell.

This disease was formerly generally confounded with hard cancer. The public are indebted to J. Burns, of Glasgow, for the first interesting account of it; and the subsequent writings of Hey, Freer, Laennec, Andral, Carswell, Wardrop, Langstaff, and others, have made us still better acquainted with the subject.

It is unquestionably one of the most alarming diseases incidental to the human body, because we know of no specific remedy for it; and an operation can only be useful (if it can be useful at all) at a time when it is very difficult to persuade a patient to submit to it. Indeed, when the diseased part is within reach of operation, and extirpated at an early period, a recovery hardly ever follows; for experience proves that it is not a disease of a local nature, but almost always extends to a variety of organs and structures at the same time, either to the brain, the liver, or lungs, &c. It is of the utmost consequence to be aware of this fact, since we should otherwise be induced to attempt many hopeless operations, and deliver a prognosis that might cause disappointment and censure. In a large proportion of patients afflicted with fungus hæmatodes, the general disorder of the system is indicated by a peculiarly unhealthy aspect; a sallow, greenish-yellow colour of the skin, which is frequently covered with clammy perspiration; constant troublesome cough; difficulty of breathing, &c.

Fungus Hæmatodes was the name introduced by Hey. J. Burns has called the disease *spongoid inflammation*, from the spongy elastic feel which peculiarly characterises it, and which continues even after ulceration has taken place. The expression, fungus hæmatodes, is by no means an eligible one; because the disease is not always followed by a protrusion of a bleeding mass; never until the disease has reached an advanced stage; and then the substance which projects is not truly a fungus, but the medullary matter itself.

If, with Dr. Carswell, we regard fungus hæmatodes as a species of cancer, then we may comprehend the disease under his general definition of the latter, as consisting in the formation or deposition of a peculiar substance, which presents great variety of consistence, form, and colour; possesses a vascular organisation of its own; gives rise to the gradual destruction or transformation of tissues; affects successively or simultaneously a greater or less number of organs; and has a remarkable reproductive tendency. Dr. Kerr defines fungus hæmatodes "as a morbid condition of the body, evinced by the development of an elastic uneven tumor, or tumors, not painful in their early stage, and becoming so only by implication with surrounding parts; tending to ulceration; and by ulceration presenting to view a soft and spongy fungus, rapid in its growth, readily bleeding in vascular textures, and emitting a peculiar serous discharge, of a very fetid odour, more or less coloured with blood." (*Cyclop. of Pract. Med.* art. *Fungus Hæmatodes.*) As I have already observed, however, the protrusion is not a fungus, nor is its structure truly spongy; the disposition to hæmorrhage, likewise, depends, as Dr. Carswell has pointed out, less upon the vascularity of the surrounding parts, than upon its own vascularity, and the thinness of the coats of its blood-vessels.

The consistence of fungus hæmatodes, or medullary sarcoma, varies in different cases, and sometimes at different points of the same tumour; being sometimes more dense than brain, or even as compact as boiled udder, while in other instances its softness is equal to that of the fœtal brain, or the milt of a fish; neither is the colour always the same in every case; and it is frequently different at various points of the same mass. Generally, it is like that of the medullary substance of the brain; but sometimes it is redder in particular places, or the medullary matter is broken down and blended with blood, and there may then be within the swelling clots of blood. It was the doctrine of Laennec, that the soft consistence of all carcinomatous formations is invariably preceded by a hard condition of them. This opinion is not entirely renounced at the present time, though the investigations of M. Andral and Dr. Carswell clearly prove that it ought to be so. "The carcinomatous deposit, besides being modified in its consistence by the tissues in which it is contained, is equally so in consequence of a difference in its composition; it may be either hard or soft at this period; and consequently the latter state is not necessarily preceded by the former." (See *Illustrations of the Elem. Forms of Disease*, fasc. iii.) Dr. Carswell illustrates this fact by reference to what happens in the cellular tissue and on serous surfaces; and more especially on the surfaces of sores formed by the destruction of protruded portions of tumors, or after the removal of the breast, eye, or testis, affected with carcinoma. In all these situations, he observes, the deposited substance may present, at the same stage of its formation, the opposite extremes of consistence; being in one case as hard as cartilage, and more or less transparent, and in another, as soft as brain, and quite fluid, and opaque.

One very important pathological fact, in relation to this subject, is the frequency of scirrhus, medullary sarcoma, and fungus hæmatodes, originating in the same morbid state, and passing from one to the other in this order, as specified by Dr. Carswell. Indeed, he adds, we often meet with all the varieties of scirrhus and medullary cancer (termed by him cephaloma), not only in different organs of the same individual, but even in a single organ. I have now seen many cases proving the truth of these statements; yet, probably, the doctrine is correct which represents fungus hæmatodes as a distinct malady, although it may be consequent upon, or complicated with, other alterations of structure. When it occurs in *young* subjects, it is always *primary*, or is not preceded nor attended by the carcinomatous formation. But in persons past the meridian of life, in whom only scirrhocancer, or hard cancer, is met with, the fungoid structure is sometimes produced *consecutively*, or in an advanced stage of it, and thus occasionally exists as a secondary complication with that disease, or as one of the advanced changes of structure consequent upon the constitutional vice." (See *Dr. Copland's Dict. of Pract. Med.* art. *Fungoid Disease.*) The same writer adds that, in a few instances, other morbid formations besides this have been found associated with the cerebriform structure, as fibrous tumors, scrofulous matters, pus, melanosis, hydatids, and earthy deposits. Dupuytren notices a form of fungus hæmatodes, which is pulsatory, and combined with erectile tissue; which latter circumstance, he says, may render the disease susceptible of a favourable change by the ligature of the artery, whose branches keep up the circulation in it; while the other elementary matters found in it, in greater or lesser quantity, as the scirrhous and cerebriform, are a great impediment to the success of this method of relief. (See *Clin. Chir.* t. iv. p. 59., and *Andral, Anat. Pathol.* t. i. p. 219.) The blood-vessels which enter scirrhus and medullary sarcoma vary greatly in number, and sometimes considerably in bulk. They are rarely perceptible in any of the varieties of scirrhus, and are but few in the organised and mammary sarcoma, which are considered by Dr. Carswell as varieties of medullary sarcoma (cephaloma); while, in ordinary medullary sarcoma, they are often so numerous as to form the greater portion of the brain-like tumor in which they ramify. In this disease they are described by the latter eminent pathologist as varying in diameter from the breadth of a hair to that of a line, and to present that peculiarity of distribution, always more or less conspicuous in newly-formed blood-vessels, which is, that their ramifications communicate with a common trunk at its opposite extremities, in the same manner as the hepatic and abdominal divisions of the vena portæ do with the trunk of this vessel. They are frequently varicose; their coats are remarkably delicate, and they have altogether much more of a venous than of an arterial character. According to Dr. Carswell's researches, they appear to be formed apart from the vascular system of the surrounding textures, as they can be seen to originate in small red points, situated at the centre or at the circumference of the carcinomatous mass, which first assume the appearance of slender streaks of blood, and afterwards acquire a cylindrical arrangement and ramiform distribution, thereby constituting what may be denominated the *proper circulation* of medullary sarcoma, or cephaloma. The communication between these vessels and those of the organ in which the medullary substance is contained, is frequently very imperfect; a circumstance which, together with the delicacy of their structure, renders them extremely liable to congestion and rupture. The most minute divisions of these vessels terminate by pencillated extremities in the carcinomatous matter, where they communicate with veins and arteries belonging to the affected organ. The latter vessels, which Dr. Carswell regards as forming what may be termed the *collateral circulation* of medullary sarcoma, are seldom so conspicuous as the former; though cases now and then occur in which they constitute the greater part of the vascular structure of the disease. They are described by the same excellent pathologist as proceeding in a radiating direction from the pedunculated attachment of a tumor, or as rising along its circumference in the cellular tissue, separating it from the neighbouring parts. It is, he observes, by means of these vessels that the materials required for the nutrition and growth of such tumors are supplied; and causes interrupting this collateral circulation will occasion the partial or complete destruction of these and other tumors. (See *Carswell's Illustrations of the Elem. Forms of Disease*, fasc. iii.)

According to the same high authority, nerves have never been detected in this or any other variety of cancer as a *new formation*, though they are sometimes included within agglomerated tumors, or even a single tumor, that has happened to form in a situation through which they pass. In some cases the nerves have participated in the change of structure; but, according to Dr. Copland, they have not been found changed beyond the limits of the tumor. In the eye the structure of the optic nerve is constantly altered; and in a case referred to by Mr. Wardrop, the anterior crural nerve passed into the centre of the diseased mass, and was so completely lost in it that it was impossible to distinguish one structure from the other. Observations of this kind led M. Maunoir to suppose that the medullary matter was actually a collection of nervous pulp, an idea very inconsistent with the well-known insensibility of such medullary matter. M. Lobstein, in combating the doctrine of M. Maunoir, declares that he has seen cases in the early stage of which the nerves passed through the tumor without undergoing any change.

A very common character of medullary tumors is to be lobular, the lobules being closely compacted together and enclosed in remarkably fine cysts, the presence of which may be demonstrated by macerating the soft substance and washing it away, or dissolving the medullary matter with the aid of alkalies. This lobulated and encysted structure is generally noticed in cases where the tumor is near the surface of the body. These cysts, in which the medullary matter is often contained, are externally fibrous and cellular, but internally they present, as Dupuytren remarks, a completely serous organisation, and here a serosity exhales from them. Sometimes the medullary matter originates from, and is adherent to, a single point of the cyst; while in other instances it adheres almost to every part of the interior of the cyst, which is itself closely connected to the surrounding textures. Under these circumstances the cyst is fibro-cellular or entirely fibrous. (See *Dupuytren, in Clin. Chir.* t. iv. p. 57.)

Dr. Hodgkin has advanced the doctrine that the presence of a serous membrane having a cystiform arrangement, is necessary for the production of cancerous and some other kinds of tumors. The existence of the cyst, he believes, precedes the formation of the morbid substance, and constitutes the seat and origin of the disease. (See *Med. Chir. Trans.* vol. xv.) Although Dr. Carswell admits that this mode of origin is sometimes exemplified, he mentions facts which leave no doubt that it is only accidental and not essential. Cysts, he observes, partake of the structure and functions of serous membrane, and consequently are subject to similar diseases. "If therefore such cysts should exist in an individual having the cancerous diathesis, they may in the same manner as a natural serous membrane become the seat of any variety of carcinoma. But although carcinomatous tumors, such as those described by Dr. Hodgkin, are found contained in cysts, attached, single, or in groups, and covered by a reflected serous membrane, these tumors may, and frequently do, not originate in the cysts. They may form in the cellular tissue external to the cysts, and during their development project inwards, carrying before them, as their common envelope, the internal and serous lining of the latter. Such, in fact, is seen to be the origin of these tumors in most of the cysts represented by Dr. Hodgkin in the work referred to. They are situated external to the cyst, are supplied with vessels which do not belong to it, and are placed in the same circumstances as tumors formed in the cellular tissue when no cyst is present.

"As an objection to the general application of the cystic origin of tumors, it may be observed that the presence of cysts in the liver, walls of the stomach, lungs, kidneys, brain, lymphatic glands, spleen, and blood, is not to be detected at any period of the development of carcinoma; and therefore, when they do occur in other organs, as the ovaries, testes, mammæ, &c., they must be regarded as a mere coincidence, or as a consequence of the disease, and not as a cause or necessary condition of it." (See *Carswell's Illustrations of the Elem. Forms of Disease*, fasc. ii.)

A very interesting fact in relation to fungus hæmatodes, or medullary sarcoma, is that of the occasional presence of the cerebriform substance in the veins and absorbents. A similar fact is noticed with regard to scirrhous cancer. Dr. Carswell believes that the carcinomatous and medullary matter is formed in the blood, whether met with in this fluid alone or in other parts at the same time, and he supports his view upon the facts—1st, that the morbid substance is found in the vessels which ramify in these malignant tumors or their vicinity. 2dly, That it is found in those vessels which communicate with the diseased parts of an organ. 3dly, That it is sometimes met with in vessels having no direct communication with another part that is the seat of the same disease. After noticing that the venous and capillary divisions of the vascular system are those in which the carcinomatous substance has been observed, Dr. Carswell describes the forms under which it appears in the blood, and which are exceedingly various; "sometimes perfectly similar to those which mark its presence in the substance or on the surface of organs. In large veins, such as the vena portæ and its branches, the emulgent vein, &c. it may present the lardaceous, mammary, medullary, or hæmatoid characters, all in the same venous trunk. These varieties of the carcinomatous formation may be found mixed together in minute quantities, or isolated into masses so conspicuous, that we can readily distinguish them from one another. Sometimes they lie merely in contact with the internal parietes of the vein; at other times they are united to the latter by means of a thin layer of colourless fibrine; or minute blood-vessels pass from the one into the other, and are often very numerous, and remarkably conspicuous in the cerebriform matter." It seems to Dr. Carswell that the presence of an organised product in the blood can have no other origin than the blood itself, and that such a product cannot be introduced into this fluid by absorption. (See *Illustrations of the Elem. Forms of Disease*, fasc. ii.)

By some pathologists a different view is taken of this part of the subject, and they maintain that, when the carcinomatous or medullary matter is found in the blood, it has been absorbed. On this principle, the extension of the disease is even attempted to be in part accounted for. But the frequently organised state of the product in the blood, and its occasional existence there without any traces of a similar formation in any other part of the system, are arguments strongly confirming the accuracy of Dr. Carswell's statements. This gentleman's doctrine is not, however, universally adopted. Thus, Dr. Copland observes that the formation of the cerebriform matter in the blood, and its subsequent deposit in the parts which are its seats, "cannot be supported by the history and progress of the local and constitutional affections. If it were previously formed in the blood, wherefore is it often deposited only in one situation? Wherefore is it not excreted by the emunctories? Wherefore does it not always affect a number of parts simultaneously? Wherefore is it never found in the arteries, and so frequently in the absorbents and veins proceeding from the seat of the disease?" These and other questions, Dr. Copland maintains, cannot be answered consistently with Dr. Carswell's doctrine. (See *Dict. of Pract. Med.* art. *Fungoid Disease.*) With respect to the medullary substance never being met with in the arteries, Mr. Hey states, that in a case of fungus hæmatodes of the thigh, "the femoral artery was filled with matter, resembling stiff coagulated blood, which prevented the blood from flowing through the divided vessel."

According to the researches of Lobstein, the firmer the tumor, and the earlier the stage of it, the greater the proportion of gelatine to the albumen in it. On the other hand, when the morbid substance is of the consistence of soft brain, the albumen in it is in much greater quantity than the gelatine. I have already explained, however, that the firm and soft conditions of the disease are by no means any certain proof of its early and advanced stages, since the morbid substance is frequently from the first of the same consistence which it exhibits in the end.

Fungus hæmatodes, or medullary cancer, is much more frequently met with in young than old persons; children of the most tender years being often its victims. I am not aware of any records by which a judgment might be formed of the comparative frequency of the disease in the two sexes. In my practice, more instances of it, in external situations, have presented themselves in males than females. The testis, as is universally acknowledged, is oftener the seat of it than the mamma. Speaking of it, however, more generally, I can offer no opinion of its comparative frequency in the two sexes. Dr. Kerr leans to the supposition that females are more frequently the subjects of it than males. (See *Cyclop. of Pract. Med.* art. *Fungus Hæmatodes.*)

It is a common remark that the persons whom it attacks are generally of a sallow complexion, lax fibre, and weak circulation. Yet, when the disease is in the early stage, and limited to some external situation, as, for instance, to one of the limbs, there may be no other apparent fault in the health; and the patient may be neither sallow nor debilitated. A fine stout healthy-looking lad was brought a few months ago to University College Hospital, who had a medullary tumor as large as an orange upon the lower border of the latissimus dorsi. The same case exemplified also one character of medullary tumors meriting particular notice, viz. the extraordinary rapidity with which they sometimes increase, even though the skin may not have ulcerated. In this boy the tumor which I have mentioned enlarged so much in the course of a week, that it not only extended completely across the axilla, but far up into its cavity. But the progress of the disease is not always quick; and at one time it may be very slow, and at other periods surprisingly rapid. Generally, when it is liberated from a part of its coverings by ulceration, or when it returns in a part in which an attempt has been made to extirpate it by operation, the growth of the protruding medullary mass is very quick.

Fungus hæmatodes has frequently attacked the eyeball, the upper and lower extremities, the testicle, and the mamma. But the uterus, ovary, liver, spleen, brain, lungs, thyroid gland, hip and shoulder joints, and various other parts and organs, may be seats of the disease.

It is in this medullary form of disease that a vascular organisation is most conspicuous; and as the coats of the vessels with which it is supplied are remarkably delicate, the circulation of the blood through them is readily interrupted; hæmorrhage from congestive rupture takes place; and the effused blood is mixed in less or greater quantity with the brain-like matter. (See *R. Curswell's Illustrations of the Elem. Forms of Disease*, fasc. ii.) The appearances thus produced are termed hæmatoid. By M. Roux, Dr. Carswell, and all writers who employ the expression *soft cancer*, fungus hæmatodes, or medullary sarcoma, is regarded either as closely allied to cancer, or as actually a variety of it. Under the generic term of carcinoma, indeed, Dr. Carswell comprehends scirrhus; the common vascular or organised sarcoma of Abernethy; also his pancreatic, mammary, and medullary sarcoma; and fungus hæmatodes, or the latter disease in an advanced stage, with a portion of the mass of the disease protruding. Dr. Carswell's reasons for this classification are:—1st, That all these diseases "often present, in the early periods of their formation, certain characters common to all of them. 2ndly, They all terminate in the gradual destruction, or transformation, of the tissues which they affect. 3rdly. They have all a tendency to affect several organs in the same individual. 4thly, They all possess, although in various degrees, the same reproductive character." When medullary cancer is not of immoderate size, and situated directly under the integuments, its surface is generally at first smooth, but after a time uneven, or lobulated; the colour of the skin not altered; the part has a soft elastic feel; and it seems as if an indistinct fluctuation were perceived in it.

FUNGUS HÆMATODES OF THE LIMBS.

In the extremities the disease begins with a small colourless tumor, which is soft and elastic if there be no thick covering over it, such as a fascia: but otherwise it is tense. At first it is free from uneasiness; but by degrees a severe acute pain darts occasionally through it, more and more frequently, and at length becomes incessant. For a considerable time the tumor is smooth and even; but afterwards it projects irregularly at one or more points; and the skin at these places becomes of a livid red colour, and feels thinner. In this situation it easily yields to pressure, but instantly bounds up again. Small openings now form in these projections, through which is discharged a thin bloody matter. Almost immediately after these tumors burst, a small fungus protrudes, like a papilla, and this rapidly increases both in breadth and height, and frequently bleeds profusely. The matter is thin, and exceedingly fetid, and the pain becomes of the smarting kind. The integuments, for a little way round these ulcers, are red and tender. After ulceration takes place, the neighbouring glands swell, and assume exactly the spongy qualities of the primary tumor. If the patient still survive the disease in its present advanced progress, similar tumors form in other parts of the body, and the patient dies hectic.

After death or amputation the tumor is found to consist of a soft substance, somewhat like the brain, of a greyish colour and greasy appearance, with thin membrane-like divisions running through it, and cells, or abscesses, in different places, containing a thin bloody matter, occasionally in very considerable quantity. There does not seem uniformly to be any entire cyst surrounding the tumor; for it very frequently dives down betwixt the muscles, or down to the bone, to which it often appears to adhere. The neighbouring muscles are of a pale colour, and lose their fibrous appearance, becoming more like liver than muscle. The bones are mostly carious in the vicinity of the disease.

The growth of medullary tumors near the surface of the body is sometimes preceded by a blow on the part; but in general the exciting cause is perfectly obscure, the disease appearing to begin spontaneously, though in connection with some unknown peculiarity, or modification of the constitution, without which no circumstances would be capable of inducing it: when we see a patient sallow and enfeebled in this disease, such change of the complexion, and the debility manifested, are not to be regarded as causes, but only as effects of the disease on the general health. (*J. Burns, On Inflammation,* vol. ii.)

Mr. Hey recorded several cases of fungus hæmatodes. If I notice the principal circumstances relative to one of these, they will suffice to inform the reader of the form in which this terrible affliction presented itself in this gentleman's practice.

A young man aged twenty-one, two years before applying to Mr. Hey, perceived a small swelling on the inside of the right knee, not far from the patella. This tumor was moveable, and did not impede the motion of the joint: it was not discoloured, but was painful when moved or pressed upon. It continued in this state half a year; and then, the man having hurt his knee against a stone, it gradually increased in bulk, but did not exceed the size of an egg. The skin was now discoloured with blue specks, which were taken to be veins. He could still walk with ease, and follow his business.

Two months before his admission into the Leeds Infirmary he met with a fall, and violently bent his knee, but did not strike it against anything. The tumor began immediately to enlarge; and within a few hours it extended half way up the inside of the thigh. About a fortnight after this accident the skin burst at the lowest part of the tumor, and discharged some blood. A dark-coloured fungus, about the size of a pigeon's egg, here made its appearance; and, a few weeks afterwards, the skin burst at another part of the large tumor, and some blood was again discharged. From the fissure arose another fungus, which had increased, in the course of the last week, to the size of a small melon, and now measured eight inches from one side of its base to the other. The base of the fungus frequently bled, especially when the man allowed his limb to hang down.

The whole tumor was now of an enormous size, being nineteen inches across, when the measure was carried over the last-mentioned fungus. From its highest part in the thigh to the lowest part, just below the knee, it measured seventeen inches, without including the fungus. The base of the tumor at the knee, exclusive of that part which ran up the thigh, measured twenty-four inches in circumference. The tumor was situated on the inner side of the limb, and was distinctly defined. The skin covering the disease was in some places livid, and had several fissures and small ulcerations upon it; but had not burst asunder, except in the two places above described. The tumor was soft, and gave a sensation of some contained fluid, when gently pressed with the hands alternately in opposite directions. The patient said he had walked without pain in his knee a week before his admission into the infirmary; and he had lost very little blood in his journey to Leeds. He complained of the greatest uneasiness in the highest part of the tumor. It had become hot and painful in the night-time, for some days past. His pulse was 114 in a minute; his tongue was clean; and his appetite had been good till the last few days. He had never felt any pulsation in the tumor.

In a consultation it was determined that the tumor should be laid open, by cutting off a portion of the distended integuments; and that, after removing the contents, if the sac should be found in a sound state, the disease should be treated as a simple wound; but if in a morbid state, amputation of the limb should be immediately performed.

A large oval piece of the integuments being removed, the tumor was found to contain a very large quantity of a substance not much unlike coagulated blood, but more nearly resembling the medullary part of the brain in its consistence and oily nature. It was of a variegated reddish colour, in some parts approaching to white, and, as blood issued from it, Mr. Hey conceived it was organised. This mass was partly diffused through the circumjacent parts in innumerable pouches, to which it adhered, and was partly contained in a large sac of an aponeurotic texture, which was connected with the capsule of the knee-joint. There was a great and universal effusion of blood from the internal surface of the sac, and from the pouches containing this morbid mass.

On finding such to be the nature of the case, amputation of the limb was immediately performed. Mr. Hey unfortunately, however, left a portion of the diseased surface behind on the inner part of the thigh, and hoping that a small narrow portion of the upper part of the sac would soon become a clean sore, and not impede the cure, he made the circular incision two inches below its higher part.

On examining the amputated limb, the vastus internus was found to be brown, and much softer than the other muscles, which were healthy. There were many small portions of blood extravasated in the substance of this muscle. The sac was formed on the aponeurotic covering of the muscle, and ended below where this aponeurosis begins to cover the capsular ligament of the knee. The two fungous substances above described appeared to have been only extensions of the morbid mass, where this had made its way through the sac and the integuments. The joint of the knee, and muscles of the leg, were perfectly sound.

I need not detail all the particulars after the operation. Suffice it to say the man suffered a great deal of constitutional disorder. After a few weeks, the granulations upon the stump became good, and the cicatrization was nearly completed at the end of the sixth week after the amputation. At this period the small and superficial portion of the upper part of the great sac, which Mr. Hey had unfortunately left, was healed; but a tumor, now about four inches in length, and between two and three in breadth, had gradually risen at the lower and under part of the thigh, beneath the cicatrix. This contained a soft substance, exactly similar, as far as the touch could discover, to that which had filled the large sac. This tumor became painful, and sometimes discharged a bloody serum, sometimes dark-coloured blood, through four or five small openings in the cicatrix.

Mr. Hey laid open the tumor, and removed its contents; but no advantage was gained by this proceeding. The interior surface was found to be too much diseased to produce good granulations. Blood continued to ooze out of the wound for a few days. Then the inner surface became covered with a blackish substance, which gradually extended itself, and formed a new fungus. A variety of escharotics were applied to destroy the fungous and morbid surface of the wound, but to no purpose; the growth of the fungus always exceeded the quantity destroyed. Undiluted sulphuric acid, applied freely, had very little effect.

An attempt was once more made to cut away the disease; but on examining the wound carefully, after the contained substance was removed, the muscular substance was found degenerated into a hard mass, which felt somewhat like cartilage. The adipose membrane was also diseased, and formed into large cells, which had contained the fungous substance. Hence another amputation seemed the only resource.

After this operation the whole surface of the stump seemed sound, except the principal artery, which was filled with a somewhat stiff matter, resembling coagulated blood, which prevented its bleeding. The inside of the vessel, on being touched with the scalpel, felt hard, and communicated a sensation like that of scraping bone.

The man was sent home as soon as his state would admit of it; but he died consumptive about six months afterwards. Besides this instance, in the thigh, Mr. Hey relates cases of fungus hæmatodes situated in the female breast, in the leg, in the neck (extending from the jaw to the clavicle, and producing suffocation), on the back part of the neck, on the back part of the shoulder, and at the extremity of the fore-arm, near the wrist.

"If I do not mistake (says Mr. Hey), this disease not unfrequently affects the globe of the eye, causing an enlargement of it, with the destruction of its internal organisation. If the eye is not extirpated, the sclerotic bursts at the last, a bloody sanious matter is discharged, and the patient sinks under the complaint." (p. 283.)

Besides some cases in similar situations to those mentioned by Mr. Hey, one is related by Mr. Burns, in which the hip-joint was the seat of this terrible affection. After detailing the progress of the case to the poor man's death, this author states that he found on dissection the hip-joint completely surrounded with a soft matter, resembling the brain, enclosed in thin cells, and here and there cells full of thin bloody water: the head of the thigh-bone was quite carious, as was also the acetabulum. The muscles were very pale, and almost like boiled liver, having completely lost their fibrous appearance and muscular properties. The same sort of morbid mischief was also found within the pelvis, most of the interior of the bones on the affected side being carious. An attempt had been made, before the patient died, to tap the bladder; but the trocar had only entered a cell filled with bloody water, and situated in a mass of the soft brain-like substance.

I have already stated enough in explanation of the dreadful nature of fungus hæmatodes. Little can be said of the treatment; for we know not of one medicine that seems to have the least power of putting a stop to the disease, which, when left to itself, has always proved fatal, with the exception of the rare cures by mortification of the parts, as illustrated in one example related by Schmidt, where a medullary tumour of the eye mortified, the sloughs were detached, the eyeball collapsed, and a small knob, consisting almost entirely of the contracted sclerotica, was the only remnant of this dreadful form of disease. A case of fungus hæmatodes of the left cheek is alleged, by Dr. Schutte, to have terminated favourably by the process of mortification and sloughing. (See *Grafe's Journ.*) Under Mr. Cline, there was a woman whose breast healed up after the diseased mass had been thrown off by sloughing. (*Lancet*, vol. ii. p. 401.) With a few exceptions of this kind, we have no reason to believe that there is the smallest chance of any spontaneous amendment, much less of a cure. Also, in some of the cases just now cited, it is not known whether any relapse followed.

We have seen that, when the chief part of a fungus hæmatodes is cut away, and only a small portion of its cyst left behind, the fungus is reproduced from this part, and soon becomes as formidable, nay, more formidable, than it was before, and this notwithstanding the application of the most powerful escharotics. Neither the red precipitate, the bichloride of mercury, the antimonium muriatum, nor the undiluted sulphuric acid, have been able to repress the growth of such fungus. (*Hey.*)

No known remedy has the power of checking or removing the complaint. Friction, with anodyne liniments, sometimes gives relief from pain in the early stages; but it does not retard the progress of the disease. Mercury and iodine have been alleged to do so, but I have never seen an instance of it.

In short, the only chance of cure consists in extirpating the whole of the distempered parts, removing not only the soft, brain-like fungous substance, but every particle of the cysts, sacs, or pouches in which it may be contained. The result of such proceedings is also for the most part unsuccessful, the disease returning in the same situation, or manifesting itself soon afterwards in others. Experience proclaims this discouraging truth so loudly, that many of the best surgeons now decline to undertake any operation in cases of this description; for, if the attempt fails, the patient is put to unnecessary pain, and his life is abridged by the more rapid and deplorable form in which the disease reappears. At all events, an operation is justifiable only in the early stages, while the disease is entirely local, if it ever be so—a circumstance much to be doubted. After the neighbouring glands have become affected, all chance of recovery is destroyed. Nor should the knife be resorted to for the removal of any external medullary tumor, when there is any sign of the existence of other tumors of the same nature in any of the viscera, glands, or other deep-seated organs. It is sometimes difficult to persuade patients, at an early period, to submit to amputation or extirpation, because the pain and inconvenience are not considerable; but if circumstances then warrant the performance of the operation, it should be urged with all the force which a conviction of its absolute necessity, and the fatal peril of delay, ought to inspire.

The attempts to cure a medullary tumor on a limb by cutting it away have been attended with such ill success, that many surgeons deem it advisable not to follow this method, but to amputate the limb at once. The annexed views of the matter appear to me to be most judicious and rational. First, that if an attempt be made to cut away the tumor, and save the limb, the surgeon must be careful to remove at the same time a considerable quantity of the soft parts in the circumference of the swelling. Secondly, that the earlier this is done, the more likely is it to succeed. Thirdly, that after the tumor has been taken out, an attentive examination of the surface of the wound should be made, and every suspicious part, or fibre, be cut away. Fourthly, that, should the disease still recur, amputation ought to be instantly performed. Fifthly, that caustics should never be applied to this disease. Sixthly, that, even when one of these operations effectually extirpates the distemper in the limb itself, the patient's entire recovery is always rendered exceedingly uncertain, by reason of the viscera, and other deep-seated parts, being frequently affected at the time of the operation with the same sort of disease, which state of them, though invisible, is often denoted by a sallow complexion, debility, indigestion, emaciation, and hectic.

I will quit this part of the subject with stating some of the principal differences between this form of malignant disease and scirrhus. A scirrhous tumor is, from its commencement, hard, firm, and incompressible. A scirrhous tumor situated in a gland is not always capable of being separated from the latter part, so much are the two structures blended. A scirrhus, in another situation, generally condenses the surrounding cellular substance, so as to form a kind of capsule, and assume a circumscribed appearance. When a scirrhous swelling ulcerates, a thin ichor is discharged, and a good deal of its substance is destroyed by the ulceration; other parts become affected, and the patient dies from the increased ravages of the disease, and its irritation on the constitution. Sometimes, though not always, after a scirrhus has ulcerated, it emits a fungus of a very hard texture. Such excrescence, however, is itself at last destroyed by the ulceration. Ulcerated scirrhous sores, also, frequently put on for a short time, in some places, an appearance of cicatrisation. On the other hand, fungus hæmatodes, while of moderate size, is a soft elastic swelling, with an equal surface, and a deceitful feel of fluctuation. It is, in general, quite circumscribed, and often included within a capsule. The substance of the tumor, instead of being for the most part hard, consists of a soft, pulpy, medullary matter, which readily mixes with water. When ulceration occurs, the tumor is not lessened by this process, as in scirrhus; but a fungus is emitted, and the whole swelling grows with increased rapidity. Scirrhous diseases are mostly met with in persons above forty years of age, while fungus hæmatodes generally afflicts young subjects. (*Wardrop.*) Many dissections have now proved that the substance of fungus hæmatodes may contain cellular septa, which include the pulpy, medullary matter.

Fungus hæmatodes, in its early stage, is generally attended with less acute pain than is experienced in cases of scirrhus. The tumor also has a less definite boundary than a scirrhus, and it is more difficult to say where the diseased structure terminates, and where the healthy commences. When the disease is in the breast, there is less tendency than in scirrhous cases to disease in the axillary glands, which may remain sound, though the disorder in the breast may have advanced to suppuration and ulceration. In the breast the disease is also much quicker in its progress than scirrhus. (*Sir A. Cooper, Lancet*, vol. ii. p. 399.)

In cases of scirrhus, the viscera are not in general affected at the same time with the disease; but in the majority of examples of fungus hæmatodes, this distemper is found affecting in the same subject a variety of parts. In addition to the outward tumor, we find swellings of a similar nature, perhaps, in the liver, the lungs, the mesenteric glands, or even in the brain. [For the position which fungus hæmatodes holds amongst other cancerous diseases, see Cancer.]

Fungus Hæmatodes of the Eye

Presents three stages. In the first, the exterior form of the eye is unchanged, and the disease is perceived through the cornea and pupil. In the second, the form of the eye is altered; the organ is enlarged, and its tunics are ready to give way. In the third (or *fungous* stage), the eye has burst and the tumor protrudes. (See *Mackenzie on Dis. of the Eye*, p. 647, ed. 2.)

The first symptoms are observable in the posterior chamber, an appearance like that of polished iron presenting itself at the bottom of the eye. (*Scarpa, On Diseases of the Eye*, p. 505, ed. 2.) The pupil becomes dilated and immoveable, and, instead of having its natural deep black colour, it is of a dark amber, and sometimes of a greenish hue. The change of colour becomes gradually more and more remarkable, and at length is discovered to be occasioned by a solid substance, which proceeds from the bottom of the eye towards the cornea. The surface of this substance is generally rugged and unequal, and ramifications of the central artery of the retina may sometimes be seen running across it. The front surface of the new mass at length advances as far forwards as the iris, and the amber, or brown appearance of the pupil, has, in this stage, been known to mislead surgeons into the supposition of there being a cataract, and cause them to attempt couching. The disease continuing to increase, the eyeball loses its natural figure, and assumes an irregular knobby appearance. The sclerotica also loses its white colour, and becomes of a dark blue, or livid hue. Sometimes matter now collects between the tumor and the cornea. The latter membrane in time ulcerates, and the diseased mass begins to protrude. In a few instances, it makes its way through the sclerotica, and is then covered by the conjunctiva. The surface of the excrescence is irregular, often covered with coagulated blood, and bleeds profusely from slight causes. When the fungus is very large, the most prominent parts slough away, attended with a fetid sanious discharge. In the course of the disease, the absorbent glands under the jaw, and about the parotid gland, may become contaminated. On dissection, a diseased mass is found extending forwards from the entrance of the optic nerve, the vitreous, crystalline, and aqueous humours being absorbed. The retina is annihilated, and the choroid coat propelled forwards, or quite destroyed. The tumor seems to consist of a sort of medullary matter, resembling brain. The optic nerve is thicker and harder than natural, of a brownish ash-colour, and destitute of its usual tubular appearance. In other cases the nerve is split into two or more pieces, the interspaces being filled up with the morbid growth. (*Wardrop.*) Nay, as Mr. Travers has stated, the optic ganglion, tractus opticus, and thalamus, have been repeatedly found diseased, and the surrounding adipose substance in the orbit affected to a considerable extent in places also where there was no direct communication with the diseased contents of the globe. (*Synopsis of the Diseases of the Eye*, p. 221.) Even the brain has been observed to share in the disease, sometimes dark-red spots appearing on the dura mater; sometimes small spots, containing a fluid like cream, being found between the pia mater and tunica arachnoides. Mr. Travers has a preparation, exhibiting a genuine example of the disease affecting the anterior right lobe of the cerebrum, and protruding the eye from its socket, while the eye itself was perfectly free from disease. (Op. cit. p. 223.) When the lymphatic glands at the angle of the jaw are enlarged, as they frequently are, they are also found converted into a kind of medullary matter, similar to that which composes the diseased mass in the eyeball. When the skin bursts over a diseased absorbent gland, a sloughy ulcer is produced; but no fungus is emitted, unless the affection of the gland with fungus hæmatodes be primary. In University College Hospital, a poor Irishman was under my care in the autumn of 1836, who had a large medullary tumor, covering all the submaxillary region, and which probably at first had been merely an absorbent gland. In this case, after ulceration of the skin, protrusion of the medullary substance, and sloughing of it, a thin fetid discharge, occasional hæmorrhage, and extreme emaciation and weakness, preceded the patient's death.

Fungus hæmatodes of the eye was formerly not discriminated from scirrhous cancer. We learn from Bichat, that more than one third of the patients on whom Desault operated for *supposed* carcinoma of the eye were under twelve years of age. Twenty out of twenty-four cases of fungus hæmatodes of the eye with which Mr. Wardrop has been acquainted, happened to children under twelve years of age. Now, as scirrhous cancer is rather a disease of aged than young persons, and we find, from Mr. Wardrop, that fungus hæmatodes of the eye mostly affects persons under twelve years of age, it is tolerably certain that most of Desault's cases, reported to be cancers of the eye, were in fact instances of the terrible disease now engaging our consideration. It is observed by Dr. Mackenzie, that the greatest number of cases has been observed in children from two to four years of age. Sometimes the disease occurs a few months after birth. In one instance, he saw it in an infant only nine weeks old, and the mother had noticed it six weeks earlier, so that the disease was probably congenital. On the other hand, it has been known to attack adults, or even persons of advanced age. (See *Mackenzie on Dis. of the Eye*, p. 652, ed. 2.) Another experienced gentleman in this department of surgery, states, however, that he has never yet seen a perfect example of fungus hæmatodes of the eye in an individual more than five years old. (*R. Middlemore on Dis. of the Eye*, vol. ii. p. 388.) According to Mr. Travers, the only parts of the eye and its appendages subject to be primarily attacked by hard cancer, are the lachrymal gland, conjunctiva, and eyelids; while the evidence of many cases has assured him that fungus hæmatodes may originate in any texture of the eye, with the exception of the lens and cornea. (*Synopsis, &c.* p. 216, 222, and 421.) This account, however, differs from that delivered by Mr. Wardrop and Professor Scarpa, who describe the disease as first commencing in the retina, and particularly at the point where the optic nerve enters the eye. "For (says the latter author), on the first appearance of the yellowish or greenish spot, the retina on examination is found to be entirely deficient, or, in other words, to have degenerated into the malignant fungus. It is also found that the choroid membrane, while the fungus hæmatodes is in its incipient state, does not appear to have suffered any remarkable alteration in its texture, and that it is only at a more advanced period of the disease that this membrane becomes thickened, and separated from its connection with the sclerotica. The choroid membrane, even in the most advanced stage of the disorder, preserves, more than all others, its natural texture." (*On the Principal Diseases of the Eye*, p. 507, ed. 2.) Dr. Mackenzie has observed, that the sclerotica appears to suffer less than any other part of the eye, and that in every case where the disease affected the eyeball, "we were ignorant of its existence before either the optic nerve, or retina, was changed." Mr. Middlemore also declares his belief, that the disease begins either in the retina or optic nerve. (*On Diseases of the Eye*, vol. ii. p. 402.)

The lachrymal gland is sometimes absorbed; in other instances, projected from the orbit; but, according to Mr. Middlemore's experience, it does become affected with fungus hæmatodes. (Vol. cit. p. 407.)

In cases of fungus hæmatodes the sight of young subjects is generally destroyed before the attention of parents is excited to the distemper. Frequently, however, a blow, followed by ophthalmia, precedes the growth of the diseased mass. When no external violence has occurred, the first symptom is a trivial fulness of the vessels of the conjunctiva, the iris becoming, at the same time, extremely vascular, and altered in colour, and the pupil dilated and immoveable. There is seldom much complaint made of pain: but the child is sometimes observed to be languid and feverish. In adults, fungus hæmatodes of the eye generally comes on without any apparent cause, though sometimes in consequence of a blow. At first the tunica conjunctiva is slightly reddened, and vision indistinct. The redness and obscurity of sight increase slowly, and an agonising nocturnal headache is experienced; the eye bursts, and the humours are discharged.

The time of the greatest pain is at the period when the eyeball is greatly distended by the diseased mass, and previously to the rupture of the cornea. This is the time when convulsions are disposed to occur. (See *R. Middlemore, On Diseases of the Eye*, vol. ii. p. 395.)

With regard to the cure of fungus hæmatodes of the eye, the only chance of effecting this desirable object depends upon the early extirpation of the diseased organ. It must be acknowledged, however, that most of the operations in which the morbid eye has been removed, have hitherto proved unsuccessful, owing to a recurrence of the disease. The reason of such ill success may be imputed to the optic nerve and other parts being almost always in a morbid state before an attempt is made to remove the eye. One case, however, described by Mr. Travers as having its seat in the cellular texture connecting the conjunctiva to the cornea, was operated upon, and no recurrence of the disease had occurred a twelvemonth afterwards. No other texture was affected more than the contiguity and extent of the disease explained. (*Synopsis, &c.* p. 413.) The most successful extirpation of an eye in an advanced stage of this disease, and perhaps almost the only satisfactory one at present on record, is that which was performed by Mr. Wishart, the cure remaining complete eighteen months after the operation. (See *Edin. Med. Journ.* vol. xix. p. 51.)

Donega operated in another case, as is alleged, with success. The disease had existed six weeks; and the patient was an infant, twenty months old. (See *Panizza, Sul Fungo Midollare dell' Occhio.* Pavia, 1826.) Some observations have been made by Mr. Lawrence on these cases, tending to raise a doubt of their having been examples of fungus hæmatodes. (*On Diseases of the Eye,* p. 623.) The operation has nearly always been found to fail when the disease is advanced so far that the posterior chamber is filled by the fungous mass. With the very few exceptions which there are to this statement, it may be correctly said that, as no internal medicines nor external applications afford the least hope of checking any form of the fungus hæmatodes, it is manifest that, when the distemper of the eye exceeds certain bounds, the miserable patient is placed beyond the reach of any effectual aid from surgery. In a case which I saw in April, 1821, in the London Eye Infirmary, the disease formed a mass as large as an orange, accompanied with enlarged lymphatic glands over the parotid. The patient was an infant. In this instance, Mr. Lawrence used, as a local application, the liquor opii sedativus, prepared by Battley, which was found to lessen considerably the child's sufferings.

See *Wardrop*'s Obs. on Fungus Hæmatodes. *Scarpa,* on the Principal Diseases of the Eye, chap. 21. *Saunders,* on Diseases of the Eye; and *B. Travers's* Synopsis of the Diseases of the Eye; 8vo. Lond. 1820. *G. Frick,* on Diseases of the Eye; 8vo. Lond. 1826. *W. Lawrence,* on Diseases of the Eye; 8vo. Lond. 1833. *R. Middlemore,* on Diseases of the Eye, vol. ii. 8vo. Lond. 1835. *W. Mackenzie,* on Diseases of the Eye; 8vo. Lond. 1835. *Panizza,* sul Fungo Midollare dell' Occhio. Pavia, 1826. *Wishart,* in Edin. Med. and Surgical Journ. vol. xix.

Under the terms BRONCHOCELE, MAMMA, TESTICLE, and TUMOR, will be found descriptions of fungus hæmatodes, or medullary sarcoma, in organs not particularly noticed in the preceding article.

See Dissertations on Inflammation, by *J. Burns,* vol. ii. *Hey's* Practical Obs. in Surgery, ed. 3. *John Abernethy,* Surgical Obs. 8vo. Lond. 1804. *G. Freer,* on Aneurism, 1807. Obs. on Fungus Hæmatodes, or Soft Cancer, by *James Wardrop;* 8vo. Edin. 1809. This last publication is highly deserving of attention; the disease in different organs being well described, and its character discriminated from that of scirrhous cancer.

A case of this disease is related in vol. v. of the Lond. Med. Journ. It was the consequence of an attempt to cure a ganglion by means of a seton, and it proved fatal. *Abernethy's* Surgical Obs. 8vo. Lond. 1804. See also a case of diseased Testicle, accompanied with Disease of the Lungs and Brain, by *H. Earle,* in Medico-Chirurg. Trans. vol. iii. p. 59, &c. in which vol. four other cases are recorded by *Mr. Lawrence,* p. 71, et seq. and one by *Mr. Langstaff,* p. 277; which last I remember to have visited in company with this gentleman and *Mr. Lawrence,* a short time before the patient died. Also *Langstaff's* Cases and Obs. in the 8th and 9th vols. of the same work. *Ph. J. Roux,* Voyage fait à Londres en 1814; ou Parallèle de la Chirurgie Angloise avec la Chirurgie Françoise, p. 211, &c. *Dupuytren,* Clin. Chir. t. iv. p. 53. *Wm. Kerr, M.D.,* in Cyclopædia of Practical Medicine. *Laennec,* Dict. des Sciences Méd., art Encéphaloides. *C. Bell,* Surgical Obs. part. iv. *Hodgkin,* in Med. Chir. Trans. vol. xv. *Robert Carswell,* in Illustrations of the Elementary Forms of Disease, fasciculi 2 & 3. 4to. Lond. 1833. *Andral,* Anat. Pathol. t. xi. p. 219. *J. J. Lobstein,* Anat. Pathol. t. xi. p. 419. *Cruveilhier,* Anat. Pathol. liv. iv.—viii.; and Essai sur l'Anat. Pathol. t. i. *James Copland, M.D.*, Dict. of Practical Med. art. Fungoid Disease, 8vo. 1837.

FURUNCULUS (from *furo,* to rage.) A boil, so named from the violence of the heat and inflammation attending it. A peculiar inflammation, beginning, as Dupuytren believed, in one or more of the prolongations of the interareolar cellular tissue of the cutis.

A boil is a circumscribed, very prominent, hard, deep red, inflammatory swelling, which is exceedingly painful, and commonly terminates in slow and imperfect suppuration. The figure of the tumor is that of a cone, the base of which is considerably below the surface of the skin. Upon the most elevated point of the boil a small whitish speck presents itself, between the fourth and the eighth day. After the apex of the tumor has turned white, it softens, and then a very small aperture is formed in it, from which a little pus mixed with blood, is discharged, and within which a portion of dead cellular tissue, the core, may be perceived. By Dupuytren, and other French pathologists, the manner in which this is produced is explained as follows: a boil is only an inflammation of the prolongations of cellular tissue, which penetrate between the areolæ of the cutis, accompanied by the vessels and nerves, distributed to the surface of the skin. With this inflammation is combined that of the cutis itself, and consequently these cellulo-vascular and nervous prolongations suffer constriction, partly from their own enlargement, and partly from the increased narrowness of the openings through which they pass. Hence their nutrition is interrupted, and they are converted into a slough, called the *core.* (See *M. Solon, in Dict. de Méd. et de Chir. Pratiques, art. Furoncle;* also *Dupuytren, in Clin. Chir.* t. iv. p. 210.)

The complaint is not attended with fever, except when the tumor is larger than usual, situated on a sensible part, or when several boils occur at the same time in different places. In the last circumstance they often produce in children, and even in irritable adults, restlessness, loss of appetite, spasms, &c. When boils are situated in the perinæum, between the anus and the scrotum, there may be difficulty in making water. Sometimes, when placed on the nape of the neck, shoulder, or thigh, they excite inflammation of the lymphatic vessels and glands of the neck, armpit, or groin. (See *Rayer, Mal. de la Peau,* t. ii. p. 548.) They rarely exceed a pigeon's egg in size, and may originate on any part of the body, though it is most common for them to take place on the nates, the thighs, the armpit, the nape of the neck, the back, and in other regions where the skin is thickest, and the prolongations of the areolar tissue most developed.

Young persons, and especially those of plethoric habits, are most subject to boils. The disease occurs with most frequency in the spring. (*Lassus, Pathologie Chir.* t. i. p. 16.) It is sometimes accompanied by a disordered state of the gastric organs. (*Nosographie Chir.* t. i. p. 124, edit. 2.) Frequently boils arise without any evident cause, and apparently in healthy constitutions. At other times they follow eruptive diseases and typhus. (*W. Gibson, Institutes, &c. of Surgery,* p. 48, vol. i.) In many cases several boils present themselves, either at once, or in succession, on various parts of the body.

The suppuration attending a boil is never perfect, and the matter which forms is frequently tinged with blood. The central portion of dead cellular tissue, or the *core*, is mostly detached about the tenth or twelfth day, leaving an open cylindrical cavity, extending from the apex to the base of the tumor. The pain now ceases; the skin contracts; the cavity becomes obliterated; and the cure is completed in about a fortnight. (See *Rayer, Mal. de la Peau,* t. ii. p. 547.)

The experiments of Dumeril and Bretonneau prove that a boil may sometimes be stopped by an early application of caustic; a plan, however, rarely tried.

In a very few cases, perhaps, it may be proper to try to resolve boils, by means of gentle evacuations, low diet, and cold applications. In the generality of instances, suppuration must be promoted by the use of emollient poultices. The tumor, when allowed to burst, generally does so at its apex. However, as the opening is long in forming, and too small to allow the sloughy cellular substance to be discharged, it is best, as soon as matter is known to exist in the tumor, to make a free opening with a lancet, and immediately afterwards to press out the matter and dead cellular tissue. This having been accomplished, healthy pus will be secreted, and the part will granulate and heal.

For the purpose of stimulating the cavity, and causing it to fill up, Professor Gibson, of Philadelphia, has sometimes employed a lotion of nitrate of silver.

Where there is reason to suppose the gastric organs to be in a disordered state, an emetic should be given in the early part of the treatment, and afterwards small repeated doses of any of the mild purging salts.

When an indolent hardness continues after the inflammatory and suppurative state of boils has been removed, the part should be rubbed with camphorated mercurial ointment.

Besides the above *acute* boil, authors describe a *chronic* one, which frequently occurs in subjects who have suffered severely from the small-pox, measles, lues venerea, scrofula, and in constitutions injured by the use of mercury. The *chronic* boil is commonly situated upon the extremities, is of the same size as the acute one, has a hard base, is not attended with much pain, nor any considerable discoloration of the skin, until suppuration is far advanced, and the matter is seldom quite formed before the end of three or four weeks. Sometimes several boils of the chronic kind occur together, or follow one another in the same patient. The discharge is always thinner than good pus, and when the boil is large, and has been long in suppurating, a great deal of sloughy cellular tissue must be cast off before the sore will heal.

The principal thing requisite in the local treatment of all furunculous and carbuncular tumors is to make an early free opening into them, and to press out the matter and sloughs, employing emollient poultices, till all the mortified parts are detached and removed, and afterwards simple, or more or less stimulating dressings.

[Nélaton objects to incisions in the treatment of carbuncles and boils. He does not admit that the core is a portion of dead cellular tissue, but considers it a deposit or secretion resulting from an inflammatory action of a peculiar character, and compares it to the plastic membranous productions found in inflammations of serous membranes. For a more detailed account of M. Nélaton's views, see CARBUNCLE.]

See *Pearson*'s Principles of Surgery. *Richter*, Anfangsgründe der Wundarzn. b. 1. *Lassus*, Pathologie Chir. t. i. p. 15. *W. Gibson's* Institutes of Surgery, vol. i. Philadelphia, 1824. *C. J. M. Langenbeck*, Nosologie, &c. b. i. p. 357. Gott. 1822. *M. J. Chelius*, Handb. der Chir. b. i. p. 74. Heidelb. 1826. *Dupuytren*, Clin. Chir. t. iv. p. 110. *Rayer*, Maladies de la Peau, t. ii. p. 546. 8vo. Paris, 1826.

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[GALL BLADDER.—The surgeon may be called upon to puncture the gall-bladder in cases of obstruction of the biliary ducts. Thus Frerichs mentions the case of a lady whose gall-bladder reached downwards to an inch and a half below the crest of the ilium, and elevated the abdominal wall in the form of a pear-shaped tumor. Owing to the great tension and pain it occasioned it became necessary to puncture it, and from the presence of adhesions there was no danger in effecting this. About ten ounces of bile flowed out. The proper instrument for such an operation is a hydrocele trocar.] *H. Ancell.*

GANGLION. (Γάγγλιον.) In surgery, an encysted tumor, formed in the course of a tendon, or its fibrous sheath. It is, as I have said, an encysted, circumscribed swelling, commonly free from pain, causing no alteration in the colour of the skin, and formed upon tendons in different parts of the body, but most frequently upon the hand or wrist. A French gentleman consulted me, who had one upon the upper part of his foot, which created a considerable weakness in the motion of the ankle. A ganglion has been met with over the tendon of the trochlearis, and also that of the external head of the gastrocnemius. (*Aston Key,* in *Guy's Hospital Reports*, vol. i. p. 416, 417.) An example is recorded in which a ganglion, situated exactly over the arteria radialis and the arteria superficialis volæ, was at first supposed to be an aneurism. (See *Edin. Med. and Surg. Journ. for April*, 1821.)

Ganglions often possess considerable elasticity. They may occur unpreceded by any accident: but frequently are the consequence of bruises and violent sprains. When opened they are generally found to be filled with a viscid transparent fluid resembling white of egg, or rather jelly. As Mr. Aston Key has observed, the contents of a ganglionic tumour differ from those of a common bursa mucosa. The latter secretes a fluid like ordinary synovia ; the ganglion most usually contains a substance like the outer layers of the crystalline lens, soft, viscid, and nearly solid. (See *Guy's Hospital Reports*, vol. i. p. 415.)

Different pathological views are entertained respecting the formation of ganglions. In France these tumors are regarded as dropsies or hydroceles of the sheaths of tendons. Most of them, it is observed, form over small compact joints, like those of the carpus and tarsus, possessing little motion, and covered by dense fibrous layers; or else, in the course of the sheaths of the tendons of the hand or foot. In these small arthrodial joints, and in the sheaths of tendons, the synovial membrane being covered by strong fibrous textures, cannot undergo any uniform distension by an accumulation of their secretion, which causes a protrusion of the synovial membrane at some interspace of the fibrous investment, which, however, extends over other parts of the internal cyst. It is also alleged that the ganglion has a communication with the interior of the fibrous sheath. (See *Bégin*, in *Dict. de Méd. et de Chir. Pratiques*, art. GANGLION.) Mr. Aston Key joins in representing ganglions as consisting of a double bag : the outer one tendinous and firm; the inner, like a synovial one, thin and secreting; but that, in most instances, the outer one cannot be separated from the inner. However, he differs from M. Bégin in regarding a ganglion as a new structure. (*Guy's Hospital Reports*, vol. i. p. 415.)

Stimulant applications sometimes succeed in curing ganglions, and, at one time, frictions with oleum origani, or with liniment of camphor, strengthened with tinct. canthar., were a common method. Of late years, friction with iodine liniments and the ointment of iodide of potassium, has also had extensive trials. I have often seen the tumors lessened by these means, but seldom cured; for, no sooner has the friction been discontinued, than the fluid in the cyst has accumulated again.

Compression is often employed. Persons with ganglions have been recommended to press upon them strongly with their thumb several times a day. After this has been repeated very often, the tumor has sometimes disappeared. Another method is to make pressure on ganglions by means of a piece of sheet-lead, bound upon the part with a bandage. In conjunction with this treatment, frictions with stimulating liniments or camphorated mercurial ointment are usually tried.

For the ganglion of the tendinous investment of the patella, a seton is occasionally employed by Mr. Key. "Blisters, stimulating plasters, and pressure with a bandage (he observes), are often resorted to with advantage. The more effectual plan of dispersing them altogether, is to puncture them with a lancet, to let out the contained fluid, and to employ firm pressure with a bandage and plaster. If this does not prove permanently successful, the seton becomes the most ready, the most mild, and the most effective remedy." (*Op. cit.* vol. i. p. 417.)

Ganglions may be cured by pressure sufficient to rupture the cyst; and some authors have recommended putting the hand affected upon a table, and then striking the ganglion several times with the fist, the back of a book, or a mallet. The cyst of a recent ganglion may also be burst, by compressing it strongly with the thumbs, with or without the intervention of a piece of money; the fluid is effused into the adjacent cellular membrane ; and, pressure being now employed, the opposite sides of the cavity become united by the adhesive inflammation, and the recurrence of the disease is prevented. On this principle, Sir Astley Cooper has often cured the disease.

For many years I have adopted the plan of curing ordinary ganglions by making a small puncture in them, discharging their contents, and then applying pressure. I have never seen any unpleasant effects follow this practice, and it is almost always successful. In 1825, Mr. Wm. Cumin, of Glasgow, published some cases and observations in favour of this method. He made the puncture with a cataract needle. (See *Edin. Med. Journ.* No. lxxxiv. p. 95.) I have usually drawn the skin a little towards one side, and then made a small opening in the ganglion with a lancet. In the treatment of ganglions situated on the back of the wrist, Mr. Aston Key also prefers a small puncture. For those which occupy the base of the palmar side of the fingers, he considers the puncture the only remedy; for the cyst cannot be ruptured, and blisters rarely answer. (See *Guy's Hospital Reports,* vol. i. p. 416.)

When ganglions become extremely inconvenient, either by obstructing the functions of a joint or causing pain, they should be carefully dissected out by first making a longitudinal incision in the skin covering them, then separating the cyst on every side from the contiguous parts, and, lastly, cutting every particle of it off the subjacent tendon or fascia.

The operation being accomplished, the skin is to be brought together with sticking plaster, and a compress placed over the situation of the tumor, with the view of healing the wound and the cavity by adhesion.

When the ganglion has burst, or is ulcerated, it is best to remove the diseased skin, together with the cyst; and of course the incision must be oval, or circular, as may seem most convenient. The grand object is not to allow any particle of the cyst to remain behind, as it would be very likely to throw out a fungus, and prevent a cure. In *Warner's Cases of Surgery* is an account of two considerable ganglions, which this gentleman, in imitation of Celsus and Paulus Ægineta, thought it right to extirpate. These had become adherent to the flexor tendons of the fingers. In the operation, he was obliged to cut the transverse ligament of the wrist; and the patients, who before could not shut their hands, nor close their fingers, perfectly regained the use of these parts. Mr. Gooch relates a case of the same kind, which had been occasioned by a violent bruise, three or four years before. The tumor reached from the wrist to the middle of the hand, and created a great deal of pain. Mr. Gooch extirpated it, and then restored the position of the hand, and free motion of the joint by the use of emollient applications, and suitable pressure, made with a machine constructed for the purpose. (See Bursa Mucosa.)

Other cases, confirming the safety of cutting out ganglions, are recorded in the London Medical Journal for 1787, p. 154; by *Eller*, in Mém. de l'Acad. des Sciences de Berlin, t. ii. ann. 1746; *Schmucker*, in Chir. Wahrnehmungen, b. i. p. 332; *Girard*, Lupiologie. See *Warner's* Cases in Surgery. Chirurgical Works of *B. Gooch*, vol. ii. p. 376. *Richter*, Anfangsgr. der Wundarzn. b. i. Lassus, Pathologie Chir. t. i. p. 399. Dict. des Science, Méd. t. xvii. p. 311. *Cumin*, in Edin. Med. and Surgical Journ. No. 84. *C. Aston Key*, in Guy's Hospital Reports, vol. i. 8vo. Lond. 1836.

GANGRENE (from *γραίνω*, to feed upon). So named for its eating away the flesh. Authors have generally distinguished mortification into two stages: the first, or incipient one, they name *gangrene*, which is attended with a sudden diminution of pain; a livid discoloration of the part, which, after being yellowish, becomes of a greenish hue; a detachment of the cuticle, under which a turbid fluid is effused; and lastly, on touching the part, a crepitus is perceptible, owing to the generation of air in the gangrenous parts.

When the part has become quite cold, black, fibrous, incapable of moving, and destitute of all feeling, circulation, and life, this is the second stage of mortification, termed *sphacelus*. Gangrene, however, is frequently used synonymously with the word mortification. (See Mortification, and Hospital Gangrene.)

GASTROCELE (from *γαστὴρ*, the stomach, and *κήλη*, a tumour). A hernia of the stomach.

GASTRORAPHIA, or gastroraphe (from *γαστήρ*, the belly, and *ῥαφὴ*, a suture). A suture of the belly, or some of its contents.

Although the term *gastroraphe*, in strictness of etymology, signifies the sewing up of any wound of the belly, yet Mr. S. Sharp informs us that, in his time, the word implied that the wound of the abdomen was complicated with another of the bowels.

The operation of sewing up a wound in the bowels, can only take place when they fall out of the abdomen, and the wound in them is visible. And, indeed, even in these circumstances, the employment of sutures is a practice, the propriety of which is questionable, as will be further considered in the article Wounds.

Gastroraphe, or merely sewing up a wound of the parietes of the abdomen, is usually done with the common interrupted suture (see Suture), but occasionally with the quilled suture or with pins.

In from three to eight days, the sutures may generally be removed, and sticking plaster alone employed. (See Wounds of the Abdomen.)

M. Pibrac, in the third volume of the *Mém. de l'Acad. Royale de Chir.*, records several interesting cases, which fully prove that wounds of the belly readily unite by means of a suitable posture and a proper bandage, without the practice of gastroraphe. These cases, however, are less decisive and convincing (if possible to be so) than the relations of the Cæsarean operation, the extensive wound of which has often been healed by simple means, after the failure of sutures.

Under certain circumstances, however, it may be essentially necessary to practise gastroraphe. For instance, were a large wound to be made across the parietes of the abdomen, a suture might become indispensably requisite to prevent the protrusion of the bowels. Yet even in this case, the sutures should be as few in number as possible. (See Sutures.)

[Gastroraphe has of late years been frequently employed after the operation of ovariotomy. The interrupted suture with silk or silver wire is preferred by most surgeons, but the quill and twisted sutures have also been used. In the present day adhesive plaster alone would not be depended upon, to unite wounds implicating the whole thickness of the abdominal wall.]

I shall conclude this article with a fact, perhaps more curious than instructive, related by M. Bordier, of Pondicherry, in the *Journal de Médecine,* vol. xxvi. p. 538. An Indian soldier, angry with his wife, killed her, and attempted to destroy himself by giving himself a wound with a broad kind of dagger in the abdomen, so as to cause a protrusion of the bowels. A doctor of the country, being sent for, dissected between the muscles and skin, and introduced a thin piece of lead, which kept up the bowels. The wound soon healed up. the lead having produced no inconvenience. The man was afterwards hanged, and M. Bordier, when the body was opened, assured himself more particularly of the fact.

GLAUCOMA (from *γλαυκὸς*, bluish green,) has been generally defined to be a greenish opacity of the vitreous humour, attended with the loss or a considerable impairment of sight. (*Weller, On Dis. of the Eye, transl. by Monteith*, vol. ii. p. 27.) Mr. Lawrence describes the colour as sea-green, clear green, muddy green, or yellowish green. (*On Dis. of the Eye*, vol. iii. p. 494.) As will be presently explained, however, the vitreous humour is not invariably implicated in some of the cases, perhaps incorrectly classed with glaucoma. Professor Beer considers the subjects of glaucoma, and the cataracta viridis, or glaucomatosa, together. He observes, that these diseases occur rather frequently, not only as true effects of inflammation of the eye, but sometimes quite unpreceded by this affection. Although glaucoma may continue for a long time as the only disorder, without the crystalline lens being changed in the slightest degree; yet Beer has never seen the case reversed, and the lens become altered as it does in glaucoma first, and the vitreous humour afterwards. In what this author describes as gouty ophthalmia, glaucoma is said to come on with the following symptoms: the iris is not observed to expand, but rather to become contracted; the pupil is not equally dilated, but extends more towards the canthi, the iris at length becoming scarcely perceptible towards each angle of the eye, especially the outer one, and the pupil of course assuming something of the appearance which is seen in the eye of a ruminating animal. In a case, however, which I once saw in the London Eye Infirmary, under Mr. Lawrence, it was particularly remarked that the diameter of the pupil was not greatest in the transverse direction; a circumstance which Beer's account would lead us to expect as constant. And it merits notice that, as the iris shrinks towards the margin of the cornea, its pupillary edge is inverted towards the lens, so that its smaller circle completely disappears. In this very dilated state of the pupil, a grey greenish opacity is perceived, seeming to be very deep, and arising from a real loss of transparency in the vitreous humour. At this period, the lens evidently becomes opaque, acquiring a sea-green hue, and the cataracta viridis, or glaucomatosa, now swells and appears to project forwards into the anterior chamber. The pain then becomes more incessant and violent; the varicose affection of the eyeball seriously increases; and the eyesight, which began hourly to diminish from the moment when the pupil was first observed to be in any degree expanded and opaque, and the iris motionless, is now so entirely destroyed, that not the slightest perception of *external* light remains, though the patient may vainly congratulate himself on discerning luminous appearances produced within the eye itself, in the form of a fiery, shining circle, especially when the organ is gently pressed upon. An eye in this condition (says Beer) has really a look as if it were dead, the cornea being as flaccid and void of lustre as in a corpse. Finally, when these symptoms have attained their utmost pitch, an atrophy of the eyeball follows, and the painful sensations about the organ cease. In corpulent individuals, however, they still continue with greater violence. Sooner or later, the other eye is also attacked with arthritic iritis, or ophthalmia, or becomes affected with glaucoma, which is ushered in by violent and incessant headache. (*Beer*, *Lehre von den Augenkrankheiten*, b. i. p. 581, &c. 8vo. Wien, 1813.) According to this author, glaucoma and the green cataract are never the consequences of any description of ophthalmia, but what he terms *arthritic*. (b. ii. p. 255. Wien, 1817.) Mr. Lawrence inclines to Beer's opinion; for, he observes, that glaucoma appears to him to be a chronic form of arthritic inflammation of the internal tunics; and, he adds, that it certainly occurs more frequently in gouty persons than others. (*On Dis. of the Eye* ed. iii. p. 495.) I have stated that glaucoma is usually regarded as an opacity of the vitreous humour. The following, however, were the particulars observed by Dr. Mackenzie in the dissection of several glaucomatous eyes. 1. The lens of a yellow, amber, or reddish brown colour, especially towards its centre; its consistence firm, and its transparency perfect, or nearly so. In some cases, however, the reddish brown colour of the central part of the posterior lamellæ was so deep as considerably to impair its transparency. The part in question was also drier than natural. 2. The vitreous humour in a fluid state; perfectly pellucid, colourless, or slightly yellow: no trace of hyaloid membrane. 3. The choroid coat, and especially the portion of it in contact with the retina, of a light brown colour, with little or no appearance of pigmentum nigrum. 4. In the retina, no trace of limbus luteus, or foramen centrale.

[Dr. Mackenzie attributes the greenish appearance of the deep-seated parts of the eye in glaucoma, to the first of these changes, viz.: the amber or yellowish brown colour of the lens, and states that in some incipient cases this was the only change that could be detected on dissection. The glaucomatous lens, viewed in its natural situation, seems of a greenish, sometimes of a deep sea-green colour. Taken out of the eye, all greenness is gone, both in the eye deprived of its crystalline, and in the lens under examination. In glaucoma, then, the lens has become in a certain sense diplo-chromatic. The lens and the vitreous humour, which is also often yellowish in glaucoma, have the power of analysing the incident light, absorbing the violet, blue, and red rays, leaving the yellow and green rays but little affected, so that they are dispersed; whence results the apparently green appearance of the humours. (*On Dis. of the Eye*, ed. iv. p. 897).

This author, however, thinks that in the later stages of the disease the lens may become opaque and cataractous, as well as glaucomatous, constituting the cataracta viridis or glaucomatosa of Beer.]

In some other cases which Mr. Middlemore had an opportunity of dissecting, the vitreous humour was of a yellow tinge, as remarked by Scarpa in his examinations; and the lens had undergone no other alteration than such as generally takes place in advanced life, being of a green, deep yellow or amber. The vitreous humour was not much increased in quantity. The choroid pigment was in a great measure absent; and the septa of the hyaloid membrane were absorbed. See *Middlemore on Dis. of the Eye*, vol. ii. p. 7.)

This gentleman describes two varieties of glaucoma: first, that which occurs in old age, and is productive of mere impairment of vision, without any material degree of pain, and, as he believes, without any inflammation; but in which the transparency of the vitreous humour is always diminished, and its colour altered, either to a yellowish or greenish tinge. Secondly, that variety which takes place from inflammation of the septa of the vitreous humour, which is marked by symptoms of a more or less severe character; is often attended with chronic inflammation of other deeply seated textures, and usually leads to the total destruction of vision. Hence, says Mr. Middlemore, the appearances of the membranes and humours will not always be the same.

In Mr. Lawrence's valuable treatise are collected the particulars of other dissections of glaucomatous eyes by Walther, Eble, and Rosas. In the eyes of a man examined by Walther, the lens and vitreous humour were in the normal state, and perfectly transparent. In the retinæ were numerous black and partly reddish spots, roundish, and of various size. In a glaucomatous eye dissected by Eble, the covering of the uvea was reddish brown, instead of the usual dark pigment. The vessels of the choroid were varicose in several places; and the pigment, which was much lighter than natural, had disappeared in several places. The retina was extraordinarily soft, the lens was small, firm, and of amber colour, and its capsule was partially opaque. The whole vitreous humour had a yellowish tint; and there were scattered through it twenty or thirty points of a grey, brownish green, or sea-green colour. In another case, that of a man of 70, who had frequently experienced arthritic inflammation of the eyes, the vitreous humour was partially thickened, and firmer. The retina exhibited some varicose enlargements, and it was of a dark grey colour.

On this part of the subject, Mr. Lawrence offers the following judicious reflections: "From the preceding pathological facts, we may conclude that the vitreous humour is not originally and essentially the seat of glaucoma; we may perhaps draw the further inference that affections, in some respects different, are included under that term. When we consider the numerous gradations between the acute internal arthritic opthalmia which destroys sight at once, and the imperfection of vision which comes on in glaucoma, properly so called; also that the difference of morbid changes may be expected, according to the stage of the complaint; we shall not be surprised at finding that the results of examination are not always alike." (See *Lawrence*, *On Dis. of the Eye*, ed. 3. p. 497.

In glaucoma, the pupil is green, or yellowish green: and if the eye be looked at laterally, no discoloration is seen. In cataract, the pupil is grey, or greyish white, and it has the same appearance in whatever direction it is viewed. In glaucoma, the loss of vision is not in direct proportion to the change of colour in the pupil. With an inconsiderable change, vision may be entirely destroyed, or seriously impaired; but in cataract there is a direct proportion between the degree of opacity and the injury to sight. In cataract, vision is best in a weak light; in glaucoma it is stronger in a powerful light, because, as the retina is less sensible, more light is required to make an impression on it. (*Lawrence*, op. cit. p. 498.)

Dr. Mackenzie was the first to apply the catoptrical test to the diagnosis of glaucoma from incipient cataract. The distinction between the appearances presented to the observer by the reflections from the flame of a candle in the two diseases, are mentioned in the article CATARACT.

Glaucoma, after it is conjoined with a varicose disease of the eyeball, is set down by Beer as incurable. According to Weller, when the vitreous humour first begins to be muddy, the disease may sometimes be checked. (*On Dis. of the Eye*, vol. ii. p. 29.)

Beer states that no treatment will avail in checking glaucoma, and preventing complete amaurosis. The prognosis is unquestionably most unpromising. I have seen many cases of glaucoma treated, but never with success. Mr. Lawrence holds out more encouragement than Beer, and recommends antiphlogistic treatment, as cupping; active purgatives; mercury, long continued, but not used so as to cause salivation; a regulated diet, and repose of the organ. (*On Dis. of the Eye*, p. 394.) Counter-irritation has also been found useful, and especially frictions with antimonial ointment between the shoulders. Arthritic inflammation of the eye is often greatly benefited by tonics, as precipitated carbonate of iron and sulphate of quinine. After depletion, one very experienced practitioner sanctions the trial of them in glaucoma. (See *Mackenzie, On Dis. of the Eye*, p. 899, ed. 4.) On the principle of there being a superabundance of dissolved vitreous humour, the same gentleman conceives that occasionally puncturing the sclerotica and choroid with a broad iris knife might prove serviceable. He also states that he has known glaucoma operated upon for cataract, and the removal of the amber-coloured lens followed by a considerable accession of vision. But as he had also known violent inflammation ensue, he does not venture to recommend this proceeding for general adoption. A grooved cataract needle, as recommended by Mr. Middlemore, seems to me the best instrument for puncturing the vitreous humour. Mr. Middlemore finds that no remedies will interrupt the progress of *senile glaucoma*, and he deems no treatment requisite, unless circumstances denote that the affection is rendered worse by the existence of chronic inflammation of the septa of the vitreous humour or neighbouring textures. If this be the case, he would employ mild purgatives, and, perhaps a little mercury, with permanent counter-irritation and the avoidance of all exertion of the eye, particularly in artificial light, or on minute objects.

In the *acute* or *inflammatory* glaucoma, Mr. Middlemore is an advocate for antiphlogistic treatment, followed up by a seton or blister to the temple, or above the eyebrow. Sometimes he excites slight irritation on the skin of the temple with nitrate of silver. Occasionally he has punctured the vitreous humour with a very fine grooved needle. He advises this to be done whenever there is much local pain, evidently depending on the tension of the globe, "and particularly when vision is nearly destroyed, and the opposite organ is becoming similarly affected." In one or two cases, where the muddiness of the vitreous humour was evidently consequent on inflammation, Mr. Middlemore, after the subsidence of the latter affection, discharged the greater part of the turbid fluid with the needle, in the hope that the new secretion would be more transparent; and he states that he has practised this operation with the greatest advantage to the patient's vision. (See *R. Middlemore*, op. cit. vol. ii. p. 19—20) The dilatation of the pupil with belladonna sometimes improves vision, when this partly remains; but the benefit is merely temporary; and sometimes it causes an increased confusion of sight.

[The following remarks upon glaucoma are based upon an analysis of fifty-one cases which have been treated in the Royal London Ophthalmic Hospital, Moorfields, during 1857, 1858, and 1859.

We recognise two states of glaucoma, viz. the acute and chronic.

Acute glaucoma, nineteen cases.

A patient attacked by this disease presents the following symptoms, viz. severe pain in the eye attacked, and in the region of the fifth nerve of the corresponding side, diffuse redness of the subconjunctival tissue, sometimes accompanied with slight chemosis, and profuse watering occasionally. The eye feels hard, the cornea sometimes appears nebulous, the aqueous humour slightly turbid, the pupil irregularly dilated and fixed, its area greyish, or greenish turbid; vision is entirely lost, or reduced to faint perception of light. The turbid state of the media (humours of the eye) rarely admits of an ophthalmoscopic examination. All the cases where the fundus of the globe and the optic nerve could be seen, presented unmistakable signs of pressure at the optic nerve, generally with blood spots upon it or in the neighbouring retina. The fundus of the globe appears of a turbid red colour, and the optic nerve also, which has a grey red circle near its periphery; the retinal vessels while in the optic nerve are thin and hardly perceptible, but up to the retinal aperture are gorged with blood; the blood spots are sometimes confined to the optic nerve and the part of the retina nearest to it, in other cases the whole of the fundus is sprinkled with them.

The cases of acute glaucoma which came under my notice have been treated by Dr. Graefe's method, viz. by excision of a portion of iris, and with excellent results.

Such an acute attack, if left to itself, or treated in any other way, except by excision of part of the iris, may subside spontaneously, and vision become restored; but the attack will return, though perhaps in a less acute form, and finally lead to loss of sight, and the eye will assume the characteristic appearance of chronic glaucoma.

In eyes which have been operated upon for this disease, the fundus, optic nerve, choroid, retina, &c. sometimes become visible the third day after the operation, and the retina is then frequently seen sprinkled with round and with large diffused blood spots; the latter are more frequent near the equator of the eye. The optic nerve is more red and well defined, the retinal vessels are of proportionate diameter throughout; sometimes the optic nerve has a more whitish, waxy appearance; in other cases the grey pink ring remains near its periphery: but in all cases the retinal vessels (in the nerve) lost their thin ill-defined shape and became gorged with blood. The round blood spots may remain for months, but the large diffused ones frequently disappear in a few weeks. The optic nerve may assume its normal pink appearance, or become more or less cupped. The youngest of the patients attacked by acute glaucoma, was a woman of 35 years of age, the oldest a man of 70. Occupation has no influence upon its occurrence. Thirteen of the patients were thin and pale, one stout and pale, and one in good health. Eleven of the fifteen had premonitory symptoms of two years' duration, while in others they were only noticed for a few weeks; they consisted in occasional increased hardness of the eye, pains in the forehead and temple, attacks of dimness of sight (especially during mental excitement), and in the perception of a halo (rainbow) round the candle. A few were troubled with flashes of light in the eye. Most of the cases became presbyopic, and had to use convex glasses. In four the attack came on without any premonitory symptoms, and in these the anterior chamber was nearly of the normal size. A rapid increase of presbyopia, of pains in the temple and forehead, and shorter intervals between the attacks of dimness, preceded the acute attack in eight cases. Three of the cases were attacked in both eyes simultaneously. We are in the habit of examining what the patient calls his sound eye, with a view of studying the prodroma of the disease. In most of the cases of acute and chronic glaucoma the other (sound) eye offers one or several of the symptoms mentioned above as premonitory. None of these eyes appeared to me to be ophthalmoscopically healthy; there was generally a marked loss of resistance to pressure at the optic nerve (*i.e.* the circulation was easily suspended); there were also increased redness of the nerve, with frequently the grey pink circle near its periphery, and some decrease of the amount of light observed in the vitreous space.

An acute attack not unfrequently occurs in those suffering from chronic glaucoma. The acute glaucoma has been observed in eyes which were blind from cerebral amaurosis; in cases where the iris and choroid had suffered from syphilis; in eyes where vision had been destroyed by chronic glaucoma; and where an advanced stage of atrophy of the optic nerve, choroid, &c. already existed.

Chronic glaucoma, thirty-two cases.

An eye affected with chronic glaucoma in its advanced stage (*i.e.* vision reduced to mere perception of light), generally presents the following symptoms: the globe is hard, the sclerotic is discoloured; enlarged, tortuous, subconjunctival vessels emerge into view in the ciliary region; the cornea is flat, and has more or less lost its sensibility, as shown by Von Graefe; its epithelium not unfrequently peels off in flakes; the iris is discoloured and almost in contact with the cornea. The pupil is enlarged, irregular, and fixed; it appears greyish or greyish green. An ophthalmoscopic examination is possible almost in all cases, though the pupil may appear very hazy. The fundus appears red, and the optic nerve well defined and cupped. The retinal veins are gorged with blood up to the margin of the cup, where they either disappear entirely, or become thin and scarce while in the cup. Pulsation of the arteries in the cup exists either spontaneously or can be produced by gentle pressure on the eye. The ages of the thirty-two cases varied from 43 to 76; they were, with some exceptions, weakly, pale, thin persons, with feeble pulse: five had suffered from severe rheumatic attacks; three from erysipelas of the head shortly before the premonitory symptoms set in; others attributed the cause of the disease to mental anxiety. With two or three exceptions all the patients had been using convex glasses for reading. The time when the first symptoms of the disease appeared, varied from fifteen years to three months. They consisted of a halo round the candle, occasional mist before the eyes, increase of presbyopia, occasional pains in the temples; in several cases the sight was lost without any pain or inflammatory symptoms: others had inflammatory attacks and pain after the eye had been blind, and others shortly before it became blind. As the disease progresses tension of the eye gradually increases, the iris advances, the cornea becomes flat, the vessels which merge in the ciliary region enlarge, the pupil becomes irregular, then less moveable, and finally neither acts by itself nor in concert with the fellow-pupil; its area becomes greyish or greenish. In fifteen out of the thirty-two cases both eyes were attacked, and in three to an equal extent; three of the cases had repeated slight attacks of inflammation (sub-acute glaucoma), and several had chronic glaucoma in one eye, while the sound eye was seized by an acute attack.

Changes of the retina and optic nerve in glaucoma.

Vision. In the beginning of acute and chronic glaucoma we observe a weakness of sight, which obliges the patient to wear convex glasses for near small objects, and an inability to recognise distant small objects; this is followed by occasional attacks of dimness: the patients, for instance, suddenly lose sight of an object, or it appears indistinct, and as if seen through a grey mist; they then notice a halo of different colours round the candle; at a later period they complain of not being able to see so many objects round them at once as formerly, *i.e.* their field of vision becomes contracted. The attacks of pain generally appear at this period. The upper and lower parts of the retina lose, in most cases, their sensibility sooner than the outer and inner. The loss of vision advanced in a few cases from the temple towards the nose, without meeting with a misty portion intervening between the blind and sound part. The field of vision has often in an advanced stage somewhat the shape of a slit. It was frequently observed that when vision was reduced to perception of shadows, the inner portions of the retina retained their sensibility the longest. Flashes of light in the dark and with the eyes closed, were observed in one case, which, however, was not a pure case of glaucoma. A patient may lose the sight of one eye without being aware of it. Other cases have occurred where a considerable loss of blood hastened the progress of glaucoma. Sudden loss of vision in slightly glaucomatous eyes, with or without pain, has occurred after stooping, during mental excitement, and during several other incidents which disturbed the circulation. Vision may return and then become gradually lost, or the eye may remain blind.

As for Von Graefe's operation it may be said that the more the turbid state of the media contribute to the impairment of vision, the better is the prognosis of the case ; and also that those patients who were operated upon in due time, have not only retained the vision they had before the operation; but sight has, in the great majority been considerably improved.

Retina. Ophthalmoscopic examination.

A satisfactory idea of the state of this membrane cannot be formed in most cases of acute, and in some of chronic glaucoma, on account of the turbid state of the media. In all cases of chronic glaucoma we find, if the media are transparent, a slight loss of transparency of the retina; in advanced cases it appears hazy and greyish; the result of this state is that a smaller amount of light is obtained in the vitreous space than is usual, because the transparency of the retina is impaired by the glaucomatous changes in it, and thus intercepts the light. In all cases of acute and chronic glaucoma, which were complicated with a turbid state of the media, ecchymoses upon, in, and beneath the retina were observed, and a few fresh or old ecchymoses were seen in cases of chronic glaucoma with transparent media. Those which are in the substance of the retina are generally small, round, and well-defined; they remain persistent for two to three months, turn brown, and gradually disappear: those beneath the retina are flat, large and generally numerous; they disappear in from two to six weeks, leaving behind an irregular distribution of the pigment granules of the hexagonal cells; they impair vision much less than those in the substance of the retina, and are most numerous beneath the middle and anterior portions of that membrane. Those effusions of blood which perforate the retina towards the vitreous humour appear as small red clouds suspended in front of the retina; they are generally accompanied by grey opaque portions of the vitreous humour. Ecchymoses at the yellow spot, or optic nerve, are more dangerous to vision than those which occur around it. The appearance of these ecchymoses, I believe, coincides with the inflammatory attacks of glaucoma.

Retinal vessels. The retinal vessels in the fellow eye to the one attacked by acute glaucoma were, with one exception, large, numerous, gorged with blood, and unequally dilated. On the diseased side in all the cases of chronic glaucoma there was a decrease in the number of the arteries, and the veins appeared unequally dilated. The retina which carried the smaller number of blood-vessels was the most diseased; in some of the glaucomatous eyes which had been blind for years there were only one or two thin vessels traceable in the retina. After Von Graefe's operation, an increase in the diameter and number of the vessels in less advanced cases of chronic glaucoma and a return to the normal straight course was observed. The vessels of the retina were, in some of the cases of acute glaucoma, numerous, tortuous, and gorged with blood; in others they were thin and few in number. The retinal vessels could not be traced to many of the ecchymoses. The optic nerve and the retinal vessels presented signs of intra-ocular pressure in all cases of acute and chronic glaucoma. These are

1. A facility of interrupting the circulation in the optic nerve by slight pressure upon the eye.
2. A spontaneous pulse in the arteries extending from the entrance of the artery to the point where it passes into the retina. This was in some accompanied by a movement of the veins, synchronous with it.
3. Decrease of all the vessels while in the optic nerve.
4. A change of colour of the optic nerve.
5. A cupping of the optic nerve in chronic and (after the inflammatory attack has passed by) in most of the acute cases of glaucoma, with a lateral displacement of the vessels, proportionate to the depth and the sharpness of the margin of the cup.

The following remarks regarding the state of the optic nerve and of the retinal vessels in it have been taken from the analysis of the above fifty-one cases:—

The changes observed in the sound eye (the fellow eye suffering from *chronic* glaucoma) were:

A. A decrease of vessels, chiefly of arteries.

B. An optic nerve in some cases of a pale-pink; in others of a pale waxy appearance; in many cases with a greyish pink circle near its periphery, and a diminished resistance to pressure; in several cases with a tendency to an arterial pulse.

The changes observed in the sound eye (the fellow eye suffering from acute glaucoma) were: an optic nerve of a pale pink colour and rather small in size, the retinal vessels in it being thin and showing a marked loss of resistance to pressure.

Changes in the eye suffering from chronic glaucoma: A cupped optic nerve, with irregularities in the size and course of the retinal vessels. The cup or excavation in the optic nerve is slight at first, and frequently confined to a part of the nerve only, but may comprise its whole surface. It becomes gradually deeper, and in advanced cases reaches to the opaque portion of the optic nerve; in these cases the whole of the optic nerve fibres, from the retinal to the scleral aperture, have been destroyed; the retinal vessels are displaced sidewards and pressed against the walls and the margin of the cup; the latter is formed by the scleral and choroidal aperture; the full retinal veins arrive at the edge of the cup, then wind round it, and reappear thin in the cup, or disappear after having passed the edge. The cupped optic nerve has, in chronic glaucoma, a grey white, or bluish grey appearance, which may turn red by effusions of blood; the vessels in a deep cup are thin, and pulsation of the arteries is rarely observed. The arterial pulse is frequently met with in the early stage of cupping of the nerve, and in eyes which suffer from slight inflammatory (glaucomatous) attacks. The optic nerve in less advanced cases assumes, after Von Graefe's operation, a waxy white appearance, the vessels become more numerous and can be traced over the margin of the cup.

The loss of vision is attributed to the destruction of the optic nerve fibres, these are pressed against the scleral and choroidal aperture: it has several times been noticed where the cup was confined to one side of the nerve, that the retina of that side was paralysed. The cup is completed most rapidly when an acute attack occurs in a chronic glaucomatous eye, and it is formed secondarily in eyes which have suffered from acute attacks of glaucoma.

In the eye attacked by acute glaucoma, in one case the optic nerve appeared flat and full and the vessels thin; in two other cases the vessels were thick and tortuous and the optic nerve small and red; and in five cases was the optic nerve deep red, with a grey circle near its periphery, and the vessels were thin and hardly perceptible while in the nerve. The red colour of the nerve is due to imbibition of blood and to small hæmorrhages from vessels into the nerve. The nerve after Von Graefe's operation, remains red for a few days and then assumes a greyish-white colour, which, in the course of a year, in three cases, was followed by a moderately cupped bluish-grey optic nerve; the vessels in the retina and in the cup being equally large.

Pathology.—Dissection of eleven eyes which suffered from chronic glaucomatous changes. The eyes had no perception of light. The tension of the globes was lessened after excision. The consistence of the vitreous was greater (harder) than normal in eight, and somewhat viscid in one case. It had a yellowish tinge in all cases. It was replaced by yellowish fluid in an eye which was staphylomatous, and in another, where circumscribed effusions of blood had occurred, between sclera and choroid, thus displacing the latter with the retina. The fluid state did not extend beyond the displaced or staphylomatous portions. The whole of the vitreous had escaped in two cases in which bleeding had occurred between sclera and choroid, the latter having been displaced.

The choroid appeared very rotten, and was, in a few cases, gorged with blood, its pigment appeared normal round the optic nerve, but had in many places disappeared from the equator of the eye to the ora serrata; there it was thinned and atrophied; we may say that the choroid was the most atrophied where the retina was most changed, *i. e.* between the equator of the eye and the ora serrata. The hexagonal cells had, in most cases, their normal shape round the optic nerve; further on they became rounded off, and had entirely disappeared from the staphylomatous choroid and from its anterior portions; their granules appeared smaller, they had lost their lustre; the changes of the hexagonal cells were proportionate to those of Jacob's membrane (rods and bulbs).

The retina.—In most cases it appeared transparent to the naked eye, but hazy and pigment-sprinkled when examined microscopically; its tissue, was very rotten and more so from the equator forwards; it was in apposition with the choroid. No yellow spot was perceptible in two cases.

We shall treat of its constituents separately.

The rods and bulbs.—They were present round the optic nerve in all cases; but appeared large, swollen, and had lost their distinctness of outline; in many places they were greyish and sprinkled with minute grey granules. The swelling, indistinctness and greyish colour increased towards the equator; and no rods were found at most places near the ora serrata; there the outer surface of the retina had an uneven, greyish, translucent, amorphous appearance.

The radial fibres (continuation of some of the rods).—Those in the retina round the optic nerve were thin and ill-defined; those further on appeared still thinner; many had shrivelled away; others were hardly perceptible, especially those beyond the equator of the eye. I could only find them extend up to the inner membrana limitans in one eye. This change of the radial fibres gave the nerve cells the appearance of being heaped together indiscriminately; they had lost their regular arrangement into piles.

The nerve cells.—They could easily be distinguished from healthy ones by their slight loss of transparency; they resembled, in some instances, agglomerations of large fat globules, by their resistance to chromic acid (they did not become granular), and by their appearing swollen. The thickness of the layer of nerve cells had decreased round the optic nerve; it became thinner further on, and hardly any nerve cells were perceptible near the ora serrata. The layer of nerve cells which is level with the ganglion cells and with the blood-vessels, had in all cases been reduced to a finely granular hazy mass, which was sprinkled with grey and with brownish patches and in most cases with fresh blood spots, only in one instance could I see some ganglion cells.

The vessels.—A glaucomatous retina is remarkable for the great increase of capillaries: this vascularity is greatest in the thicker parts of the retina, but is still very considerable near the ora serrata, so that at that part the capillaries and an amorphous, grey, translucent, rotten membrane are the only remnants of the retina.

The arteries are few and thin.

The veins are varicose; an interruption of the inner coat of the veins, with a dilatation of this weaker portion of their walls, has been noticed in several cases.

The blood effusions (round blood spots), which are frequently observed in the retina round the optic nerve and near the equator, appear to have come from the veins and generally from their lower and lateral part, the blood spreading among the nerve cells or perforating the retina and displacing the rods. Sections of the vessels show that they are flattened in different directions. The capillaries form an exceedingly dense network of angular and arched canals, which, in many instances, are filled by yellowish serum; in others by serum and by pale swollen blood corpuscles; in others they are empty. All the capillaries are large and varicose; many are aneurismatic (the latter fact was first noticed by Mr. W. Hulke), especially those in the portions of the retina near the ora serrata. The aneurismata are empty in most cases; in a few they were filled with a brownish, yellowish or black amorphous substance. The retina in one case was sprinkled with large transparent cells, some of which were near blood-vessels; to many of these no blood-vessels could be traced: either the aneurismatic pouches had been left and the adjoining vessel destroyed, or these large cells were some new formation; they resembled the aneurismatic dilatations in their disappearing or shrivelling up on the addition of acetic acid. In other places the capillaries appeared to have been ruptured, and their contents, escaping among the nerve cells, to have caused the brownish patchy appearance of that layer.

The optic nerve fibres.—Only in a few cases, and then only round the optic nerve, was I able to trace optic nerve fibres. The hyaloid surface of the retina was sprinkled with minute black pigment granules, many of which had a linear arrangement.

The optic nerve (where it passes into the eye).

The transparent portion of the optic nerve fibres was found destroyed in all cases; the cup thus formed in the optic nerve was filled by yellowish fluid, by an amorphous greyish mass, and in several cases, by blood. The sides of the cup were formed by the retinal, choroidal, and by part of the scleral aperture, the margin of the latter projected into the cup; the vessels were pressed upon the scleral margin. The fibrous tissue which formed the bottom of the cup was considerably thickened in several cases; in others the optic nerve (beyond the cup) appeared healthy, except a great quantity of pigment molecules, which were deposited into the fibrous tissue which surrounds the nerve fibres.

According to Mr. Dixon, "patients affected with glaucoma are almost invariably beyond the middle period of life; perhaps between fifty and sixty is the most common age for the occurrence of the disease. It usually affects both eyes. The globe, instead of having that slight degree of elasticity which it possesses in health, is peculiarly hard, giving to the finger almost the sensation of a stone.

"The sclerotic, which is often marked with faint dusky patches, is traversed by several large, tortuous, purple veins, emerging abruptly close to the margin of the cornea. Sometimes there is, in addition, a faintly marked, vascular zone; the cornea, although it may be sufficiently transparent to allow of the iris and lens being well seen, presents a peculiar unevenness of its epithelial surface; so that the lines of the window frame, instead of being distinctly and sharply depicted on it, appear broken, wavy, and irregular, and the light itself dull, as if reflected from a steamy glass.

"Sometimes the cornea is decidedly hazy throughout; and occasionally the epithelium is found vesicated in small patches, closely resembling minute drops of water which have run together on a dewy window-pane.

"If a good view of the iris and lens can be obtained, the former is found in close approximation to the cornea, equally dilated all around to a mere ring; or else the pupil is irregularly oval and quite fixed.

"It is commonly stated that the pupil in glaucoma is always transversely oval. This form, although very often seen, is by no means constant. The fibrous appearance of the iris is lost, and its colour, either in parts or throughout, is changed to a peculiar slaty tint. Sometimes the veins of the iris are sufficiently enlarged to be distinctly visible to the naked eye.

"The lens advances so as almost to touch the hinder surface of the cornea; it is opaque, sometimes rather milky looking, and indistinctly striated. Its threefold division is often very well marked, as if, by undergoing maceration in water, it had swollen up, and were about to burst its capsule. The colour of the lens varies much. It may be greyish or greenish drab, dirty yellow, or dull orange; and marked with opaque earthy patches or streaks.

"Vision of objects is wholly extinct; usually there is not even perception of light.

"I have said that the morbid appearances enumerated may be produced in two different ways. They may have been the slow result of disease going on, with intervals of apparent quiescence, for months or even years; or sight may have become extinct after a few hours of agony, and all the inflammatory changes in the tissues of the eye (except the opacity of the lens) be apparently completed within a few days.

"The chronic form begins very insidiously, and is probably set down as 'incipient amaurosis.' The patient complains of dimness of sight, and sometimes—by no means invariably—sees bright flashes or colours passing before him. Dull pain in the eye or in the head may, or may not, be present. In the former case, a faint vascular zone in the sclerotic often attends the onset of the pain. The iris gradually loses its briskness of movement, and the pupil becomes enlarged; not uniformly, but so as to assume an irregular instead of a circular form. It is sometimes transversely oval; but this shape is by no means so frequent as some writers have asserted.

"This state of things may go on for several months, without any very acute inflammation showing itself. Chronic iritis may then set in, the veins of the iris becoming visible, and the pupillary margin adhering to the capsule at one or two points. The sclerotic zone, in that case, would, of course, be developed. By this time vision may be lost, or restricted to the recognition of large, well-lighted objects. Then opacity of the lens begins slowly to show itself; or, perhaps, the cornea first becomes hazy, and its epithelium uneven, so that the increasing cataract is scarcely perceived. Gradually the iris and lens advance towards the cornea. The large, dark purple veins have by this time shown themselves on the surface of the sclerotic; and not until the end of many months, or even of a year or two, from the first failure of sight, does blindness become complete.

"The sequence of morbid changes seems to be as follows:—First, in the retina and choroid, going on, perhaps, to serous effusion between these coats, which causes the bulging forwards of the lens and iris, by pressing from behind upon the vitreous body; then congestion and inflammation of the iris and cornea; and, last of all, opacity of the lens, as a consequence of its deranged nutrition.

"As regards the treatment of the chronic form, it is quite impossible to lay down any rules which shall apply to all cases, it must be based upon a careful study of the patient's general health, and an avoidance of whatever may seem to have destroyed the due balance of the circulating forces. As a general principle it may be affirmed that the subjects of these insidious and dangerous changes in the eye are feeble and depressible, and therefore bleeding and salivation are most injurious. But, except in the very earliest stage of the disease, which is, unfortunately, very difficult to detect—the most careful treatment will often prove of little avail. In the acute form of glaucoma the sclerotic is slightly reddened, the veins emerging at the edge of the cornea are usually enlarged; the pupils dilated, oval and quite fixed; no decided opacity of the lens exists, but an ill-defined haziness of the pupillary space. The iris has a mottled, slaty tint and a more fibrous appearance, is bulged forward and almost touches the cornea ; the cornea looks slightly dull, as if minutely granular ; the globe is stonehard and tender when pressed upon." (*Dixon*, *Diseases of the Eye*, p. 224, 1855.)

A surgical treatment of the acute and chronic form of glaucoma has been introduced by Professor V. Graefe, of Berlin ; the leading idea of the operation consists in relieving the intra-ocular pressure, and the operation essentially consists in introducing a cataract knife through the semi-transparent part of the sclerotic, close to the corneal edge into the anterior chamber, and making an incision from one-quarter to one-sixth of an inch long ; when the knife is withdrawn the aqueous humour and the iris follow it; the prolapsing iris is drawn out at one corner of the section and the drawn-out portion snipped off with scissors, so that from one-quarter to one-third of it is removed ; it is supposed that by this means the vitreous and aqueous chambers are thrown into one, that the remainder of the iris atrophies, and that the tension of the globe being diminished, the absorption of the fluid effused in the deeper tissues of the eye, is encouraged ; the retinal vessels admitting more blood, small blood effusions are more frequent on the retina. Mr. Bowman introduces the knife at the upper edge of the cornea, thus allowing the upper lid to cover part of the very large pupillary opening.

The prognosis of chronic glaucoma depends upon the stage in which the eye affected is operated upon; when *blind* for some time it is not expected to regain sight, and the operation is performed only to relieve pain and tension. A chronic glaucomatous eye, with mere perception of light, is *rarely* improved by the operation; but generally the pain and the progress towards blindness are arrested. An eye with subacute glaucoma, and still more one suffering under an acute glaucomatous attack, offers the best prospects of success for the operation, especially if the attack has occurred very recently, and if the turbid state of the media contributes much to the loss of vision.

Of seventy-eight cases operated upon, six were cases of chronic glaucoma without perception of light ; one of them had both eyes operated on, two the right, and three the left eye only. Fifty-three more were cases of chronic and subacute glaucoma, with different degrees of impaired vision; of these, nineteen had both eyes operated on, sixteen the left, and eighteen the right eye only. Nineteen were cases of acute glaucoma, eight of which had both eyes operated on, five the left, and six the right eye only.

Of the seven chronic glaucomatous blind eyes operated upon for the relief of pain and tension one requires mention. In this instance the lens capsule was touched, and hard portions of lens of a transparent yellowish appearance presented in the section; the eye was at once closed, and pressure with a piece of cotton-wool applied ; no further escape of the contents of the eye followed, and the wound healed well, though the patient had a severe attack of what appeared to be catarrhal ophthalmia, with pains for three days.

Of the seventy-two eyes with chronic or subacute glaucoma operated on, with a view of restoring vision as well as of relieving pain and tension, bleeding from the iris into the anterior chamber occurred in twelve cases ; the blood escaped in some cases from the ciliary attachment of the iris, in others from near the pupillary edge, and in some it was seen oozing from the free surface of the iris. The bleeding came on either during the operation or not unfrequently after the speculum had been removed. In one case it began a quarter of an hour after the operation, and in another the day following ; in the latter case it was followed by suppuration of the globe. The blood as it oozes out should be removed at once, otherwise it may clot, assume the shape of the anterior chamber, and is difficult to remove. The end of the scoop is generally placed in the corneal wound, and pressure with some other instrument is made upon the cornea from below towards the wound ; or simply pressure is made on the cornea with the scoop. It appears to be less safe to pass the scoop quite into the anterior chamber and thus to remove the blood. A counter puncture has been made in one case to allow the blood to escape. It takes, if allowed to remain, from three to nine days to become absorbed. The subacute form of glaucoma appears to be most liable to bleeding after the operation.

The lens in seven cases became opaque, without any fragments escaping: most of these cases had been operated upon with the lance-shaped knife.

Hard portions of transparent lens, where its capsule had been wounded, escaped in three cases; the remainder of the lens became opaque in two of them : pressure to avoid further escape of lens or vitreous was applied. In the third case remaining fragments of the lens appear to have escaped *some time after* the operation, a clear pupil with improved vision being found the third day after it. There had been much pain in the eye for some time.

In one case the lens in its capsule presented in the section, and six hours after the operation was found with about a third of the vitreous humour (of abnormal consistence) at the side of the patient; the pain, which had been severe, subsided after this had happened. Some lenticular fragments escaped also in another case in which the lens had not been touched ; some vitreous followed while removing the remainder of the lens with the scoop, but the application of pressure stopped any further escape that might have happened, and no pain followed.

The opaque lens of several of the above cases was extracted with a favourable result.

The section was, in some of the first cases operated upon, kept open by portions of iris which were left there, to allow the fluid which might accumulate in the anterior chamber during the first days after the operations to drain off.

A gaping of the section, with accidents similar to those accompanying an irritable prolapse of the iris after extraction, was in two cases caused by fluid vitreous, which distended the wound. It was gradually coated over with lymph and flattened down ; the lens remained transparent in both cases.

One case presented all the fatal accidents of the operation—first some difficulty in seizing the iris, then escape of some vitreous, then of the lens, then of a large portion of vitreous with the hyaloid fossa attached to it, then of the remainder of the vitreous, followed by about half an ounce of blood. Slight pressure was applied ; no pain followed.

Twenty-seven eyes attacked by acute glaucoma were operated upon. Three of them were followed by bleeding from the iris, which appeared to stop after the small iris vessels were emptied. In one case the lens was wounded, it escaped with some of the vitreous, and a troublesome *iritis* with lymph formation followed.

Sixteen out of a hundred and seven eyes may be said to have been injured by the operation; that is to say, so many patients who would have lost vision if no operation had been done, went through a certain amount of pain and anxiety with a chance of having sight restored. It may be said that in about eighty cases the operation has had a good, and, so far, a lasting result.

For exact details the reader is referred to the tables which have been published in the Ophthalmic Hospital reports. The results for vision, later than those tabulated, are equally satisfactory: stationary in nearly all cases as regards the power of distinguishing small objects, and greatly improved as regards the recovery of sensibility of the more peripheral parts of the retina in many others.

Mr. Hancock (in No. 12 of the Ophthalmic Hospital Reports) recommends the division of the ciliary muscle in glaucoma. He states that "the ciliary muscle is either, as in the acute or earlier period of the disease, thrown into undue action, or, as in the advanced stages of the same complaint, is converted into a state of mere atrophy and is thus deprived of its elasticity, and that, from the peculiar arrangement of the vessels of the choroid with reference to this muscle, the circulation through these vessels is impeded." One object of the operation is "the improvement of the blood-vessels by removing constriction, and so relieving the circulation through them, with the view of either entirely arresting, or at all events of diminishing, the abnormal secreting action."

"The operation, which is very simple and by no means painful, is performed in the following manner: A Beer's cataract knife is introduced at the outer and lower margin of the cornea where it joins the sclerotica. The point of the knife is pushed obliquely backwards and downwards, until the fibres of the sclerotica are divided obliquely for rather more than one-eighth of an inch; by this incision the ciliary muscle is divided, whilst if there be any fluid accumulated it flows by the side of the knife. In performing the operation care should be taken not to allow the incision to extend at all into the transparent cornea, as when this takes place the iris is apt to protrude through the cut, and the pupil is consequently deformed by being drawn in that direction, &c."

The writer thinks it necessary to remark that he has met with several cases of glaucoma at the Eye Infirmary, Moorfields, which had thus been operated on by Mr. Hancock, and where a fresh glaucomatous attack made Von Graefe's operation of iridectomy necessary.

For a full account of the nature and treatment of glaucoma see *Archivs für Ophthalmologie* (edited by Von Graefe, Donders and Arlt). Bd. iii. Abthl. ii. Berlin, 1857,—and Dr. Stelmag von Carion, *Die Ophthalmologie, &c.* 1857.]

C. Bader.

See also Tr. *G. Benedict*, de Morbis Humoris Vitrei, 4to Lips. 1829. *G. J. Guthrie*, on Operative Surgery of the Eye, 8vo. ed. 2. Lond. 1827. *C. H. Weller*, on Dis. of the Eye, tr. by *G. C. Monteath*, 2 vols. 8vo. 1821; or rather the last German ed. 8vo. 1826. Also, *Jones*, Ophthalmologiæ, Fasc. 1. *W. Lawrence*, on Dis. of the Eye, 8vo. Lond. 1844. ed. 3. *W. Mackenzie*, in Glasgow Med. Journ. vol. iii. p. 259; and a Treatise on Dis. of the Eye, ed. 4. 8vo. Lond. 1854. Ph. Tr. *Walther*, Abhand Augen, &c. Landsh. 1810. *Eble*, in Ammon's Zeitschrift, vol. i. *R. Middlemore*, on Dis. of the Eye, vol. ii. 8vo. Lond. 1835. [*Wharton Jones*, on Ophthalmic Medicine and Surgery, ed. 2. 1855. Ophthalmic Hospital Reports, 1857, 1858, 1859.]

GLEET. By the term *gleet* is commonly understood a continued running, or discharge from the urethra, after the inflammatory symptoms of a clap have for some time ceased, unattended with pain or scalding in making water, &c. Mr. Hunter remarks that it differs from a gonorrhœa in being uninfectious, and in the discharge consisting of globular bodies, contained in a slimy mucus, instead of serum. He says that a gleet seems to take its rise from a habit of action which the parts have contracted. The disease, however, sometimes stops of itself, even after every method of treatment has been ineffectually tried. This probably depends upon accidental changes in the constitution, and not at all upon the nature of the disease itself. Mr. Hunter had a suspicion that some gleets were connected with scrofula. Certain it is, the sea-bath cures more gleets than the common cold bath, or any other mode of bathing; and a cure may sometimes, but not always, be accomplished by an injection of diluted sea-water.

[The opinion of most surgeons of the present day is that a gleety discharge following a gonorrhœa is not lightly to be pronounced free from infecting properties. Very slight additional irritation, such as intercourse with the opposite sex would produce, may convert the colourless discharge of gleet into a purulent fluid, which will cause all the symptoms of gonorrhœa in a female.]

Gleets are often attended with a relaxed constitution. They also sometimes arise from other affections of the urethra, besides gonorrhœa. A stricture is almost always accompanied with a gleet; and so sometimes is disease of the prostate gland.

It is remarked by Mr. Hunter that if a gleet does not arise from any evident cause and cannot be supposed to be a return of a former gleet, in consequence of a gonorrhœa, either a stricture or diseased prostate gland is to be suspected; an inquiry should be made whether the stream of urine is smaller than common, whether there is any difficulty in voiding it, and whether the calls to make it are frequent. If there should be such symptoms, a bougie rather under the common size should be introduced; and, if it passes into the bladder with tolerable ease, and the patient is nearly fifty, or upwards, the disease is probably in the prostate gland, which should *next be examined.* (See URETHRA, *Strictures of;* and PROSTATE GLAND.)

Balsams, turpentines, and the tinctura cantharidis, given internally, are of service, especially in slight cases; and when they are useful, they prove so almost immediately. Hence, if they had neither lessened nor removed the gleet in five or six days, Mr. Hunter never continued them longer. The same observation applies to cubebs, so celebrated as a remedy for gonorrhœa and gleet, and the common dose of which is ʒij. in any convenient fluid three times a day. As the discharge, when removed, is apt to recur, such medicines should be continued for some time after the symptoms have disappeared.

When the whole constitution is weak, the cold bath, sea-bath, bark and steel medicines may be given.

With regard to local applications, the astringents commonly used are lotions of sulphate of zinc, alum, or acetate of lead.

Stimulating applications consist either of injections, or bougies. Violent exercise may be considered as having the same effect. Such applications should never be used till the other methods have been fully tried and found unsuccessful. They at first increase the discharge, and, on this account, are sometimes abandoned too early. Two grains of the bichloride of mercury, dissolved in eight ounces of distilled water, make a very good stimulating injection. In irritable habits such an application may do great harm, and therefore, if possible, the capability of the parts to bear its employment should first be made out.

Bougies sometimes act violently, but Mr. Hunter thought them more efficacious than injections. A simple unmedicated one is generally sufficient, and must be used a month or six weeks before the cure can be depended upon. Bougies, medicated with camphor or turpentine, were formerly employed for the cure of gleet; they did not require so long a trial as common bougies: at present, I believe, they are not used by any surgeon of eminence. Whatever bougies are employed should be under a common size.

Mr. Hunter knew a gleet disappear on the breaking out of two chancres on the glans. Gleets have also been cured by a blister on the under side of the urethra, and by electricity.

In every plan of treatment, rest or quietness is generally of great consequence; but, after the failure of the usual modes, riding on horseback will sometimes immediately effect a cure.

Regularity and moderation in diet are to be observed.

Intercourse with women often causes a return or increase of gleet; and in such cases it gives suspicion of a fresh infection; but the difference between this and a fresh infection is, that here the return is almost immediately after the connexion.

Gleets in women are cured nearly in the same manner as those of men. Turpentines and balsams, however, have no specific effect on the vagina; and the astringent and stimulating injections used should be stronger than those intended for male patients.

[The mucous membrane of the urethra, like that of other parts of the body, in certain individuals, is very susceptible of irritation and readily secretes a larger quantity of mucus than usual on the slightest additional irritation; pus globules also are frequently added, so as to produce a muco-purulent secretion. Many gleets depend upon this constitutional peculiarity, and hence the difficulty experienced in their successful treatment.

The surgeon, therefore, must not fail to combine constitutional remedies with his local treatment, and these will vary in each individual case according to the state of the system and of the disturbance of the general health.

When the gleet is kept up by some diseased state of the urethra itself, or of the prostate gland, independent of any peculiarity of constitution, the case is more easy of cure. The appropriate remedies for stricture, for prostatic diseases, for enlarged lacunæ, for valvular folds, for preternatural sensibility of particular portions of the urethra, must be had recourse to.

The instruments used by French surgeons for exploring the urethra — the *bougie à boule*, the *bougie à nœud*—may be of great service in detecting the existence and the locality of enlarged lacunæ, of valvular folds, or of increased sensibility.

Nelaton recommends valvular folds to be destroyed by a bougie used with force, or by a cutting instrument introduced through a canula: for the increased sensibility of portions of the urethra he advises injections by means of a catheter having an orifice at its extremity, and passed down to the sensitive point so as to insure the application of the injection to the diseased surface. (*Elém. de Pathologie Chir.* vol. v. p. 367, 368.)]

GLOSSOCATOCHUS (from γλῶσσα, the tongue, and κατέχω, to depress). The ancient glossocatochus was a sort of forceps, one of the blades of which served to depress the tongue, while the other was applied under the chin.

[GLUCOHÆMIA or *Glycohæmia* (from γλῦκυς and αἷμα). *Saccharine blood* (Dr. H. Bennett, *Clin. Lec.* 1858). *Melitæmia* (Simon). *Glycosuria. Diabetes.* A disease in which the blood contains an excess of sugar, which percolates through the kidneys in solution with the urine. According to the recent researches of M. Claude Bernard, during health, a glucogenic substance analogous to hydrated starch is formed in the liver, and converted either by a ferment in the blood or by catalysis into grape sugar, to be decomposed in the pulmonary or systemic capillaries by the oxygen of the air; the transpositions being through dextrine to sugar, lactic acid, and finally to carbonic acid gas and water. A large quantity of organic matter is probably thus transposed very rapidly in the blood, the formation of the glucogenic substance being in some measure independent of the nature of the food. Glucogen is often derived, chiefly, if not altogether, from albuminous materials conveyed by the portal vein to the liver. In health, a few hours after meals a minute portion of sugar developed from this substance may sometimes be detected in the arterial or venous blood, but it does not occur in sufficient quantity to render the urine saccharine.

Although it has been shown experimentally that sugar in a dilute form introduced into the blood becomes decomposed and does not reappear in the urine, a temporary saccharine tendency of the blood, and a symptomatic diabetes, frequently occur. Neither the quantity nor the density of the urine in such cases is materially altered, but the morbid blood has the effect of an irritant, modifying the nutrition of parts, and producing scaly diseases of the skin, boils, carbuncles, or abscesses, which have sometimes been observed to precede or accompany confirmed diabetes. (*Prout.*) Or the sugar may be determined to other organs, as to the salivary glands, or the mucous membrane of the stomach or intestines. Sugar is also found in the urine of women during pregnancy, while nursing, and in childbed, having a direct association with the secretion of milk. (*Dr. H. Blot; Dublin Hospital Gaz. from Bullet. Gén. de Thérapeutique.*) It occurs also in various diseases of the brain and spinal cord, particularly such as are attended with convulsive movements; in dyspeptic and gouty individuals (*Prout*); in diseases of the liver; and as an accessory symptom in other affections.

M. Bernard has shown, experimentally, that the formation of sugar in blood, as it is transmitted through the liver, is increased in animals by irritating the eighth pair of nerves at their origin in the fourth ventricle, or by piercing the upper part of the spinal canal; also that section of the eighth pair destroys this formation, but that it is restored and saccharine urine produced by artificially irritating the central cut extremities. He found also that whenever the respiratory function is violently stimulated sugar appears in the urine, and that the action of the Woorali poison, and the inhalation of ether and chloroform, occasion a temporary diabetes. Bernard explains the variations in the production of sugar by the liver, in these experiments, by variations in the abdominal circulation, produced by impressions made through the nervous system. Sugar is found in the urine also in marsh fevers, in greatest quantity at the commencement, and diminishing gradually towards the termination of the paroxysm. (*Burdel*, *L'Union Médicale*, No. 139, 1859.)

A doubt has been cast on the alleged sugar-forming function of the liver by Dr. F. W. Pavy (*Proceed. of the Royal Society*, vol. ix. p. 300), who regards the sugar found in the liver after death as a post-mortem formation. He states that blood drawn from the right ventricle during life contains scarcely an appreciable amount, although, when drawn from the same cavity after death, it contains a large proportion. This gentleman's experiments also tend to show that the sugar found in the hepatic system does not exist there during life; but he admits the formation by the liver of a substance which, in contact with complex nitrogenous materials, is convertible into sugar, designating this substance "hepatine." According to Dr. Pavy, with the destruction of life the transposition of hepatine into sugar takes place; and on sacrificing an animal by division of the lower part or crushing the centre of the medulla oblongata, and maintaining the circulation by artificial respiration, sugar can be made to appear in the urine. The conversion of hepatine into sugar during life, according to Dr. Pavy, is never a physiological, but always a pathological result.

In another series of experiments performed on dogs, Dr. Pavy found (*Guy's Hospital Reports*, vol. v. 1859, p. 204) that saccharine urine is produced, probably only temporarily, by the following lesions of the sympathetic system of nerves:—

Division of the lower part of the medulla oblongata, and artificial respiration;

Destruction of the medulla ob. through its centre, and artificial respiration;

Division of the ascending branches of the superior cervical ganglia on one or both sides;

Removal of one or both carotid ganglia;

Division of the thoracic sympathetic on one or both sides;

Decapitation and artificial respiration;

Deligation of the vertebrals and carotids, together with division of the contents of the vertebral canals on both sides;

Ligature of the carotids, and destruction of the parts in front and behind the transverse processes of the atlas in the vicinity of the foramen.

But that it is not produced by —

Separation of the brain from the med. oblong. at the crura cerebri;

Division of the spinal cord in the cervical region, and of both pneumogastrics;

Deligation of the carotids and vertebrals;

Division of the contents of the vertebral canals alone;

Division of the contents of the vertebral canals and of the structures around the carotids, leaving the arteries free.

Saccharine urine also occurred in poisoning with strychnine, with artificial respiration.

Mr. Harley subsequently performed a series of experiments which confirm Bernard's views (*On the Saccharine Function of the Liver*, *Proceed. of the Royal Soc.* vol. x. p. 289); and according to the doctrine at present prevailing, two products of cell-growth are simultaneously produced in the liver—sugar and bile: the sugar passes by diffusion into the blood by the hepatic veins, and the bile into the biliary ducts by filtration. Under certain pathological conditions, the sugar, from imperfect metamorphosis, in place of being consumed, is voided in the urine; just as the imperfect metamorphosis of the bile absorbed from the intestines is the result of certain pathological conditions of the liver or of the blood itself. (See art. PYÆMIA, TOXICOHÆMIA; also *Frerichs' Clinical Treatise on Diseases of the Liver*, New Syd. Soc. Ed. 1860.) But here this analogy ceases, inasmuch as the sugar is filtrated in solution by the kidneys as soon as formed; whereas the bile, at the stage of bile-pigment, accumulates in sufficient quantity in the blood to constitute jaundice.

Although glucohæmia belongs strictly to the domain of medicine, and for a full account we must refer to medical writers, it is sufficiently associated with injuries and surgical affections to demand the attention of the surgeon. Falls and injuries of the head, spine, hips, and loins, are often attended with saccharine urine. Since the promulgation of Bernard's views, tumors and concretions pressing on the par vagum have several times been found associated with diabetes. Suppurating skin diseases have been observed to dry up, and sores to heal rapidly, under the disease. Caries of the teeth is said to be common from the action of the saliva ferment in the grape sugar of the blood producing lactic acid. (*Falck*, *Edin. Monthly Journal*, Oct. 1854.) Diffuse cellular inflammation has been known to follow bleeding in diabetic patients (*Duncan*); and such subjects are especially liable to tuberculosis, and also to gangrene of the extreme parts of the body, several cases of spontaneous gangrene having been recorded.

The introduction of sugar of various kinds, including "diabetic" sugar, into the blood of animals has produced cataract (*Dr. Willshire*, *The Lancet*, Oct. 27, 1860), and glucohæmia is frequently the cause of cataract in the human subject. Mr. France cites twenty-one cases: he states, "The cataracts have in every example been symmetrically developed on both sides; the lenses have increased remarkably in their antero-posterior diameter, so as to encroach on the depth of the anterior chamber." "The colour and bulk of the cataracts have invariably indicated their soft consistence," and the affection has only arisen after considerable duration of the saccharine urine. Operations in the latter stages of this disease have generally proved unsuccessful, and are of questionable propriety in any stage. (*On Diabetic Cataract, by J. T. France, Guy's Hospital Rep.* ser. iii. vol. vi.) A very remarkable case has been recorded in which cataracts alternated with this disease. (*Johnson's Med.-Chir. Rev.* Oct. 1827, p. 176.)

A saccharine state of the blood has been observed supervening jaundice, in which case the blood is cleared of the biliary pigment by the diuretic action of the sugar. In a case recorded by Frerichs the glucohæmia ceased entirely before the death of the patient, the kidneys were normal in their minute structure, but the pons Varolii and roof of the fourth ventricle were somewhat softened, and in their substance numerous little brown masses were found, the remains of capillary apoplexies. (Lib. cit. p. 149.)

The more prominent symptoms of diabetes mellitus are:—a dry, parched tongue, sometimes red and clean; heat, pain, and sense of sinking in the epigastrium; craving appetite; intense thirst; costiveness; for the most part a dry, rough skin, but sometimes profuse perspiration, the skin often exfoliating; the cuticle and sweat often of a sweet taste and odour; excessive secretion of urine with saccharine qualities; sugar sometimes found in almost all the fluids and tissues of the body; listlessness, aversion to exercise, depression of spirits, and general symptoms of debility; the temperature of the body lower than in health, with chilliness; hectic fever; and very marked atrophy.

The older authors describe diabetic blood as darker than natural, less coagulable, and its crasis or mixture accordingly loosened, and not separating into serum and clot, but too copiously dissolved and melted down (*Willis*), with an appearance of treacle. The results of modern analysis as to the proportions of the solid and fluid constituents vary greatly. It sometimes contains a greater and sometimes a smaller proportion of solids than in health, depending on its actual state when drawn from the vessels; influenced on the one hand by the discharge of a large quantity of fluid by the kidneys, and on the other by the quantity of fluid ingested to quench the thirst. The same circumstances must very materially influence the proportions, as determined on analysis, of the fibrin, albumen, and other substances. Upon the whole, these substances, and the solids generally, appear to be diminished. Rollo, Ambrosiani, Bouchardat, F. Simon, G. O. Rees, Müller, M'Gregor, and others, have shown, conclusively, that it contains sugar, which exists in it in very minute proportions at any one time, but is formed so rapidly and abundantly that the kidneys will sometimes separate, for long periods, upwards of a pound daily. It occurs in the larger quantity when blood has been drawn two or three hours after meals, and has been detected at that period, although, when drawn in the morning, no traces were visible. Glucogenic blood generally separates into a light-coloured, turbid serum, resembling whey, and a loose dark clot, or it may even be milky. Unaltered chyle has been found mixed with it, and almond-oil taken into the stomach has passed off by the kidneys without change. After death it is fluid, grumous, and black or chocolate-coloured, and Rollo and Babington (*Cyclop. Anatomy and Phys.* vol. i. p. 427) state that it possesses the peculiarity of resisting putrefaction longer than healthy blood.

The urine is sometimes enormous in quantity: as much as 13 or 14, 40, 52, and even 70 pints, or more, have been discharged in twenty-four hours. It frequently exceeds the total quantity of the solid and fluid ingesta. It is paler than usual; has sometimes a turbid, wheyish appearance with a greenish tint; an odour resembling that of new hay, or milk, or chloroform; and a specific gravity varying from 1025 to 1060. According to Schönbein there is no sugar in the earliest stages of the disease, but albumen. Albumen also appears sometimes to alternate with the sugar, and presents itself when the symptoms have been relieved by treatment. The quantity of sugar varies greatly; it may be from a few drachms to many ounces in twenty-four hours, sometimes appearing only during digestion, and it is not found in the kidney, but percolates through it in solution, a portion being always found in combination with chloride of sodium. It is occasionally insipid. The sugar gives the urine the power of deflecting the polarised ray to the right. The quantity of urea excreted appears to be variable: Kane found an excess; others have observed an apparent diminution. This variability is to be accounted for by the varying state of dilution of the blood and urine, although in the main a diminution might be expected from the atrophy of the tissues. Lithic acid crystals sometimes occur, but the proportion of lithic acid is subject to the same causes of variation. Sometimes, for a few days before dissolution, the excretion of sugar ceases.

Diabetes is more common in the male than in the female sex, and after than before puberty, although it sometimes occurs in children, and is frequently hereditary. The causes mentioned by writers are extremely numerous, but their *modus operandi* is not determined, and many of them are very doubtful. Probably the disease arises from causes of an opposite character. It is most frequent in cold, damp climates, and has been referred to suppressed action of the skin. By many it is considered as a disease of primary assimilation, produced, on the one hand, by long-continued excessive excitation of the digestive organs, as by the abuse of alcoholic fluids, and on the other by insufficient nutrition, living too exclusively on vegetable diet, and other depressing agencies. Others refer it almost exclusively to influences which depress the nervous energies. Prout and Bernard affirm that animals are not subject to the disease, which points to the influence of the mind. Either of these series of causes might produce a diseased state of the semilunar ganglion, or solar plexus, and of the organic nerves generally. A starch diet has been shown to produce diabetes in a few days. (*American Journal of the Medical Sc.* vol. xxxv. p. 469. *Hammond*). But that the starchy and saccharine principles of food are not the sole sources either of the sugar found in the liver physiologically, or that occurring in the urine, seems to be proved by these principles being converted in the liver into an emulsive mixture with fattening qualities, and also by the fact, that individuals deprived of all amylaceous diet, for long periods, have continued to excrete very large quantities of sugar. M. C. Bernard's opinion, that an excess of glucogen is formed in the liver, and that there is not a failure of oxygenation, since the effete nitrogenous elements of the blood become duly oxygenised, and urea occurs in urine containing a very large quantity of sugar, has been extensively accepted. This is by no means inconsistent with the theory of the ganglionic system depressing or withdrawing its influence from the chylopoietic viscera, nor with the results of some of the recent experiments performed on that system of nerves. Diabetes frequently accompanies disease of the pancreas; out of nine cases Frerichs found atrophy, or fatty degeneration of this gland, in five. The arrest of chemical development of the glucogenic matter appears sometimes to take place at the formation of lactic acid as in saliva, or dextrine, constituting the disease called *diabetes insipidus*. Diabetes occurs frequently in the tuberculous habit, and many of its subjects [die phthisical. The facts under the present head indicate some association between diabetes insipidus, albuminuria, diabetes mellitus, and tuberculosis.

The *treatment* of this disease, notwithstanding a better knowledge of its pathology, is still very unsatisfactory, and too frequently unsuccessful. Every effort has been made to obtain a favourable result by a modification of the diet. Macgregor, Rollo, and those who believed that the sugar is formed in the alimentary canal from vegetable substances, excluded all such substances, adopting a strictly animal diet. This treatment has often had a very decided effect in diminishing the quantity of urine and the amount of sugar; but experience has shown that it suspends these symptoms without curing the disease, and patients cannot endure it beyond a limited period. Even with such a diet the quantity of sugar will sometimes continue to increase, and all sudden changes of diet, even of an opposite kind, are attended with a temporary amelioration too frequently followed by a return of the symptoms in an aggravated degree. Complete deprivation of food causes the sugar to diminish or disappear, and in one case it disappeared for forty-eight hours after total abstinence, and did not reappear until three days after a gradual return to food. (*Andral.*) In addition to animal food, cruciferous and oleraceous vegetables, and gluten bread, have been recommended, but after a time patients tire of the last-mentioned substance. Dr. Camplin obtained a cure in his own person (*On Diabetes and its Successful Treatment*, second ed., 1860) by foregoing wine, bread, and everything saccharine or amylaceous, to the utmost possible extent, and adopting a *bran cake*, prepared in a particular way, by which the bran is reduced to a very fine powder, and is mixed with the smallest possible quantity of starch; using also fish, milk, fresh cruciferous vegetables, with abstinence from much liquid; tea in preference to coffee, toast-and-water, and, if any alcoholic fluid, claret, or pale French brandy. This diet, with warm clothing, sponging with tepid water, followed by friction, an occasional warm bath in winter, or sponging with cold salt and water in summer, change of air and occupations, and tonics, of which the effervescent citrate of ammonia and iron appeared to be the best, has been attended in his own and in other cases with the happiest results. Numerous cases, however, have resisted such a system of treatment. It has lately been shown that sugar itself, particularly substances consisting of glucose, as honey and fruits, may be administered to diabetics, to the extent of from five to eight ounces daily, not only without increasing, but with an abatement of the symptoms (*Dr. Budd, Med. Times and Gaz.*, May 22nd, 1858); and, according to Bernard's views, sugar may be employed on rational principles, inasmuch as it is converted in the liver into an emulsive substance, and by fattening serves to counteract the tendency to emaciation, the sugar of the disease being produced from albuminous substances. Caution is necessary, however, that sugar is not given in excess of the converting function of the liver.

Dr. Camplin's plan of treatment does not essentially differ from that which was resorted to previous to the recent doctrines as to the source of the sugar, and we find Bouchardat, Bernard himself, and Rayer, agreeing with Home, Rollo, and the most judicious of their predecessors, in proscribing amylaceous and saccharine aliments generally; not because they are the source of the sugar, but on account of their augmenting the activity of the liver and kidneys. Together with a system of diet, the advantage of attention to air and exercise cannot be overrated; hence the interior of hospitals, and the close dwellings and crowded streets of towns, are not favourable localities for the successful treatment of glucohæmia. The vapour-bath and hot baths, and especially the hot-air bath, or *sudatorium*, have been found highly beneficial. The too frequent failure of all modes of treatment has been referred to the influence of our cold and moist climate (*Ranking's Abst. of Med. Sc.* vol. i. p. 57); and those who believe the disease to be intimately associated with a state of suppressed perspiration place their reliance on diaphoretics. The skin becoming moist and soft is one of the earliest indications of amendment, the diminution of the saccharine excretion keeping pace with the improvement of the skin. Change to a warm climate has been especially recommended. Dr. Christie found the disease more manageable in Ceylon, and many cases recorded by Dr. Imray afford evidence of the beneficial influence of a tropical climate. (*Edin. Med. and Surg. Jour.*, Jan. 1845, p. 83.)

Dr. Gray, of Glasgow, adhering to the opinion that, in many cases at least, the sugar is produced in the stomach, recommends rennet in doses of a tablespoonful three, four, or six times a day, about half an hour after each meal, for the purpose of converting the sugar into lactic acid; administering alkalies at the same time to neutralise the acid. By the rennet the ultimate conversion of the sugar into carbonic acid and water is believed to be promoted, and several cases are given in confirmation of its efficacy.

Blood-letting, general and local, is advocated by Dr. Watts, of Glasgow, and others. When we consider that influences which augment the temperature and produce hyperæmia of the liver are followed by the production of glucohæmia, and also that, but for the excessive action of the kidneys, the blood-vessels would be loaded with imperfectly elaborated blood, the measure is feasible in the early stages of some cases; but it is not considered requisite or proper in old persons, in chronic cases, or where great debility has already supervened.

In the medicinal treatment there is no known specific. From the disease having its origin probably in various pathological conditions, each case requires to be studied *per se*. Opium, particularly in the form of Dover's powder, has been often found useful, and has sometimes been given with advantage in very large doses. It quiets the nervous irritability, and diminishes the action of the kidneys, its influence in the latter respect being most conspicuous when it occasions profuse perspirations. It very probably also counteracts hyperæmia of the liver, its utility in this respect being explained by Bernard's experiments. Bitter tonics and alkalies are also often useful. The bicarbonates of soda and potassa have been found to diminish the quantity of sugar. The preparations of iron are often indicated, and the protoiodide and the *Tinct. Ferri Sesquichloridi* have proved particularly beneficial. Dr. Watson finds creosote useful; he considers that it checks the conversion of food into sugar. (*Lectures*, vol. ii. p. 611.)

Henry Ancell.

BIBLIOG.—In addition to the more recent papers and works quoted in this article, consult the Cyclopæd. of Practical Medicine, also *Copland's* Medical Dictionary, art. "Diabetes."

GOITRE. See THYROID GLAND.

GONORRHŒA (from γονὴ, the semen, and ῥέω, to flow). Etymologically, an involuntary discharge of the semen; but always, according to modern surgery, a discharge of purulent infectious matter, from the urethra in the male, and from the vagina and surfaces of the labia, nymphæ, clitoris, urethra, and, as is alleged to have been made out by the late M. Cullerier, sometimes even from the lining of the uterus, in the female subject. (See *Dict. de Méd. et de Chir. Pratiques*, t. iv. p. 149.)

Dr. Swediaur, after censuring the etymological import, as conveying an erroneous idea, says, if a Greek name is to be retained, he would call it blennorrhagia, from βλέννα, mucus, and ῥέω, to flow. However, as most of the moderns consider the discharge as pus, not mucus, the etymological import of blenorrhœa is as objectionable as that of gonorrhœa. Mr. Howship has repeatedly examined the discharge with a microscope, but without perceiving any essential difference between such discharge and the pus effused from an ulcer. (*On Complaints affecting the Secretion and Excretion of the Urine*, p. 260.) In English, the disease is commonly called a *clap*, from an old French word *clapises*, which were public shops, kept and inhabited by single prostitutes, and generally confined to a particular quarter of the town, as is even now the case in several of the great towns in Italy. In German the disorder is named *ein tripper*, from dripping; and in French, *une chaudepisse*, from the heat and scalding in making water.

Mr. Wallace, of Dublin, objects to the terms gonorrhœa and blennorrhagia, and proposes to name the disease *catarrhal primary syphilis.* (*On Venereal Disease and its Varieties*, p. 233. London, 8vo. 1833.)

When an irritating matter of any kind is applied to a secreting surface, it increases that secretion, and changes it from its natural state to some other. In the present instance, it is changed from mucus to pus.

Till about the year 1753, it was generally supposed that the matter from the urethra, in cases of gonorrhœa, arose from ulcers in the passage; but about that time it was ascertained that pus might be secreted without a breach of substance. It was first accidentally proved by dissection, that pus might be formed in the sac of the pleura, without ulceration: and Mr. Hunter afterwards examined the urethra of malefactors and others, who had been executed, or died, while known to be affected with gonorrhœa, and demonstrated that the canal may be entirely free from every appearance of ulcer.

The time when a gonorrhœa first appears, after infection, is extremely various. It generally comes on sooner than a chancre. Mr. Hunter had reason to believe that, in some instances, the disease began in a few hours; while, in others, six weeks previously elapsed; but he had known it begin at all the intermediate periods. However, it was his opinion that about six, eight, ten, or twelve days after infection, are the most common periods. In an immense majority of cases, MM. Ratier and Cullerier have found the period between the third and seventh day after coition as that in which a gonorrhœa most frequently commences. (See *Dict. de Méd. et de Chir. Pratiques*, art. BLENNORRHAGIE.)

The internal surface of the urethra is subject to inflammation and suppuration, from various other causes besides the venereal poison; and sometimes discharges happen spontaneously, when no immediate cause can be assigned. Such discharges may be called *simple* gonorrhœa, having nothing of a specific infection in them.

MM. Cullerier and Ratier assert that an intense gonorrhœa may occur from venereal excess, between two individuals whose genitals are perfectly sound, and that either one or both parties may experience the disorder. They declare that they have had many opportunities of verifying this fact. Amongst other patients, they visited one woman who apparently enjoyed perfect health, and yet communicated gonorrhœa to all who had connexion with her. They mention also a girl who gave a most severe clap to a young man, though she never had had any venereal complaint herself, and was found on examination to be quite free from disease. (See *Dict. de Méd. et de Chir. Pratiques*, art. BLENNORRHAGIE.) These statements agree with those made many years ago by several surgeons of the British army. (See VENEREAL DISEASE.) I may here observe, however, that the secretions from the pudenda may not be healthy, and yet no appearances of disease may admit of detection even by ocular examination of the parts.

Mr. Hunter knew of cases in which the urethra sympathised with the cutting of a tooth, and all the symptoms of a gonorrhœa were produced. This happened several times to the same patient. The urethra has been suspected to be sometimes the seat of gout; and Mr. Hunter was acquainted with instances of its being the seat of rheumatism. These occurrences MM. Cullerier and Ratier have never noticed, and when they do happen, are deemed by them to be merely accidental coincidences. (See *Dict. de Méd. et de Chir. Pratiques*, art. BLENNORRHAGIE.)

Mechanical and chemical irritations of the urethra, or of those surfaces of the female pudenda which are the seat of gonorrhœa, may excite a purulent discharge. Contusion and forcible distension of the female pudenda will bring it on. In cases of violation of female children, a discharge usually follows; and hence the person accused of the crime, is commonly alleged to have been guilty also of infecting the injured party. But it is of importance as a subject of medical jurisprudence to be aware that the discharge frequently arises in the party violated from the causes above specified, without the prisoner having had any venereal complaint himself. Were this fact not remembered, a guilty person might be acquitted on the ground that he could not have infected the child, as it was ascertained that he had no disease about him.

Men who cohabit with leucorrhœal women, or at the period of the menses or lochia, often experience a discharge from the urethra, in consequence of such connexion. MM. Swediaur, Cullerier, and Ratier have all ascertained by experiments, that acute inflammation of the urethra, and a purulent discharge may be excited by injecting into the passage diluted liquid ammonia. (See *Dict. de Méd. et de Chir. Pratiques*, art. Blennorrhagie.) What experienced surgeon is unaware of a discharge from the urethra being often excited by the mechanical irritation of bougies? These facts make it perfectly obvious, that a discharge from the urethra is not necessarily a venereal complaint, or in any way connected with a specific poison.

Although catarrhal syphilis (as Mr. Wallace terms gonorrhœa) occurs mostly on the mucous or muco-cutaneous surface of the genital organs, he remarks that it may take place on any surfaces of these descriptions to which the venereal poison has been applied, as those of the eye, rectum, &c. (See *Wallace on Ven. Dis.* p. 236.) This gentleman seems thus to advocate the identity of the poisons of syphilis, and one species of gonorrhœa; but he observes, that as "we are not at present acquainted with any symptoms upon which we can always rely with confidence to distinguish discharges produced by other causes of irritation, we must not think of attributing to this poison all, or even a majority of the discharges of this kind, which we meet with in practice." (*ib.*)

When a secreting surface has once received the inflammatory action, its secretions are increased and visibly altered. Also, when irritation has produced inflammation and an ulcer in the solid parts, a secretion of matter takes place, the intention of which, in both, seems to be to wash away the irritating matter. But, in inflammations arising from specific or morbid poisons, the irritation cannot be thus got rid of; for, although the first irritating matter be washed away, yet the new matter has the same quality as the original had; and, therefore, upon the same principle, it would produce a perpetual source of irritation, even if the gonorrhœal inflammation, like many other specific diseases, were not, what it really is, kept up by the specific quality of the inflammation itself. This inflammation seems, however, to be only capable of lasting a limited time, the symptoms peculiar to it vanishing of themselves, by the parts becoming less and less susceptible of irritation; and the subsequent matter can have no power of continuing the original irritation, for otherwise there would be no end to the disease. The time which the susceptibility of the irritation lasts must depend upon difference in the constitution, and not upon any difference in the poison itself.

Mr. Hunter believed that the venereal disease only ceased spontaneously when it attacked a secreting surface, and produced a mere secretion of pus, without ulceration. Such were some of the sentiments of this great man, who was a firm believer in the identity of the poisons of syphilis and gonorrhœa; but this idea, and the hypothesis about the impossibility of any spontaneous cure of venereal sores, are now entirely relinquished.

Mr. Hunter also erroneously supposed that the poison of gonorrhœa and the venereal virus were the same. He though the had seen all the symptoms of lues venerea originate from gonorrhœa only; he assures us that he had even produced venereal chancres by inoculating with the matter of gonorrhœa; and that he had repeated the experiment in a manner in which he could not be deceived. (p. 293, *et seq.*)

Mr. Hunter's experiments, however, have been repeated with a different result; but, as one of his advocates has remarked, can we wonder at this, when we consider from how many causes purulent discharges may arise, and how impossible it is to distinguish the venereal from any other? (*Obs. on Morbid Poisons, by J. Adams, M.D.* p. 91, ed. 2.)

In attempting to explain why a gonorrhœa, and a chancre do not equally produce lues venerea, and why the medicine which almost universally cures chancre, has less effect on gonorrhœa, one believer in Mr. Hunter's doctrine says that we must take into consideration that the seat of the two diseases is different; that the same cause may produce different effects upon different parts; that the same poison, when mixed with different fluids, may be more or less violent in its operation; and that there may be greater or less attraction of certain fluids to a part, according to its nature and composition. (*Inquiry into some Effects of the Venereal Poison, by S. Sawrey*, 1802, p. 4.) Mr. Sawrey truly remarks, p. 6, that if the gonorrhœal matter has clearly and decidedly produced chancre, or contaminated the system *in any one instance*, the question is determined. It could in no instance produce these effects unless it had the power of doing so. This writer brings forward some cases to prove that the poison of gonorrhœa may produce gonorrhœa or chancre: but the limits of this work only afford room to observe that these instances are by no means decisive of the point, because some objections may be urged against them, as, indeed, Mr. Sawrey himself allows.

Why does not gonorrhœa equally contaminate the system as chancre? In gonorrhœa, says Mr. Sawrey, the discharge is very plentiful; it is not, in general, attended with ulceration; the poison is much more diluted, and mixed with a mucous and puriform fluid. It is deposited in the urethra and its lacunæ, where little or no pressure is applied, and it finds easy egress out of the canal. In chancre there is breach of substance, the poison is not much diluted, &c.

Why does not chancre generally in the same person produce gonorrhœa, and gonorrhœa, chancre? Mr. Sawrey, in answer, expresses his belief, that these incidents are not very unfrequent. He says he has known persons having a chancre, which continued for months, become affected, after that time, with a clap, without any further exposure. His opinion is, that the matter of the chancre had insinuated itself into the urethra, and produced the disease; though he confesses, many would explain the circumstance by supposing that the chancre and gonorrhœa were both communicated at the same time by two different poisons.

Mr. Hunter conceives that the presence of one disease renders the adjacent parts less susceptible of the influence of the other.

Another defender of this side of the question is Dr. Swediaur, who endeavours to prove the fallacy of the following positions:—1. *That the poison which produces the clap does never, like that of chancres, produce any venereal symptoms in the mass or lues itself.* 2. *That the poison of the clap never produces chancres, and that the poison of chancres never produces a clap.* 3. *That mercury never contributes to, nor accelerates, the cure of a clap; but that, on the contrary, every blennorrhagia may be certainly cured without mercury, and without any danger of leaving a lues behind.*

His arguments run thus:—the reason why claps do not, like chancres, constantly produce lues, is that most of them excite only a superficial inflammation in the membrane of the urethra, without any ulceration. Hence, absorption cannot easily take place, the poison being out of the course of the circulation. But he has seen claps with an ulcer in the urethra followed by the most unequivocal symptoms of lues itself. He mentions the urethra being defended with a large quantity of mucus, as the thing impeding the common formation of ulcers, which do occasionally occur when the mucus is not secreted as usual, or is washed away. He asserts that in many cases, where he had occasion to examine both parties, he was convinced that the chancres were communicated by a person affected with a simple gonorrhœa; and *vice versâ*, that a virulent clap had been the consequence of an infection from a person having merely chancres. He says that if a patient with a venereal running does not take care to keep the prepuce and glans perfectly clean, chancres will very often be produced. He owns that a great many claps are cured without mercury; yet, repeated experience has shown him a cure cannot always be thus accomplished. Mild cases, without ulcer or excoriation in the urethra, may certainly be radically cured without a grain of mercury; and though mercury should be given, it would not have the least effect; not because the disease does not proceed from the venereal poison, but because it is out of the course of the circulation. He contends that the topical use of mercury in injections acts usefully even in these cases. But, when a clap is joined with ulceration in the urethra, it is always cured more safely and expeditiously with mercury, and is frequently incurable without it. A lues also follows cases attended with ulcers in the urethra. He allows that all claps are not venereal. (See *Pract. Obs. on Venereal Complaints, by J. Swediaur.*)

The sentiments of Mr. B. Bell are quite at variance with those of Hunter, Sawrey, Swediaur, Adams, &c.; but, my limits will only allow me to enumerate a few of his leading arguments.

If the matter of gonorrhœa and that of chancre were of the same nature, we must admit that a person with a chancre only can communicate to another not only every symptom of pox, but of gonorrhœa; and that another with gonorrhœa only can give to all with whom he may have connexion chancres, with their various consequences. This ought indeed to be a very frequent occurrence; whereas all allow that it is even in appearance very rare.

On the supposition of the matter of gonorrhœa and of chancre being the same, the latter ought to be a much more frequent occurrence than the former, from the greater ease with which the matter of infection must, in every instance, be applied to those parts on which it can produce chancres than that of the urethra, where, instead of chancre or ulceration, it almost always excites gonorrhœa. It is difficult to conceive how the matter by which the disease is communicated should find access to the urethra; while all the external parts of the penis, particularly the glans, must be easily and universally exposed to it; and yet gonorrhœa is a much more frequent disease than pox. Cases of gonorrhœa are in proportion to those of chancre, according to Mr. B. Bell's experience, as three to one. It is obvious that the very reverse should happen if the two diseases were produced by the same kind of matter.

The grand practical consideration, depending on the possibility of the venereal disease arising from gonorrhœa, is, whether mercurials should not be exhibited, in all cases, with the view of preventing such a consequence.

Waiving, on my own part, all attempts to decide the point, whether the matter of a chancre and that of one species of gonorrhæa, are of the same nature, I shall merely content myself with stating that, so far as my observation and inquiries extend, the majority of the best practitioners consider the exhibition of mercury unnecessary and consequently improper in gonorrhœa. This fact almost amounts to a proof that, if venereal symptoms do ever follow a clap, they are so rare, and I may add, always so imputable to other causes, that the employment of mercury, as a preventive, would, upon the whole, do more injury than benefit to mankind; and this, even admitting (what, in my mind, has never been unequivocally proved) that the matter of gonorrhœa is really capable, in a very few instances, of giving rise to the venereal disease. However, a few surgeons will not yet altogether renounce the employment of mercury in gonorrhœa. Thus, Mr. Wallace gives small doses of it with copaiba or cubebs, after the active inflammation has subsided. (See *Wallace on Ven. Dis.* p. 248.)

Mr. Carmichael, who is a believer in a plurality of venereal poisons, inculcates the doctrine that what he terms the *papular venereal disease*, or that which is characterised by a papular eruption, if the skin become affected, originates from a peculiar virus, which gives rise to gonorrhœa, and which is different from poisons supposed by him to excite other forms of the venereal disease. As, however, the simple primary ulcer, excoriation and gonorrhœa very frequently exist together, Mr. Carmichael suspects that they all arise from the same identical poison. (See *Essay on Ven. Dis.* p. 76, ed. 2. 8vo. Lond. 1825.) At the same time, this gentleman concurs in the common belief, that constitutional symptoms after a gonorrhœa are very rare. With regard to Mr. Carmichael's views, several facts present themselves. 1. The formation of excoriations and simple sores does not necessarily require the influence of any poison. 2. Sores, capable of imparting every form of constitutional syphilis, are now frequently believed by men of great experience, to present themselves in the form of simple ulcers. 3. Numerous surgeons would ascribe the constitutional symptoms which, in a small proportion of cases, follow gonorrhœa, to the existence of venereal ulceration together with this disease, or at some period before or after it. 4. The facts that primary venereal sores of every description are capable of healing up spontaneously, and that some of them, being small and superficial, are therefore disregarded, and allowed thus to heal, are considerations which interfere considerably with some of Mr. Carmichael's ingenious conclusions. However, if it were proved that constitutional symptoms of a peculiar kind, like those specified by Mr. Carmichael, were limited to gonorrhœal cases, then there would be reason for suspecting that their nature must be determined by the influence of a poison not corresponding to that of other forms of the venereal disease.

[M. Ricord considers the poison of gonorrhœa distinct from that of syphilis, and will not admit that it is ever followed by secondary symptoms. Other French cotemporary surgeons of great experience, however, M. Vidal, M. Baumés, M. Réquin, maintain that gonorrhœa is occasionally succeeded by syphilitic infection of the constitution, and that one and the same poison is the cause of both chancre and gonorrhœa. I cannot agree with this latter opinion. I have frequently seen chancres resulting from accidental inoculation from a chancre, but have never seen a gonorrhœa so produced, even from a urethral chancre, nor have I ever observed a chancre to arise on the glans or prepuce from the matter of a gonorrhœa, with which these structures have been for weeks completely covered. On the other hand, the transference of secondary symptoms from one person to another, in which I thoroughly believe, added to the occasional occurrence of a concealed chancre, to my mind sufficiently accounts for the supposed cases of secondary syphilis as a sequela of gonorrhœa. (See SYPHILIS.)]

The first symptom of gonorrhœa is generally an itching at the orifice of the urethra, sometimes extending over the whole glans. A little fulness of the lips of the urethra, the effect of inflammation, is next observable, and soon afterwards a running appears. The itching changes into pain, more particularly at the time of voiding the urine. There is sometimes no pain till after the appearance of the discharge and other symptoms; and in many gonorrhœas, there is hardly any pain at all, even when the discharge is considerable. At other times, a great degree of soreness occurs long before any discharge appears. There is generally a particular fulness in the penis, and more especially in the glans. The glans has also a kind of transparency, especially near the beginning of the urethra, where the skin being distended, smooth, and red, resembles a ripe cherry. The mouth of the urethra is, in many instances, evidently excoriated. The surface of the glans itself is often in a half-excoriated state, consequently very tender; and it secretes a sort of discharge. The canal of the urethra becomes narrower, which is known by the stream of urine being smaller than common. This proceeds from the fulness of the penis in general, and either from the lining of the urethra being swollen, or in a spasmodic state. The fear of the patient, while voiding his urine, also disposes the urethra to contract; and the stream of urine is generally much scattered and broken, as soon as it leaves the passage. There is frequently some degree of hæmorrhage from the urethra, perhaps from the distension of the vessels, more especially when there is a chordee, or a tendency to it. Small swellings often occur along the lower surface of the penis, in the course of the urethra. These Mr. Hunter suspected to be enlarged glands of the passage. They occasionally suppurate and burst outwardly, but now and then in the urethra itself. Mr. Hunter has also suspected such tumors to be ducts, or lacunæ of the glands of the urethra distended with mucus, in consequence of the mouth of the duct being closed, in a manner similar to what happens to the duct leading from the lachrymal sac to the nose, and so as to induce inflammation, suppuration, and ulceration. Hardness and swelling may also occur in the situation of Cowper's glands, and end in considerable abscesses in the perinæum. The latter tumors break either internally or externally, and sometimes in both ways, so as to produce fistulæ in perinæo.

A soreness is often felt all along the under side of the penis, frequently extending as far as the anus. The pain is particularly great in erections; but the case differs from chordee by the penis remaining straight. In most cases of gonorrhœa, erections are frequent, and even sometimes threaten to bring on mortification.

The natural slimy discharge from the glands of the urethra is first changed from a fine transparent ropy secretion, to a watery whitish fluid; and the lubricating fluid, which the passage naturally exhales, becomes less transparent; both these secretions, becoming gradually thicker, assume more and more the qualities of common pus.

The matter of gonorrhœa often changes its colour and consistence, sometimes from a white to a yellow, and often when the inflammation is severe, to a greenish colour. When the inflammation is very high, shreds of lymph are sometimes discharged with the urine. (*Wallace.*)

These changes depend on the increase and decrease of the inflammation, and not on the poisonous quality of the matter itself; for an irritation of these parts, equal to that produced in a gonorrhœa, will produce the same appearances. Mr. Wallace finds that the less the inflammatory action, the less alkaline the discharge. (*On Venereal Diseases*, p. 244.)

The discharge is produced from the membrane of the urethra and from the lacunæ, but, in general, only for about two or three inches from the external orifice. Mr. Hunter says seldom further than an inch and a half, or two inches at most. This he terms the specific extent of the inflammation. Whenever he had an opportunity of examining a urethra affected with gonorrhœa, he always found the lacunæ loaded with matter, and more visible than in the natural state. Before the time of this celebrated man, it was commonly supposed that the discharge arose from the whole surface of the urethra, and even from Cowper's glands, the prostate, and vesiculæ seminales. But, if the matter were secreted from all these parts, the pus would collect in the bulb, as the semen does, and thence be emitted in jerks; for, nothing can be in the bulbous part of the urethra without stimulating it to action, especially when in a state of irritation and inflammation.

[Gonorrhœal inflammation may extend the whole length of the urethra, and even to the bladder itself. Sir A. Cooper describes the appearance of the urethra in a criminal executed while labouring under gonorrhœa, in the following terms: "For an inch and a half down, the urethra was exceedingly red, and there was some effusion of matter on the internal surface; the urethra was red at the bulb, but not of so deep a colour. The inflammation, therefore, is not confined to an inch and a half down the urethra, but often extends over the bulb, and in this way produces strictures."]

When the inflammation is violent, some of the vessels of the urethra often burst, and a discharge of blood ensues. Sometimes such blood is only just enough to give the matter a tinge. In other instances erections cause an extravasation by stretching the part.

When the inflammation goes more deeply than the membranous lining, and affects the reticular, or spongy structure of the urethra, it produces in it an extravasation of coagulable lymph, the consequence of which is a chordee.

Mr. Hunter suspected that the disease is communicated or creeps along from the glans to the urethra, or, at least, from the lips of the urethra to its inner surface, as it is impossible that the infectious matter can, during coition, get as far as the disease extends. He mentions an instance in which a gentleman who had not cohabited with any woman for many weeks, to all appearance caught a gonorrhœa from a piece of plaster, which had adhered to his glans penis while he was at a privy abroad; the infection is accounted for by supposing that some person with a clap had previously been to the place and had left behind some of the discharge, and that the above gentleman had allowed his penis to remain in contact with the matter till it had dried.

Many symptoms, depending on the sympathy of other parts with the urethra, sometimes accompany a gonorrhœa. An uneasiness, partaking of soreness and pain, and a kind of weariness, are felt about every part of the pelvis. The scrotum, testicles, perinæum, anus, and hips, become disagreeably sensible, and the testicles often require to be suspended. So irritable indeed are they in such cases, that the least accident, or even exercise, which would have no effect of this kind at any other time, will make them swell. The glands of the groin are often affected sympathetically, become swollen, and even occasionally suppurate, but not so generally as when they inflame from the absorption of chancrous matter. Mr. Hunter has seen the irritation of a gonorrhœa so extensive as to render the thighs, buttocks, and abdominal muscles painful. He knew one gentleman who never had a gonorrhœa without being immediately seized with universal rheumatic pains. Gonorrhœal rheumatism is now recognised as a frequent and severe complaint.

When the disorder, exclusive of the affections from sympathy, is not more violent than has been described, Mr. Hunter termed it a *common, or simple venereal gonorrhœa*; but, if the patient is very susceptible of such irritation, or of any other mode of action which may accompany the venereal, then the symptoms are in proportion more violent. In such circumstances the irritation and inflammation sometimes exceed the specific distance, and extend through the whole urethra. There is often a considerable degree of pain in the perinæum; and a frequent, though not a constant, symptom, is a spasmodic contraction of the acceleratores urinæ and erectores muscles. In these cases, the inflammation is sometimes considerable, and goes deeply into the cellular tissue, but without producing any effect, except swelling. In other instances it goes on to suppuration, often becoming one of the causes of fistulæ in perinæo. Thus, Cowper's glands may suppurate, and the irritation often extends even to the bladder itself.

When the bladder is affected, it becomes more susceptible of every kind of irritation. It will not bear the usual distension, and therefore the patient cannot retain his water the ordinary time; and the moment the desire of making water takes place he is obliged instantly to make it, with violent pain in the bladder, and still more in the glans penis, exactly similar to what happen in a fit of the stone. If the bladder be not allowed to discharge its contents immediately the pain becomes almost intolerable; and even when the water is evacuated, there remains for some time a considerable pain both in the bladder and glans.

Sometimes, though rarely, when the bladder is much affected, the ureters, and even the kidneys sympathise; and Mr. Hunter had reason to suspect that the irritation might be communicated to the peritoneum, by means of the vas deferens.

Mr. Hunter mentions a case in which, while the inflammatory symptoms of a gonorrhœa were abating, an incontinence of urine came on; but, in time, spontaneously subsided.

A very common symptom attending a gonorrhœa is a swelling of the testicle. (See Testicle, Diseases of.)

Another occasional consequence is a sympathetic swelling of the inguinal glands. (See Bubo.)

A hard cord is sometimes observed leading from the prepuce along the back of the penis, and often directing its course to one of the groins, and affecting the glands. At the part of the prepuce where the chord takes its rise, there is most commonly a swelling. This sometimes happens when an excoriation and a discharge from the prepuce, or glans penis, exist.

Thus the symptoms of gonorrhœa in different cases seem to be subject to infinite variety. The discharge often appears without any pain; and the coming on of the pain is not at any stated time after the appearance of the discharge. There is often no pain at all, although the discharge is in considerable quantity, and of a bad appearance. The pain often goes off, while the discharge continues, and will return again. In some cases, an itching is felt for a considerable time, which is sometimes succeeded by pain; though, in many cases, it continues till the end of the disease. On the other hand, the pain is often troublesome, and considerable, even when there is little or no discharge. The neighbouring parts sympathise, as the glands of the groin, the testicle, the loins and pubes, the upper parts of the thighs, and the abdominal muscles. Sometimes the disease appears a few hours after the application of the poison; sometimes not till six weeks have elapsed. Lastly, it is often impossible to determine whether the case is a gonorrhœal discharge, or rather one produced by the application of infectious matter, or only an accidental discharge, arising from some unknown cause.

Treatment of Gonorrhœa.

Mr. Hunter supposed that every form of the venereal disease arose from the same cause, and that, as we have a specific remedy for some forms, it might be conceived or expected this would be a certain cure for every one; and, therefore, that it must be no difficult task to cure the disease, when in the form of inflammation and suppuration in the urethra. But we have already explained that the poison of gonorrhœa is distinct from that of syphilis, and experience teaches us that gonorrhœa is most variable in its symptoms, while under treatment; and the most uncertain, with respect to its cure, many cases terminating in a week, while others continue for months under the same remedial means.

Whatever differences of opinion may be entertained respecting the cause of gonorrhœa, and particularly with regard to its being excited by the influence of a specific poison, its inflammatory nature cannot be overlooked; and it is this character of the disorder, which determines, in a great measure, the plan of treatment. The great indication, however, insisted upon by Mr. Hunter, was that of destroying the disposition and specific mode of action in the solids of the parts, and as they become changed, the poisonous quality of the matter produced will also be destroyed.

Gonorrhœa is incapable of being continued beyond a certain time in any constitution; and, when it is violent, or of long duration, it is owing to the part being very susceptible of such irritation, and readily retaining it. As no specific remedy for gonorrhœa is known, it is fortunate that time alone will effect a cure. Mr. Hunter was inclined to think medicine not of the least use, in nine cases out of ten. But even this would be of some consequence, if the cases, capable of being benefited, could be distinguished. Surgeons of the present day, however, have less despondency on this subject than the distinguished man whose opinion I have just now cited.

The means of cure, generally adopted, are of two kinds, internal remedies and local applications; but, whatever plan is pursued, Mr. Hunter inculcates the doctrine that we are always to attend more to the nature of the constitution, or to any accompanying disease in the parts themselves, or parts connected with them, than to the gonorrhœa itself.

When the symptoms are of the ordinary inflammatory kind, known by the extent of the inflammation not exceeding the specific distance, Mr. Hunter found stimulating applications less dangerous than when irritable inflammation is present: they seemed to him capable of altering the specific action; but, to produce this effect, their irritation must be greater than that of the original injury; and, as MM. Cullerier and Ratier observe, they must be tried at the very beginning of the case. The parts will afterwards recover of themselves, as from any other common inflammation.

Mr. Hunter believes, however, that in the beginning the soothing plan is generally the best. If the inflammation be great, and of the irritable kind, no violence is to be used, for it would only increase the symptoms; and he states that nothing should be done that can tend to stop the discharge, as it would not put a stop to the inflammation.

But, if the disease has begun mildly, a stimulating injection may be used, in order quickly to get rid of the specific mode of action. This application will increase the symptoms for a time; but, when it is left off, they will often abate, or wholly disappear; and, after such abatement, mild astringents may be used, the discharge being the only thing to be removed.

When itching, pain, and other uncommon sensations are felt for some time before the discharge appears, Mr. Hunter diffidently expresses his inclination to recommend the soothing plan, instead of the irritating one, in order to bring on the discharge, which is a step towards the resolution of the irritation; and he adds that to use astringents would be bad practice, as by retarding the discharge they would only protract the cure. When there are stricture or swelled testicles, astringents should not be used; for, while there is a discharge, such complaints are relieved.

Mr. Hunter thus expresses himself in regard to the effect of mercury in gonorrhœa: "I doubt very much of mercury having any specific virtue in this disease, for I find that it is as soon cured without mercury as with it, &c. So little effect, indeed, has this medicine upon a gonorrhœa, that I have known a gonorrhœa to take place (while the patient was) under a course of mercury sufficient for the cure of a chancre. Men have also been known to contract a gonorrhœa when loaded with mercury for the cure of a lues venerea; the gonorrhœa, nevertheless, has been as difficult of cure as in ordinary cases."

Mr. Hunter does not say much in favour of evacuants, diuretics, and astringents, given internally. He allows, however, that remedies, which act specifically on the parts, as the balsams, conjoined with any other medicine, which may be thought right, may help to lessen the discharge, in proportion as the inflammation abates.

Local applications may be either internal to the urethra, external to the penis, or both. Those which are applied to the urethra seem to promise most efficacy, because they come into immediate contact with the diseased parts. They may be either in a solid or a fluid form. A fluid is only a very temporary application. The solid ones, or bougies, may remain a long while, but in general irritate immediately, from their solidity alone; and Mr. Hunter says the less bougies are used when the parts are in an inflamed state, the better. At present, bougies are rarely used in gonorrhœa, in consequence of their tendency to bring on a swelling of the testes.

The fluid applications, or injections, in use are innumerable, and gonorrhea frequently gets well with many of various kinds. They often have an immediate effect on the symptoms, and hence must have power; though the injection which possesses the greatest power is unknown. As injections are only temporary applications, they must be used often, especially when found useful, and not of an irritating kind.

Mr. Hunter divides injections into four kinds, the *irritating*, *sedative*, *emollient*, and *astringent*. According to his doctrines, irritating injections of every kind, act in this disease upon the same principle; that is, by producing an irritation of another kind, which ought to be greater than the venereal; by which means the venereal is destroyed and lost, and the disease cured, although the pain and discharge may still be kept up by the injection; effects, however, which will soon go off, when the injection is laid aside. In this way bougies also perform a cure. Most of the irritating injections have an astringent effect.

Irritating or stimulating injections should never be used when there is considerable inflammation present; especially in constitutions which are known to be incapable of bearing much irritation; nor should they be used when the inflammation has spread beyond the specific distance; nor when the testicles are tender; nor when, upon the discharge ceasing quickly, these parts have become sore; nor when the perinæum is very susceptible of inflammation, and especially if it formerly should have suppurated; nor when there is a tendency in the bladder to irritation, known by the frequency of making water.

In mild cases, and in constitutions which are not irritable, such injections often succeed, and remove the disease almost immediately. The practice, however, ought to be attempted with caution, and not, perhaps, till milder methods have failed. Two grains of the bichloride of mercury, dissolved in eight ounces of distilled water, form a very good stimulating injection; but an injection of only half this strength may be used when it is not intended to attempt a cure so quickly. If, however, the injection, even in that proportion, gives considerable pain in its application, or occasions a great increase of pain in making water, it should be further diluted.

Sedative injections will always be of service, when the inflammation is considerable, and they are very useful in relieving the pain. Perhaps the best sedative is opium, as well when given by the mouth, or anus, as when applied to the part affected, in the form of an injection. But even opium will not act as a sedative in all constitutions and parts; but, on the contrary, often has opposite effects, producing great irritability. Lead may be reckoned a sedative, so far as it abates inflammation, while at the same time it acts as a gentle astringent. Fourteen grains of acetate of lead, in ℥viij. of distilled water, make a good sedative astringent injection.

Drinking freely of diluting liquors may have a sedative effect, as it in part removes some of the causes of irritation, by rendering the urine less stimulating to the bladder when the irritation is there, and to the urethra in its passage through it. The vegetable mucilages of certain seeds and plants, and the emollient gums are recommended. Mr. Hunter does not entertain much opinion of their efficacy, though some of his patients told him that they experienced less uneasiness in making water when their drink was impregnated with mucilaginous substances.

Emollient injections are the most proper, when the inflammation is very severe; and they probably act by first simply washing away the matter, and then leaving a soft application to the part, so as to be singularly serviceable by lessening the irritating effects of the urine. Indeed, practice proves this; for a solution of gum arabic, milk and water, or sweet oil, will often lessen the pain and other symptoms.

The irritation at the orifice of the urethra is frequently so great that the point of the syringe cannot be suffered to enter. In this case no injection should be used till the inflammation has abated; but in the meanwhile fomentations may be employed.

Astringent injections act by lessening the discharge. They should only be used towards the latter end of the disease, and when it has become mild. But if the disease should begin mildly, they may be used at the very beginning; for, by gradually lessening the discharge, without increasing the inflammation, we complete the cure, and prevent a continuance of the discharge called *gleet*.

The apprehension that injections give a tendency to inflamed testicle and stricture, has lessened very much the frequency of their use; though it is to be suspected, with regard to strictures, that the long continuance of the discharge will be more likely than the injection to produce them. This opinion has been entertained by many good and experienced practitioners, and I observe that it is professed by Mr. Wallace. (*On Ven. Dis.* p. 251.) While much morbid sensibility exists, this gentleman prefers an injection, composed of 15 grs. of nitrate of silver to an ounce of water. When the sensibility has been lessened, he uses an injection of half a grain of bichloride of mercury to an ounce of water, or a grain and a half of the sulphate of copper; or acetate of zinc.

On the principle of gonorrhœa being manifestly an inflammatory disorder, it is at first mostly treated at the present day by antiphlogistic means. In this country, however, we rarely take blood from the arm, unless the complications of the case require it, as may happen when the inflammation exceeds the specific distance, retention of urine comes on, or inflammation of the testicle occurs. In severe cases, leeches may be applied to the perinæum; and the patient use the warm bath, hip bath, or bidet, under the influence of which he will be able to discharge his urine with comparatively little pain or difficulty. If there exists a state of active inflammation, Mr. Wallace applies leeches to the perinæum, or to the body of the penis, or to the internal surface of the prepuce, or to the glans in the neighbourhood of the frænum. "The leech-bites may be covered with a cataplasm, and allowed to bleed as long as convenient. When we wish to stop the bleeding, this may be done by touching the wounds made by the leeches with a pointed piece of nitrate of silver. Any ecchymosis produced in the penis or scrotum by the application of leeches quickly disappears." If the patient prefers it, Mr. Wallace sanctions puncturing one or more of the veins on the dorsum penis. (See *Wallace on Ven. Dis.* p. 247.) If any distress continue after the antiphlogistic treatment has been persisted in for a day or two, he observes that the greatest advantage will be derived from full doses of opium and henbane, combined with calomel. In the intervals between the periods of using the warm bath, the penis, scrotum, and perinæum, should be fomented with a decoction of poppy heads. The bowels are to be kept open; a stimulating diet avoided; and mucilaginous diluent beverages taken freely, with the view of rendering the secretion of the urine more abundant, and its quality less irritating to the urethra.

Many modern surgeons have relinquished the use of all injections in the treatment of gonorrhœa, and manage the disease on common antiphlogistic principles. Mr. Howship states that when injections are used, they are not unfrequently followed by a most distressing and permanent irritability of the bladder. (*On Complaints affecting the Secretion and Excretion of the Urine*, p. 268.) But the common objection to them is founded upon the suspicion that they increase the frequency of inflamed testicle and stricture.

Since Mr. Hunter's time many surgeons have been in the habit of keeping the penis, in the incipient inflammatory stage of gonorrhœa, covered with linen, continually wet with the liquor plumbi diacetatis dilutus ; a practice which is certainly both rational and beneficial. Mr. Abernethy, in his *Lectures on Surgery*, speaks in favour of this method. And some surgeons have seen great relief derived from the use of a suspensor scroti, or double handkerchief, combined with rest and the elevation of the penis. A suspensory bandage is believed to lessen the chance of the testicles being attacked by inflammation.

For the relief of the ardor urinæ and irritable state of the bladder in gonorrhœa, opium, camphor, conium, and hyoscyamus, have been extensively employed. Sir Benjamin Brodie informs me that when the disease is attended with chordee, the vinum colchici frequently has beneficial effects. In consequence of this information, I have sometimes prescribed the vinum colchici, and found it useful in relieving the strangury, ardor urinæ, and irritable state of the bladder.

In the treatment of gonorrhœa, the liquor potassæ is a favourite internal medicine with many practitioners, who begin with prescribing it, and continue its use until the inflammatory stage has subsided. However, according to Mr. Howship, its effects are uncertain, and sometimes it excites uneasiness and irritation about the neck of the bladder, and difficulty of voiding the urine. Hence, whenever he directs this medicine, it is in combination with some aperient, so that it may not remain long in the bowels. (*On Complaints affecting the Secretion and Excretion of the Urine*, p. 269.)

When the glands of the urethra remain enlarged after all inflammation has subsided, mercurial ointment, or that of the iodide of potassium, may be rubbed on them.

In many strong plethoric constitutions, the symptoms are violent, and there is a great tendency to inflammatory fever. In such instances, opiate clysters, though at first productive of relief, sometimes increase the fever, and consequently aggravate all the symptoms. In those cases the balsam of copaiba also sometimes increases the inflammatory symptoms. In a constitution of this kind, the treatment consists chiefly in evacuations, the best of which are bleeding and gentle purging. The patient must live sparingly, and above all, use little exercise.

In a weak and irritable constitution the symptoms are frequently violent, the inflammation extending along the urethra, and even affecting the bladder. Here the indication is to strengthen; and according to Mr. Hunter, bark alone has been known to effect a cure. All evacuations are hurtful.

A fever has been known to stop the discharge, relieve the pain in making water, and finally cure the disease. On other occasions, Mr. Hunter has seen all the symptoms of gonorrhœa cease on the accession of a fever, and return when the fever was subdued. In other examples, a gonorrhœa mild at first, has been rendered severe by the coming on of a fever, and upon its subsidence the gonorrhœa has ceased. Although a fever does not always cure a gonorrhœa, yet as it may do so, nothing should be done while it lasts. If the local complaint should continue after the fever is gone, it is to be treated according to symptoms.

A gonorrhœa may be considerably affected by the patient's manner of living, and by other diseases attacking the constitution. Most things which hurry or increase the circulation aggravate the symptoms; such as violent exercise, drinking strong liquors, eating high-seasoned, indigestible food, some kinds of which act specifically on the urethra, so as to increase the symptoms more than simply heating the body would do; such as pepper, spices in general, and spirits.

In cases which have begun mildly and in which the inflammation is only slight, or in others in which the violent symptoms have subsided, such medicines as have a tendency to lessen the discharge may be given, together with the local remedies before mentioned. Turpentines are the most efficacious, particularly the balsam of copaiba (See *Copaiba*) and cubebs. (See *Edin. Med. and Surgical Journ. for January*, 1818, *and for the same month*, 1819: also, *H. Jeffery's Pract. Obs. on Cubebs*, 8vo. Lond. 1821.) Of the latter medicine ʒij. may be given thrice in the twenty-four hours, or an equivalent dose in the form of capsules, essence, or watery extract may be preferred. But with respect to these and all other medicines, which act upon the disease through the medium of the urine, if they succeed at all, it is always within a week or ten days from the beginning of their use; and therefore if no amendment take place in this time, they should not be continued.

Bleeding from the Urethra is sometimes relieved by the balsam of copaiba. Mr. Hunter did not find astringent injections of use. Ice-cold water applied to the penis, scrotum, and perinæum, is one of the best expedients.

Painful Erections are greatly prevented by taking twenty drops of tinctura opii, or half a drachm of vinum colchici, at bedtime. Hemlock has also some power in this way; and many surgeons, among whom is Mr. Dunn, of Scarborough, have a favourable opinion of camphorated poultices, and of the internal exhibition of camphor.

Chordee.—When the inflammation is not confined merely to the surface of the urethra, but affects the corpus spongiosum, it produces in it an extravasation of coagulable lymph, as in the adhesive inflammation, which, uniting the cells together, destroys the power of distension of the corpus spongiosum urethræ, and makes it unequal in this respect to the corpora cavernosa penis, and therefore a curvature takes place at the time of an erection, which is called a *chordee.* The curvature is generally in the lower part of the penis. When the chordee is violent, the inner membrane of the urethra is so much upon the stretch, that it may be torn, and a profuse bleeding from the urethra excited, that often relieves the patient, and even sometimes proves a cure. This is the *inflamma-*

tory chordee; another kind has been named *spasmodic*.

In the beginning of the inflammatory chordee, bleeding from the arm is often of service; but it is more immediately useful to take blood from the part itself by leeches; for we often find that when a vessel gives way, and bleeds a good deal, the patient is greatly relieved. Exposing the penis to the steam of hot water frequently affords great relief. Poultices have also beneficial effects; and both fomentations and poultices will often do most good when they contain camphor. Opium, given internally, is of singular service; and if it be joined with camphor the effect will be still greater. Hyoscyamus will sometimes agree with the patient better than opium, or even than the acetate, or muriate of morphia; and frequently opium has the best effect, when administered in the form of an enema.

When the chordee continues after all inflammation has terminated, no evacuations are required; for the consequences of the inflammation will gradually cease on the absorption of the extravasated coagulable lymph. Mercurial ointment, rubbed on the part, will promote this event. When the common methods of cure are unavailing, hemlock is sometimes useful. Electricity is said to have been of service. A chordee is often longer in going off than any other consequence of a gonorrhœa, but, in the end, it disappears.

For bringing about the removal of the extravasated lymph, camphorated mercurial ointment is better than the simple unguentum hydrargyri. According to Mr. Hunter, *spasmodic chordee* is benefited by bark. (*On the Venereal Disease*, ed. 2.) The recent leaves of belladonna, powdered and made into an ointment with an equal weight of lard, and rubbed over the penis, are stated to hinder priapism, and relieve chordee, more effectually than any other application hitherto proposed. (*J. A. Paris, in Pharmacologia*, vol. ii. p. 110, ed. 5.)

Bladder affected.—Opiate clysters, the warm bath, and, if the patient is of full habit, bleeding, are proper. The excellent effects of the vinum colchici, as stated to me by Sir Benjamin Brodie, I have already noticed. Leeches may be applied to the perinæum. When this affection lasts a considerable time, and is not mitigated by common methods, Mr. Hunter advises trying an opiate plaster on the pubes or the loins, where the nerves of the bladder originate; or a small blister on the perinæum. A belladonna plaster would probably act more powerfully than one of opium. In another place, he mentions bark, hemlock, sea-air, and sea-bathing, among the proper means.

Swelled Testicle. See TESTICLE, DISEASES OF.

Retention of Urine. See URINE, RETENTION OF.

GONORRHŒA IN WOMEN.

Gonorrhœa in women is a much less painful complaint than in men, and less subject to complications, as bubo, retention of urine, &c. The complaint may not generally prevent the patient from following her usual occupations, and the menses are as little affected by it as it is by them.

The disease is not so easily ascertained in women as in men, because the former are subject to a disorder called *fluor albus*, or *leucorrhœa*, which resembles gonorrhœa. A mere discharge in women, is less a proof of the existence of a gonorrhœa than even a discharge without pain in men. The kind of matter does not enable us to distinguish a gonorrhœa from a fluor albus; for, in the latter affection, the discharge often puts on all the appearance of pus. Pain is not necessarily present, and therefore forms no line of distinction. The appearance of the parts often gives us but little information; "for," says Mr. Hunter, "I have frequently examined the parts of those who confessed all the symptoms, such as increase of discharge, pain in making water, soreness in walking, or when the parts were touched, yet I could see no difference between these and sound parts. I know of no other way of judging, in cases where there are no symptoms sensible to the person herself, or where the patient has a mind to deny any uncommon symptoms, but from the circumstances preceding the discharge; such as her having been connected with men supposed to be unsound, or her being able to give the disorder to others; which last circumstance, being derived from the testimony of another person, is not always to be trusted to, for obvious reasons." But, though there may sometimes be great difficulty in forming a judgment of some of these cases, the surgeon may frequently come to a right conclusion by recollecting, as Mr. Dunn has reminded me, that, besides the difference depending on the suddenly severe symptoms of gonorrhœa, fluor albus may be known by the great debility; the sinking of the stomach; the weariness of the limbs; the pain of the back, always increased by the erect posture; the severe headaches; the painful menstruation, together with the very gradual increase of the disease.

From the manner in which the disease is contracted, it must principally attack the vagina, a part not endowed with much sensibility. In many cases, however, it produces a considerable soreness on the inside of the labia, nymphæ, clitoris, carunculæ myrtiformes, and meatus urinarius. In certain cases, these parts are so sore that they will not bear to be touched; the person can hardly walk; the urine gives pain in its passage through the urethra, and when it comes into contact with the above-mentioned parts.

The bladder, and even the kidneys, occasionally sympathise. The mucous glands on the inside of the labia often swell, and sometimes suppurate, forming small abscesses, which open near the orifice of the vagina.

According to Mr. Hunter, the venereal matter from the vagina sometimes runs down the perinæum to the anus, and produces a purulent discharge, or even ulceration, in that situation. The disease in women may wear itself out, as in men; but it may exist in the vagina for years, if the testimony of patients can be relied on.

[*External or Vulvar Gonorrhœa.*—Gonorrhœa in the female may affect specially the external parts or surfaces, including all the structures exterior to the carunculæ myrtiformes, namely, the labia, the nymphæ, the clitoris, the preputium, the vestibulum, and the fossa navicularis. This form of the disease is usually termed vulvar gonorrhœa. It resembles in many respects what has been called external gonorrhœa in the male, affecting similar mucous surfaces of the glans penis and prepuce (*balano-posthitis*), and is equally amenable to treatment by simple local applications, first of a soothing, and afterwards of an astringent character. In vulvar gonorrhœa the parts affected are red, more or less swollen and inflamed, their sensibility is much increased, and their surfaces often present excoriations, or even superficial ulcerations. Sometimes the labia, nymphæ, and preputium are considerably swollen and distorted by œdematous infiltration, and, in extreme cases, usually originating in neglect, the skin between the labia and thighs, as well as that of the inguinal regions, are excoriated, and exude a highly fetid purulent secretion. The attendant inflammation is not always confined to the mere surface, but occasionally invades the glandular structures of the vulva and the submucous cellular tissues, giving rise to phlegmonous and lacunar abscesses. The symptoms vary in degree according to the extent and severity of the attack. In simple cases they consist of itching, tenderness, scalding after micturition from the contact of urine, with, in some cases, uneasiness about the hips and perinæum; increased discharge, at first of mucus, afterwards of a muco-purulent, and lastly of a purulent secretion, accompany these symptoms. In the more severe cases the patient is unable to walk, from the excessive tenderness of the external parts, and it is with difficulty she can bear even the sitting position; the discharge is increased in quantity, becomes more acrid in quality, capable of excoriating the surfaces with which it comes in contact, and emits a peculiarly offensive odour. When lacunar or phlegmonous abscesses form, there are superadded to the above symptoms the localised throbbing pain, accompanied by pyrexia, which are usually associated with the formation of matter in the neighbourhood of the visceral outlets.

The treatment, where no abscess exists, consists in regulating and moderating the diet, in administering remedies to counteract inflammatory action. Saline aperients, with or without antimony, and sometimes anodyne medicines are all that is required. The abstraction of blood, by general bleeding, is seldom necessary, and the local application of leeches is inadmissible, both on account of the state of the parts and the fear of inoculation from the possible presence of an unobserved chancre, which might be concealed between or just within the carunculæ myrtiformes, and thus escape notice. The local treatment by soothing and mild astringent lotions will be found most efficient. Decoction of poppies, solutions of opium, or of preparations of morphia, will meet the former indication; the ordinary astringent metallic salts, such as the sulphate of zinc, the nitrate of silver, the acetate of lead, the sulphate of copper, of the strength of one or two grains to the ounce of water, or Goulard's lotion, of double strength, or a weak lotion of chlorinated lime or soda, will effectually meet the latter. Should abscesses form, emollient poultices may be applied; and when fluctuation becomes distinct, the abscesses should be freely opened, in order to prevent burrowing and the formation of fistulæ, which latter are otherwise apt to form, communicating either with the vagina or rectum, or with both. Should the mucous membrane be undermined by the abscess, portions of it may be advantageously removed. An abscess in the external labium should, as a general rule, be opened on its cutaneous surface.

Vaginal Gonorrhœa.—Gonorrhœal inflammation may extend from the vulva to the vagina; but most frequently the disease commences in the vagina itself. The vaginitis resulting from gonorrhœal infection is not always to be detected by ocular inspection; but, in well-marked acute cases, by the aid of the speculum, increased vascularity will be observed, especially on the raised portions of the vaginal folds; occasionally ulcerated surfaces may be here and there seen; and when the disease has existed for some time, and has been severe, an appearance resembling the affection of the eyelids, termed granular lids, may, as a more rare occurrence, be noticed, indicating that the mucous follicles have become implicated. It is seldom that the submucous cellular tissue is invaded, but in exceptional cases phlegmonous abscess and even sloughing have supervened. The local symptoms are generally of a milder character where the vagina is the seat of the disease, than when the external parts are affected; and although the discharge is much more profuse in vaginitis, the patient's sufferings are infinitely less. However, in the onset of the attack, and in acute cases, the pains and uneasiness about the groins, hips, and pelvic region generally, are greatly complained of; but the excessive tenderness attendant on vulvitis is not experienced. In fact, in the majority of cases the inconvenience is so slight that the patient can hardly persuade herself that she is labouring under any more serious affection than leucorrhœa. Indeed, so much do the two affections resemble each other that it is often difficult even for the surgeon to diagnose correctly between them. The contagious nature of the discharge in all cases of gonorrhœa and its non-contagious character in most cases of leucorrhœa constitutes the principal difference; but this distinctive character is lost in severe cases of leucorrhœa, in which the discharge may from its acrid or irritating quality produce an inflammation and discharge in the male urethra resembling, in most of the accompanying symptoms, a severe gonorrhœa.

The treatment of gonorrhœal vaginitis should be general and local. The patient should avoid bodily exertion; her diet should consist of mild and for the most part farinaceous aliment; she should avoid all stimulants, and the only medicines usually required would be saline aperients, or other remedies directed against inflammatory action. The surgeon will depend more upon local treatment for the relief and cure of this affection. Amongst the local remedies, injections hold the first rank. While the inflammatory symptoms are present, these should be of an emollient and soothing character, or mildly astringent. The decoction of poppies, or weak opiate solutions, and the preparations of lead, form the best injections under these circumstances; the acetate of lead lotion, 1 gr. to the ounce, or the ordinary Goulard lotion, to which opiates may be added, answer exceedingly well. But when the inflammatory symptoms have subsided, and a profuse purulent discharge constitutes the prominent feature of the case, the more strongly astringent injections are to be preferred. The sulphate of alum; the nitrate of silver; the sulphate of zinc; the sulphate of copper, all form very efficient injections, beginning with the strength of 1 gr. to the ounce of water, gradually increased to 5 or 6 grs., as the disease becomes of older date, or when it assumes a chronic form. The vegetable astringents, such as the decoction of oak bark, of elm bark; infusions of catechu or of kino, of hæmatoxylon, a solution of tannin from 1 to 2 drachms to a pint of water, or of a strong decoction of walnut leaves, answer exceedingly well, either alone or with the addition of some of the above-named metallic salts. The common injection for females at the Lock Hospital consists of oak bark, to which is added sulphate of zinc in the proportion of 6 grs. to the ounce. Should these injections fail to arrest the discharge, the direct application of the sulphate of copper or of the nitrate of silver to the surface of the vagina may be had recourse to. In applying these caustics, the speculum should be used, and the vaginal surface should be slightly cauterised from behind, forwards, as the speculum is being withdrawn. This should be done once every two or three days, and the application should be so made that the cauterised surfaces should alternate with the portions of the mucous membrane not receiving the caustic, so that, if possible, on removing the speculum no two cauterised surfaces should come in contact. Another efficacious plan of treatment, when the ordinary measures fail, is to secure the separation of the diseased surfaces of the vagina from each other; this is effected by plugging the vagina with lint or charpie after the passage has been well syringed with some of the above-named astringent injections, or after the caustic has been applied as above recommended. The plugging should be removed and replaced daily. To facilitate the removal of the plugs, some surgeons attach pieces of silk or twine to the dossils of lint or charpie previous to their being introduced; these are to be brought out at the vaginal orifice. I am myself satisfied with the use of long strips of lint, without threads attached, which are readily removed by the aid of the common dressing forceps. The bivalve speculum is the most convenient instrument to use for the purpose of introducing the strips of lint, or portions of charpie. In obstinate or chronic cases, the surgeon will often derive advantage from the internal administration of bark; of steel; the mineral acids, or of other tonic remedies combined with a more generous diet, and the moderate use of wine and other stimulants.

Uterine Gonorrhœa.—The inflammation attending a gonorrhœa will occasionally extend from the vagina and os uteri to the interior of the neck and body of the uterus; rendering the affection obstinate and tedious, resisting all the ordinary modes of treatment. This affection will be readily discovered by examination with the speculum. A peculiar glairy tenacious mucus will be seen, filling the cervix and os uteri, and depending from these into the vagina, and which is removed with difficulty on account of its extreme tenacity. Granular, or superficial ulceration of the os uteri is not an unfrequent accompaniment of this affection.

The treatment here required is to remove the tenacious mucus, so as to allow the injections or caustic to come into immediate contact with the diseased surface. This object is best effected by injecting from a large syringe, through the bivalve speculum, previously introduced, and by deterging the os uteri with dossils of lint, held by an appropriate forceps. When the mucus is completely removed, the nitrate of silver should be applied to the ulcerations on the os, if any exist, and should also be introduced into the cervix uteri. This treatment should be repeated every third or fourth day, but not during nor close upon a menstrual period. On the intermediate days, common injections may be used by the patient herself, two or three times daily, in order to remove the vaginal discharge, which is certain to accompany the uterine affection. When, in spite of this treatment, the glairy discharge persists, the interior of the body of the uterus may be suspected as participating in the diseased action. Under these circumstances, the surface of the affected membrane must be reached. This must be done, however, with extreme caution. A narrow tube, fitting loosely in the neck of the uterus, may be introduced, and a small syringe, holding half an ounce only, should be attached to it. By an instrument of this kind a small quantity of an astringent lotion may be brought in contact with the mucous lining of the body of the uterus. The piston should be suddenly depressed, to allow the injection to pass out by jets, but of not more than a drachm at a time, and free egress should be allowed for the fluid by the side of the tube. Even with these precautions severe symptoms of abdominal pains, with chills and feverish symptoms, will occasionally follow injections into the uterine cavity. The great danger to be guarded against is the possibility of the injection entering into the Fallopian tubes, and from thence into the peritoneal cavity. Of the metallic salts, the sulphate of zinc, the sulphate of copper, or the nitrate of silver, of the strength of 1 gr. to the ounce, or a weak solution of a vegetable astringent, may be used for these intra-uterine injections.

Urethral Gonorrhœa. — The urethra may be affected by the disease in the female, but its occurrence is considered exceptional. The symptoms which accompany urethral inflammation resemble those in the male. Itching followed by pain in the urethra with scalding on micturition are experienced. The urethral orifice may be seen to be swollen and inflamed, and the whole course of the canal is felt to be thickened by digital examination. A purulent discharge will exude spontaneously, or may be made to appear by pressure exerted on the urethra from behind forwards. If the bladder become affected frequent desire to urinate is superadded to the other symptoms, but retention of urine is seldom present. A similar treatment to that adopted in the male subject may be had recourse to. The preparations of copaiba and cubebs will be equally efficacious, and injections may be used, but they are generally dispensed with on account of the shortness of the canal and the close proximity of the bladder, which render it difficult to inject the one without the other. On this account some surgeons prefer cauterising the urethra with the nitrate of silver; this is, however, seldom necessary, the balsamic remedies acting with sufficient promptness and certainty. It should be borne in mind that urethral gonorrhœa is rarely found as an isolated complaint in the female; vulvitis or vaginitis will be usually found accompanying it, and they will of course require their appropriate treatments. The inguinal glands not unfrequently inflame and enlarge, but rarely suppurate in female urethritis.

Rectal and Anal Gonorrhœa.—From the position of the vulva and anus and the shortness of the intervening perinæum, the discharge escaping from the former must frequently come in contact with the latter, especially in the recumbent posture; notwithstanding this unfavourable proximity, it is seldom that the anus or rectum becomes affected with gonorrhœal inflammation. Condylomata, accompanied by discharge, are not unfrequently observed in the neighbourhood of the anus both in male and female, but as a symptom of secondary syphilis and not of gonorrhœa. Inflammation and discharge arising from gonorrhœal infection in these parts only, must, I repeat, be considered of rare occurrence. When present and affecting the submucous tissue and skin at the verge of the anus, it resembles in appearance balanitis in the male or vulvitis in the female, being characterised by increased redness, and tumefaction of the parts affected, accompanied by excoriations and superficial ulcerations. When the external parts are alone implicated, local treatment by lead or other astringent lotions constantly applied, will speedily effect a cure. The disease, however, has been known to extend to the mucous lining of the rectum, giving rise to pain and a sensation of weight about the perinæum and anus, to tenesmus and painful defæcation, and a discharge of purulent matter from the rectum escaping by occasional jets rather than by a continual oozing. It must be borne in mind that both these affections occur as complications of and in association with gonorrhœa, occupying the more usual sites of the disease, the treatment of which must proceed simultaneously with that required for the rectum. The application of the nitrate of silver or of the sulphate of copper directly to the inflamed mucous surface of the rectum is the most efficacious plan of treatment after the inflammatory symptoms have been combated by the ordinary soothing and antiphlogistic remedies. Injections, if had recourse to, should be small in quantity, and the same as those recommended for vaginitis. Soothing injections of starch and opium will give relief in the first instance, while the inflammatory symptoms and those of excessive irritation exist. When these have subsided, those of an astringent character should be substituted.

The strength of the injections may be from one to two grains to the ounce of water of any of the metallic salts already mentioned, and as they should be retained, not more than two ounces in quantity should be used at a time, or some of the vegetable astringents may be preferred.]

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GORGET. An instrument used in the operation of lithotomy, for the purpose of cutting the prostate gland and neck of the bladder, so as to enable the operator to introduce the forceps and extract the stone. It is, in fact, a sort of knife, at the end of which is a beak, that fits the groove of the staff, and admits of being pushed along it into the bladder. Besides cutting gorgets, constructed for the preceding design, there are also blunt ones, intended to be introduced into the wound, their concavity then serving as a guide for the forceps into the bladder.

GRANULATIONS. The little conical eminences which form on the surfaces of ulcers and suppurating wounds, and serve for filling up the cavities, and bringing nearer together and uniting the margins of ulcers and wounds, healing by what is termed the *second intention*. They receive their name from their granular appearance.

[Before the time of Hunter, the observation of surgeons led them to believe that unclosed wounds and ulcers were the seat of several successive processes, each capable of being hastened or improved by art:—these were digestion, cleansing, incarning, and cicatrising. Medicaments intended to promote the first process, usually of the turpentine sort, were called *digestives*, a name which survives to this day as an appellation for stimulating ointments. Digestion consists apparently in those processes which precede suppuration. Cleansing, or mundification, consists in the throwing off any films of imperfect fibrinous matter which may have adhered to the wound, and the remedies supposed to promote it, usually metallic solutions, as the oxymel æruginis, were called detersives. Incarning corresponds with granulating, and was wont to be promoted by sarcotics, of which myrrh, aloes, and sarcocolla were the most famous. Cicatrisation was promoted by epulotics. (*Turner's Art of Surgery*, vol. i. 1732.) Hunter, whose observations of matter of fact are above all praise, gives the following history of the origin and growth of granulations.] "I have often (says Mr. Hunter) been able to trace the growth and vascularity of this new substance. I have seen upon a sore a white substance exactly similar, in every visible respect, to coagulating lymph. I have not attempted to wipe it off, and the next day of dressing, I have found this very substance vascular; for, by wiping, or touching it with a probe, it has bled freely. I have observed the same appearance on the surface of a bone that has been laid bare. I once scraped off some of the external surface of a bone of the foot, to see if the surface would granulate. I remarked, the following day, that the surface of the bone was covered with a whitish substance, having a tinge of blue. When I passed my probe into it, I did not feel the bone bare, but only its resistance. I conceived this substance to be coagulable lymph, thrown out from inflammation, and that it would be forced off when suppuration came on; but on the succeeding day, I found it vascular, and appearing like healthy granulations." [After Hunter's time, when surgeons began to occupy themselves with investigations of the minute processes of growth and disease, with very imperfect microscopes, there prevailed the idea, derived from Hunter's exaggerated solidism, that all organisation depended upon blood-vessels, and was effected by them; moreover, it was believed that pus globules were altered blood globules, and that the processes of inflammation and repair were to be explained in a mechanical kind of way.] Thus, Mr. J. W. Earle, in his inquiry into the nature of inflammation, gives the following explanation of the formation of granulations. "When the globules of the blood have been effused on the surface of a wound, it is clear that, after a time, their continued passage will have established an immense number of furrows, or canals, in that which was at first merely an amorphous layer or covering of fibrin, which canals must be the continuations of the genuine capillaries, and which, like them, must be wholly unprovided with distinct coats, like larger vessels. In proportion as these channels become established, the fibrinous layer is no longer in its original condition, but is pierced by innumerable perforations, which offer a readier egress to the serum and fibrin, as well as to the globules, so that at length nearly the whole of the discharge from the surface of a wound may find its way through them directly, instead of, as previously, by percolation. As the fresh fibrin exudes through the original layer by these channels, or perforations, it will coagulate around them in little heaps, whose central points must be the channels, or continuations of the genuine capillaries, through which it had exuded. As, on the one hand, the colouring matter of the globules was lost, in proportion to the difficulty with which they were forced by the pressure of the *vis a tergo*, through the parenchyma and fibrin, as yet imperforate, so, on the other hand, in proportion now as their passage is facilitated by the establishment of the above-mentioned canals, the globules will *advance further into the fibrin*, and approach nearer to the surface of the wound, *without being deprived of their colouring matter*. When this period has arrived, the fibrin, which was at first opaque, and of a dirty white colour, has assumed a jelly-like and more transparent appearance (in consequence of its combination with the serum, which is constantly passing through it), actually contains real blood, and has every character which pertains to granulations." (See *J. W. Earle, in Lond. Med. Gaz.* 1835, p. 219.) [But Sir E. Home, some years before, had pointed out the real process of exudation, and the formation of pus in it, in opposition to the theory which assumed that pus was but altered blood. He has the merit of showing the identity of pus and granulation, a notion ridiculed by Hunterians. (See *Phil. Trans.* part 1. 1829.)

From the time of Hunter to the modern microscopic era, the following were the doctrines usually taught respecting granulations.] The surfaces of granulations are very convex, the reverse of ulceration, and they present a great many small points, or eminences, so as to appear rough. The smaller such points are, the more healthy the granulations. The colour of healthy granulations is a deep florid red. When livid, they are unhealthy, and have only a languid circulation. Healthy granulations, on an exposed or flat surface, rise nearly even with the surface of the surrounding skin, and often a little higher; but when they exceed this, and take on a growing disposition, they are unhealthy, become soft, spongy, and have no disposition to form skin. Healthy granulations are always prone to unite to each other, so as to be the means of uniting parts.

They are not endowed with the same powers as originally formed parts. Hence they more readily ulcerate, and mortify. The curious mode in which granulations contract, when sores are healing, and even for some time after they are healed, has been explained in the article CICATRISATION. (See *Hunter on the Blood, Inflammation, &c.* p. 473, *et seq.* 1794.)

It was a question whether granulations can ever be formed without suppuration. Mr. Hunter seemed inclined to think that they may occasionally be produced without it, and he supported his opinion by the relation of the dissection of a limb which had suffered a compound fracture, and in which he observed a substance resembling granulations. Dr. John Thompson, on the other hand, declares that he has never seen any granulation, and still less a granulating surface, where pus was not formed. (See *Lectures on Inflammation*, p. 408.)

The exact process by which the blood-vessels, nerves, and absorbents of granulations are formed, is still amongst the secrets of nature. The observations of Mr. Hunter on the subject amount only to conjecture. "The growth of nerves, and their development in granulations (says Dr. J. Thompson), is a subject of equal curiosity with the growth of blood-vessels in the same structure. Their existence in granulations is proved by the pain which is felt on our pinching, rubbing, or wiping the surface of a sore. Even the granulations which arise from the surface of bone are sensible; and the same granulations are in the course of a few hours provided not only with blood-vessels and nerves, but also with a system of absorbents. The existence of absorbents in granulations is proved, not only by the changes of bulk which we see them daily undergo, becoming gradually, in the healthy state, smaller, firmer, and more compact, but also by the frequent disappearance, in whole or in part, of a granulating surface, by the process of ulcerative absorption." (See *Thompson's Lectures on Inflammation*, p. 419.) According to Sir Astley Cooper, granulations which spring from parts endued with great sensibility, like muscles, are extremely sensitive; but granulations which arise from bones, he says, have no sensibility whatever. These observations are qualified with the condition, that the bone be uninflamed, and it is acknowledged that granulations, arising from the cancellated structure of bones, are sometimes extremely sensitive. He describes granulations from tendons as quite insensible, and those from aponeuroses and fasciæ as possessing very little sensibility. Every young dresser of sores at an hospital, who has been too lavish of the red precipitate ointment, must have learned from experience that granulations are furnished with absorbent vessels, and that mercury may be absorbed from the surface of ulcers, and bring on an unwished-for salivation of the patient. Indeed, the absorbent power of granulations is frequently the means of producing baneful effects upon the constitution, by the introduction of deleterious substances into the circulation. Thus, arsenic, applied to sores, is often conveyed into the system, and, on this account, is to be regarded as a dangerous external remedy. Sir Astley Cooper quotes one instance, in which the patient seems to have been poisoned by the indiscriminate application of arsenic to a fungus of the eye. Opium also, when applied to the surfaces of sores, is very readily absorbed, producing similar effects to those which arise from its introduction into the stomach. Thus, when the quantity absorbed is too great, excessive costiveness, extreme pain in the head, and torpor of the system, are the consequences, which require the frequent administration of active purgatives for their removal. A temporary amaurosis has been known to be produced by the absorption of the extract of belladonna from the surface of irritable malignant ulcers. (*F. Tyrrell; A. Cooper's Lectures*, vol. i. p. 169.)

[The reader will notice the unfounded assumption of the development of nerves in granulations because they are sensitive, and the still more extraordinary assumption of the existence of lymphatic vessels, on the ground that granulations are capable of altering in volume, of perishing by disintegration, and of imbibing liquid medicines applied to their surface. (See ABSORPTION.)

If we may give, as shortly as possible, a *résumé* of the more modern observations on this matter, we may say that granulations appear to consist of a portion of the plastic matter of the blood employed for the reparation of such wounds as do not heal by the first intention. Their common situation is in suppurating wounds or healing ulcers of the skin, and they are commonly found in diseased joints; but Mr. Paget confirms Hunter's observation, that they may exist without suppuration. "In subcutaneous injuries or diseases (he says), granulations sometimes form, which develope themselves into cellular tissue through nucleated blastema. So I found in a case of simple fracture, in which the ends of the bones remained long disunited; they were enclosed in a cavity formed by condensation of surrounding tissues, but containing no pus, and were covered with a distinct layer of florid granulations." (*Lectures on Surgical Pathology*, vol. i. p. 208, Lond. 1853.)

Supposing an injury which leaves various cut surfaces exposed. First there ensues a period of repose, during which the wound is covered with a whitish glaze, and a serous oozing (or *quitture*, as our fathers called it) takes place. Then, in three, four, or more days, a translucent whitish substance, not a mere film or glaze, but a something succulent, covers the wound, and within twenty-four hours assumes a rosy, and then a decidedly red tint. During the period of repose, it is supposed by Mr. Paget that the blood-vessels are enlarging, and preparing to pour out the exudation.

The exudation developes itself into nucleated cells, now well known as *plastic* or *fibro-plastic*, or granulation cells. They have strong resemblances to the white corpuscles of the blood, and to pus cells. They are described by Mr. Paget as at first "spherical, palely or darkly nebulous, from about $\frac{1}{1800}$ to $\frac{1}{2500}$ of an inch in diameter. They contain a few shining, dark-bordered granules, and lie imbedded in a variable quantity of clear pellucid substance by which they are held together." These cells develope themselves into filamentous tissue, by the processes of elongation and splitting. "Singly (says Mr. Paget) they are colourless; but in clusters they are ruddy, even independent of the blood-vessels. In granulations that are making healthy progress,—in such as, after three or four days' growth, are fluid, moist, level, scarcely raised above the surrounding tissues, uniformly granular, or like a surface of minute papillæ,—one can conveniently trace the cells in various stages, according to the position they occupy. The deeper seated ones are always most advanced, and often much elongated or nearly filamentous; while the superficial ones are still in a rudimental state, or near the edges of the granulating surface are acquiring the character of epithelial cells."

The surface of granulations is usually bathed in pus. This liquid appears to consist of the same exudation as forms granulations, with the cells misdeveloped into pus cells, and the intercellular substance melted down into the *liquor puris*. A profuse suppuration, and consequent waste of material, is usually a sign that the healing process is prevented by some constitutional or local irritation.

As we have already narrated, Mr. Paget believes that some *subcutaneous* injuries are repaired by a material which sets at once into a fibrillary state (*nucleated blastema*) without going through the process of cell development. (See REPAIR, WOUNDS.)

The formation of new vessels in granulations has always excited the admiration of the pathologist. The process has been accounted for in one of two ways. It has been supposed, for example, that in the new *blastema* or reparative material effused, blood and blood-vessels are formed, as they are in the embryo, and that the new blood-vessels so formed join themselves to those of the parent body. (See *Wedl; Pathological Histology*, Sydenham Society, p. 81; *Schwann and Schleiden*, *ib.*)

The other view, which is adopted by Mr. Paget, is, that the capillary vessels of granulations are outgrowths of the vessels of the part on which the granulations are situated, and from which they were exuded. Little vessels shoot out into the new layer of granulations, and inosculate in every direction, forming arches, from whose convexity again fresh shoots are given off. Mr. Paget believes likewise that petty streams of blood may exude into the granulation material, and that vessel walls may be formed around these.

However formed, the vessels should be numerous enough in healthy granulations, to give a florid surface, covered with a succulent layer, which the eye soon learns to recognise as healthy. Sometimes the granulations seem very small and irritable, and the vessels too numerous; more often, on the contrary, they are too large, pale, puffy, and exuberant, and defective in vascular supply. Or they may be exuberant and vascular likewise, secreting pus profusely, as happens sometimes when patients with ulcerated surfaces consume too much meat and beer.

Neither nerves nor lymphatics have been found in granulations. The assumption of their existence by the surgeons of the foregoing generation was an effect of the want of a proper system of philosophising in medicine, and of imperfect observation, which did not include general and comparative physiology.

The chemical composition of granulations is said to be albuminous, like that of lymph and pus, passing into the gelatinous as it becomes more fully developed into skin and areolar tissue. They constitute, as it were, a transition stage; and when their surface is converted into epithelium, their function is discharged, their vessels shrink, and they lose their identity in the scar or cicatrix which succeeds.

The surface of granulations, and the exudation which they yield, instead of *healing* or becoming developed into cuticle, sometimes remains in a permanent state, constituting the condition known as *indolent ulcer*, lining membrane *of sinus*, &c. During any period of weakness, and especially at the approach of death, they are apt to break up into a sanious liquid, or, in the old phraseology, to *ulcerate afresh.*

Granulating surfaces readily cohere together; thus the opposite portions of a wound which have not united by the first intention, and which are covered with healthy granulations, will often unite by organic union, when these granulating surfaces are applied one to the other and so kept. This is called healing by the second intention, or by the inosculation of granulations.] *R. Druitt.*

GUNSHOT WOUNDS AND INJURIES receive their name from the manner in which they are produced, being generally caused by hard, obtuse, metallic bodies, projected from cannons, muskets, or other species of firearm. With such injuries, it is also usual to comprehend a variety of dreadful accidents arising from the explosion of shells, or the violence with which pieces of stones from ramparts, or splinters of wood on board ship, are driven about. Gunshot wounds are the most considerable of the contused kind; and what is to be said of them will apply, more or less, to all contused wounds, according to the degree of contusion. The effects of a gunshot wound differ so materially in different men, and the appearances are so various, according to the nature of the part wounded, and the greater or lesser force with which it has been struck, that no invariable train of symptoms can be laid down as its *necessary* concomitants. If a musket or pistol-ball has struck a fleshy part, without injuring any material blood-vessel, we see a hole about the size of, or smaller than, the bullet itself, with a more or less discoloured lip, forced inwards; and, if it has passed through the parts, we find an everted, less livid, more ragged, and larger orifice at the point of its exit. The hæmorrhage is in this case very slight, and the pain may be inconsiderable, insomuch that, in many instances, the wounded man is not aware of his having received any injury.

[It is not, however, always practically an easy matter to distinguish the wound of entrance from that made by the escape of the ball, by the character of the edges alone. The margins of the wound at the point of entrance are not in every, nor even in the majority of the cases inverted, nor are those of the point of exit of the bullet always everted. If the speed of the ball has been swift, especially if it be a conical one, and no bone has been struck so as to impede the velocity of the missile, then there is but little characteristic difference either in the size or appearance of the two wounds. The margins of the escape wound are sometimes undermined when produced by a bullet having little original velocity, or from having had its velocity diminished by contact with, or transmission through, bone; this is due to the natural resistance or toughness of the skin, yielding or being lifted up by the ball before it is actually torn, and it is this peculiar elasticity and toughness of the integument which causes these projectiles to be often arrested in their flight when nearly spent; so that it is a very common occurrence to have to cut down upon and extract balls, lying immediately beneath the skin, on the side of the limb opposite or nearly opposite to the point of entrance.]

If the ball has torn a large vessel, or nerve, the hæmorrhage will generally be profuse, or the pain of the wound severe, and the power of the part lost. Some men will have a limb carried off, or shattered to pieces by a cannon-ball, without exhibiting the slightest symptoms of mental or corporeal agitation; nay, even without being conscious of the occurrence: and when they are, they will coolly argue on the probable result of the injury; while a deadly paleness, instant vomiting, profuse perspiration, and universal tremor, will seize another on the receipt of a slight flesh wound. This tremor, which has been so much talked of, and which to an inexperienced eye is really terrifying, is soon relieved by a mouthful of wine or spirits, or by an opiate; but, above all, by the tenderness and sympathising manner of the surgeon, and his assurance of the patient's safety." (See *Hennen's Principles of Mil. Surgery*, p. 33, edit. 3.)

On the other hand it is correctly noticed by Mr. Guthrie, that the continuance of the constitutional alarm, or shock, ought to excite great suspicion of serious injury; and when wounds have been received in such situations, or bear such appearances, as render it doubtful whether any parts of vital importance have been injured, or not, the manner in which the constitutional perturbation lasts may be assumed as evidence of the fact, when other symptoms more indicative of the injury are wanting; and, under all such circumstances, a very cautious prognosis should be delivered. (*Commentaries of Surgery*, p. 3, ed. 6.)

Respecting the general tendency of gunshot wounds not to bleed copiously, unless large vessels be injured, it is a fact which necessarily depends upon the degree of contusion usually attending these injuries. But it is also true, as the preceding author has stated, that, although some gunshot wounds bleed but little at first, there is in the greater number of cases more or less of blood; and in wounds of vascular parts, like the face and neck, the quantity lost is often considerable, though the main arterial branches may not be injured. (*Op. cit.* p. 1, ed. 6.)

In gunshot wounds another circumstance is observed, which is often remarked in other cases, viz., when a large artery is partially divided, the bleeding is more profuse and dangerous than when the vessel is completely severed, and the hæmorrhage, if not repressed by a tourniquet or other means, will often continue until the patient dies. Thus Mr. Guthrie speaks of three cases, in which life was lost from wounds of the femoral, brachial, and carotid arteries, no effectual means of stopping the hæmorrhage having been adopted. In 1830, a young man, at the attack on the Hôtel de Ville, in Paris, received a ball in the upper and inner part of the right thigh, and the femoral artery was wounded; he was conveyed to the Hôtel-Dieu, but lost so much blood in the streets that, when he reached the hospital, he was in a dying state. (*Dupuytren*, *Clin. Chir.* t. ii. p. 464.)

[Cannon-balls, and even bullets, sometimes produce severe internal lesions without occasioning a breach of continuity in the integument. These injuries before the time of Ambrose Paré (who was the first to explain correctly the manner of their production) were termed wind contusions. The muscles, bones, or solid viscera may be bruised, broken, or crushed by these missiles, or hollow viscera may be ruptured without leaving any appearance of injury on the surface of the skin, sometimes not even discoloration.]

Such cases were for a long while imputed to the violent motion supposed to be communicated to the air by the ball itself. It was imagined that this elastic fluid, being rapidly displaced by the shock of the projectile, was capable of making such pressure on surrounding bodies as to destroy their texture.

[Some experiments have been recently made by M. Pelikan to determine the influence which a cannon-ball produces on the surrounding atmosphere in its rapid flight through it. He had a machine constructed for measuring the force exerted by the wind of balls passing at various distances. At three inches from it, the passing ball produced not the slightest effect; after repeated experiments the results attained were constantly the same. His conclusions are: 1. That a projectile passing very close to any object exercises only an insignificant influence upon it. 2. That which is called the wind of a ball, even with a full charge of powder, has so trifling a force, as to be incapable of determining any lesion, even with pieces of large calibre.]

The mischief, formerly imputed to the air, is occasioned by the ball itself. Its producing a violent contusion, without tearing the skin and entering the limb, is to be ascribed to the oblique direction in which it strikes the part, or, in other instances, to the feebleness with which the ball strikes the surface of the body, in consequence of its having lost the greater part of its momentum, and acting principally by its weight, being, in short, what is called a spent ball. Daily observation evinces that balls which strike a surface obliquely, do not penetrate, but are reflected, though they may be impelled with the greatest force, and the body struck may be as soft and yielding as water. This alteration in the course of the ball, not only happens on the surface of the human body, but also in the substance of a limb which it has entered. Thus a bone, a tendon, &c. may change the direction of a ball which touches them at all obliquely. Hence, the track of a gunshot wound is not always straight, and balls sometimes run under the integuments nearly all round the body or limb.

A ball, when it strikes a part of the body, may cause several kinds of injury. 1. It may only occasion a contusion without penetrating the part, on account of its being too much spent, or of the oblique way in which it strikes the surface. 2. It may enter and lodge in the substance of a part; in which case the wound has only one aperture. 3. It may pierce through and through; and then there are two openings, one at the entrance, the other at the exit of the ball. At the entrance there is commonly more contusion and ecchymosis than at the exit of the ball. The former opening is generally narrower; the latter wider and more irregular, especially when the ball has been flattened by its having struck a bone. The aperture made by the ball in the clothes is always much narrower than that occasioned in the corresponding integuments. 4. A cannon-ball, or large fragment of shell, may tear off a whole limb.

As is observed by a most eminent practitioner, the effects of gunshot wounds depend very much upon the manner in which the gun has been loaded, and the distance at which it has been discharged. If a fowling-piece is merely loaded with powder, without any wad, and fired off very near the person who receives injury, the integuments are violently contused. But, if the same charge be rammed down, the effects will differ according to the degree of resistance and the distance of the wounded party. The following case occurred in the practice of Dupuytren. Two persons quarrelled; and one of them discharged a fowling-piece, loaded only with powder, at the abdomen of his adversary, who instantly fell dead. The mouth of the gun had been not more than a foot or two from him. Dupuytren, having been juridically required to ascertain the cause of death, found the clothes torn, a hole in the parietes of the abdomen more than an inch in diameter, the intestine wounded, and the wad in the middle of the abdomen. Parties attempting suicide sometimes, in their confusion, forget to put the ball into the pistol. The explosion occasions a violent distension of the parietes of the mouth; and though the vertebral column is not injured, the soft palate is lacerated, and sometimes the lower jaw fractured. (*Dupuytren*, in *Clin. Chir.* t. ii. p. 419.)

The many accidents which occur in the shooting season, should lead every surgeon to remember that small shot acts in two ways: it either strikes in a mass, "*il fait balle*," as the French term it, which depends upon the goodness of the fowling-piece and its nearness to the wounded person, or else it is scattered, and each shot hits separately. In the first case its effects are generally more formidable than those of a single bullet. (See *Dupuytren*, ib.) I lately visited, with Mr. Broxholm of Sunbury, a young man who, in taking a fowling-piece out of a cart, received its contents at the inner and upper part of the arm, the mouth of the gun being at the moment close to the limb. The shots in a mass passed obliquely through it, on the outer side of the humerus, occasioning an opening at their entrance not more than an inch and a half in diameter, but one at their exit much larger, and of an irregular triangular shape. This case was not followed by any very severe consequences; a circumstance to be ascribed partly to the patient's good constitution, and partly to the fortunate circumstances of the bone, as well as other important parts having escaped injury, and no foreign body having lodged in the part. The wound was, however, attended with more laceration than one caused by a single bullet would have been.

Angular, uneven bodies, such as pieces of iron, hammered leaden bullets, cut lead, fragments of shells, &c., produce far more dangerous wounds than round smooth balls. Several persons were wounded at Paris, in the late disturbances, by irregular pieces of balls, which had been broken by striking first against iron bars. (*Clin. Chir.* t. ii. p. 429.)

In sieges, many severe injuries are produced by fragments of stones and brickwork being driven about with immense violence, on being struck by cannon-balls. Even the ground itself is frequently scattered with such force as to cause injuries of a serious nature. Several examples of such occurrences are noticed by M. Larrey, jun. (See *Hist. Chir. du Siége de la Citadelle d'Anvers*, p. 42, &c.) Irregular angular bodies keep up inflammation until they are discharged in the course of the suppuration, or they are extracted. But the textures sometimes become habituated to the presence of a ball, which is regular and smooth, and not of too large a size. A ball of this kind has been known to lodge for a considerable time in the brain, the heart, or lungs. Fibrine is first effused around it, and, becoming organised, assumes the character of villous membrane, from which pus exudes, but which is rendered gradually thinner, puts on a smooth appearance, and at length secretes only a little serosity. Sometimes, however, the serous cyst accidentally inflames, an abscess forms, and fistulæ ensue, which continue as long as the cause of the irritation. According to the researches of Dupuytren, wherever balls lodge for a time and excite inflammation and suppuration, they are enveloped in a cyst, whose structure resembles that of a mucous membrane; and after a certain period, a communication is established between the cavity of the cyst and some point of the surface, or of the interior of the body. On the other hand, when a ball excites neither inflammation nor suppuration, the cyst presents an organisation exactly like that of a serous membrane, and contains between it and the ball a limpid serosity. (See *Dupuytren*, in *Clin. Chir.* t. ii. p. 432.) If, after extracting the ball from such a cyst, the wound be closed and healed by the first intention, a swelling is apt to form, composed of a collection of serous fluid in the cyst which is left. Hence, Dupuytren recommends either the removal of the cyst with the ball, or filling it with lint.

On account of the contusion which the parts suffer from the violent passage of the ball through them, a part of the textures surrounding the wound is most commonly deadened, and must afterwards be thrown off in the form of a slough. Hence, such wounds are generally prevented from healing by the first intention, and most of them necessarily suppurate. This does not take place equally in every gunshot wound, nor in every part of the same wound; and the difference commonly arises from the variety in the velocity of the body projected; for, where the ball has passed with little velocity, which is sometimes the case at its entrance, but still more frequently, at the part last wounded, the injury may sometimes be healed by the first intention. (*J. Hunter*, *Palmer's Edit.* p. 543.) [Several instances of wounds healing by the first intention, without suppuration, are recorded; in all probability, caused by bullets in rapid flight.]

M. H. Larrey, in his account of the gunshot wounds, which occurred at the siege of the citadel of Antwerp, has recorded several cases where the solutions of continuity were perfectly regular, and more or less like those made by a cutting instrument. Thus, one which was caused by the fragment of a shell, carried away a portion of the integuments of the chest, leaving a wound of a regular and elliptical shape, resembling that produced by an amputation of the breast. Its sides were brought together without sutures, and a cure was speedily accomplished. (See *Hist. Chir. du Siége de la Citadelle d'Anvers*, p. 138.) [As a general rule, however, splinters from shell cause much laceration and are followed by sloughing and copious suppuration.]

Foreign bodies more frequently lodge in gunshot wounds than any others, and are commonly of three kinds. 1. Pieces of clothing, or other things, which the ball forced before it into the limb. 2. The ball itself. 3. Loose splinters of bone. It is only when the ball strikes the naked flesh, touches no bone, and goes quite through the part, that the wound can be free from extraneous matter. Foreign bodies are the cause of numerous unfavourable symptoms, by irritating sensible parts, and exciting pain, inflammation, spasms, hæmorrhage, long suppuration, &c.; and the more uneven, pointed, and hard they are, the more likely they are to produce these evils. Hence, spicula of bone are generally the most to be dreaded.

The great obliquity and length of the fissures, produced in the cylindrical bones by musket-balls, are such as are not remarked in any ordinary fractures. When I was with the army in Holland, in the year 1814, I had in the hospital at Oudenbosch, several fatal compound fractures of the thigh, caused by gunshot violence. The fissures in some of these examples were found to extend two-thirds of the length of the bone. This fact is noticed by Mr. Guthrie: "The fractures extend far above and below the immediate part struck by the ball, and, as far as depends upon my information from the examination of limbs that were amputated, farther downwards than upwards; so that, from a fracture in the middle of the thigh, I have often seen fissures extend into the condyles, and cause ulceration of the cartilages of the knee-joint," &c. (*On Gunshot Wounds*, p. 190.)

It is commonly stated that when a cannon-ball tears off a limb, it produces a violent concussion of the whole body, and a general derangement of all its functions. This, however, is by no means always true. I saw some years ago in London, a young sailor, whose arm had been completely torn off at the shoulder by a cannon-ball from one of the forts at Guadaloupe, in March, 1808: he suffered no dreadful concussion of his body, nor were his senses at all impaired. This case was very remarkable, as the scapula was so shattered, that Mr. Cumming of Antigua, was under the necessity of removing the whole of it. The patient recovered in two months. The axillary artery did not bleed.

[Like other injuries, gunshot wounds in unhealthy constitutions are not unfrequently followed by inflammation and deposition of pus in some internal viscus; more especially the lungs or liver; or sero-purulent effusion may take place into the cavity of the pleura; or the neighbouring cellular or muscular tissues may be the seat of these purulent deposits; or one or more of the joints may become inflamed, and purulent matter be infiltrated into them. The veins leading from the injury are found very generally to be thickened and to contain puriform matters. This unhealthy condition of parts sometimes commences very insidiously; but is generally accompanied with acceleration of the pulse, rigors, copious perspirations, and low typhoid symptoms. When these unfavourable occurrences follow amputation, they are preceded by an unhealthy aspect or sloughy state of the stump. For further information on this point see the article PYÆMIA.]

From the circumstance of the inner surface of gunshot wounds being often more or less deadened, they are late in inflaming. This explanation of the fact, as delivered by John Hunter, is the best yet offered. Traumatic inflammation being at first generally indolent, gives to gunshot wounds, in their first stage, as Dupuytren observes, a deceitful appearance of mildness (see *Clin. Chir.* t. ii. p. 452); for afterwards, the inflammation, which is often more considerable at the entrance than the exit of the ball, becomes very intense. But when a ball has fractured a bone, which fracture has occasioned great injury of the soft parts, independently of that caused immediately by the ball itself, the inflammation will come on as quickly as in cases of compound fracture; because the deadened part bears no proportion to the laceration or wound in general. (*J. Hunter*, *Palmer's Edit.* p. 543.)

From the same circumstance of a part being often deadened, gunshot wounds frequently cannot be completely understood in the first instance; for, in many cases, it is at first impossible to know what parts are killed, whether bone, tendon, or soft part. Nor can this be ascertained till the slough separates, which often makes the wound much more complicated than was previously imagined. For some viscus or a part of some viscus, or a part of some large artery, or even a bone, may have been killed by the violence. If a piece of the intestine has been killed, the contents of the bowel will begin to come through the wound when the slough separates. If a portion of a large blood-vessel is killed, a profuse, and even fatal hæmorrhage may come on, when the slough is detached, although no material quantity of blood may have been previously lost. (See *Hunter, Palmer's Edit.* p. 544.) Thus several days after the receipt of the wound, and when all danger from inflammation is over, a bleeding *per anum*, occasioned by the separation of a slough from some internal vessel, may destroy the patient, as happened in a very interesting case reported by Mr. Guthrie. (p. 13. ed. 2.) A soldier of the 2nd battalion of the 44th regiment was shot in the ham at the assault of Bergen-op-zoom, in 1814. There was no hæmorrhage for ten days; but at the end of this period, the popliteal artery gave way, and I was obliged to take up the femoral artery, by which means the bleeding was effectually stopped, and the man recovered.

When the ball moves with little velocity the mischief is generally less, the bones are not so likely to be fractured, the parts are less deadened, &c. However, when the velocity is just great enough to splinter a bone which is touched, the splintering is generally more extensive than if the impetus of the ball had been much greater, in which case a piece is more likely to be taken out. When the ball moves slowly, it is more likely to be turned by any resistance it may encounter in its passage through parts, and hence the wound is more apt to take a winding course.

The track of a ball is generally more or less tortuous in consequence of the unequal resistance of the different textures and the deviations of the projectile itself.

When a ball enters a part with great velocity, but is almost spent before it comes out again, in consequence of the resistance it has met with, there may be a good deal of sloughing about the entrance, and little or none about the exit, owing to the different degrees of celerity with which the ball traversed the parts. (See *Hunter*, *On Inflammation*, *Gunshot Wounds*, *&c.*)

The effects of a ball upon a bone vary according to circumstances. Sometimes they only amount to a contusion of it; but this accident, though slight in appearance, is frequently followed by perilous consequences. The periosteum, if not destroyed, inflames and separates from the bone, and necrosis ensues to a greater or lesser extent. If the bone be of a spongy texture, the inflammation may spread far in its internal vascular structure. In the skull the two tables are almost always attacked by necrosis, and the dura mater inflames consecutively. If the force of the projectile be such as to overcome the resistance of the bones, these are broken with greater facility in proportion as their hardness is more considerable and their elasticity less. The flat bones, like those of the cranium and the scapula, are sometimes perforated as cleanly as if a portion of them had been taken out with a circular saw. In other instances they are more extensively broken and comminuted. A ball may break a part of a long bone, like the tibia, without a fracture being produced, extending through all its circumference; but more commonly, the middle compact portions of the long bones are reduced into numerous fragments of various shapes and dimensions. If the projectile retains but very little impetus, or strikes a bone obliquely, this may be fractured without being at all splintered. Of this, two instances are recorded by Dupuytren. (*Clin. Chir.* t. ii. p. 442.)

Gunshot wounds may have either one or two apertures, according as the ball has lodged or passed quite through the part. In some cases the openings are diametrically opposite each other; in others they are not so, the direction of the ball having been changed by the resistance which it met with from a bone, cartilage, tendon, &c. Thus a ball has been known to enter just on the inside of the ankle and come out near the knee, to enter the forehead and come out at the temple, &c. (*Richerand*, *Nosographie Chir.* t. i. p. 219, edit. 2.) Dr. Hennen mentions an instance in which a ball entered near the pomum Adami, and after running completely round the neck, was found in the very orifice at which it had entered. "This circuitous route is a very frequent occurrence, particularly when balls strike the ribs or abdominal muscles, for they are turned from the direct line by a very slight resistance indeed, although they will at times run along a continued surface, as the length of a bone along a muscle or a fascia, to a very extraordinary distance." Dr. Hennen refers to cases in which the ball traversed almost the whole extent of the body and extremities. "In one instance, which occurred in a soldier, with his arm extended in the act of endeavouring to climb up a scaling-ladder, a ball, which entered about the centre of the humerus, passed along the limb, and over the posterior part of the thorax, coursed among the abdominal muscles, dipped deep through the glutæi, and presented on the forepart of the opposite thigh, about midway down. In another case, a ball, which struck the breast of a man standing erect in the ranks, lodged in the scrotum." (*Principles of Military Surgery*, p. 34. ed. 3.) Le Vacher saw a case in which a ball entered the front of the thigh, and came out at the point diametrically opposite, without the femur being broken. Facts of this description are all capable of explanation, by reference to the laws of projectiles.

[The foregoing remarks apply to wounds made by the spherical bullet. The conical balls used so extensively in the Crimean and more recent campaigns, inflict a much more severe and dangerous wound than the old round bullet. "Usually they admitted of being very little deflected from their course, piercing bones and generally perforating the limb, sometimes even wounding several men. Conical bullets, from their wedge-like action, have the peculiar tendency to produce longitudinal fractures of the bones of the extremities of very considerable extent; sometimes, indeed, running through the whole length of a bone. The greater weight of the conical bullet was partly a cause of its increased power of injury.

"The conical bullets of the Russians differed considerably from either the old Minié ball with the iron cap, or the Enfield rifle bullet of the British army. They used three forms. The heaviest and largest weighed 840 grains, and was a solid mass of lead with three flanges near the flat base and tapering to a sharp apex. The second was less weighty and without flanges, but had a hollow in the base to admit of its expansion. The third had neither flange nor hollow at the base. All were considerably heavier than the Enfield rifle bullet which only weighs 580 grains. Of all these bullets, the worst and most dangerous wounds appeared to be inflicted by the British old-fashioned Minié bullet with the iron cap. The cap sometimes had the effect of splaying out the ball on its encountering an obstacle, and thus much increasing the extent of the parts brought into direct contact with the missile. Next in destructive power would appear to be the largest Russian ball, but this, the Enfield rifle ball, and the two other varieties of conical ball above mentioned, differed but little in this particular. When these bullets came in contact with the shaft of a long bone, they generally produced a compound comminuted fracture of a very serious nature. In the case of the femur, the comminution was very generally so extensive as to render amputation necessary. The round balls much more frequently lodged, and the fractures of long bones produced by them were usually much less comminuted and less extensively split than by the conical bullet." (*Medical and Surgical History of British Army in the Crimea.*)]

Dupuytren observes, nothing is more diversified and extraordinary than the course of projectiles amidst the textures of the body. In 1830, a combatant, on the *Pont d'Arcole*, was struck by a ball, which entered at the internal angle of the left eye; and the wound, which took a direction backwards, and rather to the right, seemed as if it had gone quite through the head. However, the ball, after passing below the cranium, made its exit above the right shoulder. The man soon recovered, without any dangerous symptoms. Another man was wounded in the head, on the *Pont Nôtre Dame*; the ball went through his hat, travelled along the right side of the nose, penetrated the upper lip, broke four of the upper teeth, fractured the lower jaw, came out behind the chin, entered again at the root of the neck behind the clavicle, and lodged in the cushion of the left shoulder. This patient died of inflammation of the chest. (See *Clin. Chir.* t. ii. p. 448.)

When there is only one opening, we may infer that the wound contains a foreign body. An exception to this observation occurs, however, when a ball, instead of tearing the clothes, or linen, carries a portion of them, in the form of a pouch, into the wound, and, when such portion of the clothes is withdrawn, the ball falls out; and if this circumstance be not noticed, the presence of a single opening may lead to the idea that the bullet is lodged in the part. An instance of this kind is cited by Paré, for the purpose of refuting the former notion, that the ball burnt the parts. A case, in which a piece of a shirt was carried in this manner four inches into the flesh, is mentioned by Mr. Guthrie. (p. 4. ed. 6.) [A deep hole may be made in the soft parts and bone by the projecting angle of a fragment of shell without its remaining in the wound, and lead to the supposition that it was caused by a bullet which has become lodged in the part. An instance of this occurred before Sebastopol in the shaft of the tibia.]

In 1814, a French soldier, wounded under the walls of Paris, was brought to the Hôtel-Dieu. On examining the upper part of the leg, Dupuytren found some cloth forced into the tibia; and on pulling it out, which required considerable effort, a ball was extracted, completely enveloped in a piece of gaiter. Amongst the wounded brought into La Pitié, in July, 1830, was one case in which a ball had penetrated the abdomen, propelling before it a portion of the shirt which was not torn, and served very usefully to facilitate the extraction of the projectile. (See *Dupuytren*, in *Clin. Chir.* t. ii. p. 426.) It is possible also for a ball to be stopped immediately it has entered the body, and then to be ejected by the elasticity of the parts against which it strikes, as the cartilages of the ribs. (*Guthrie*, p. 5, ed. 6.)

When there are two apertures made by one shot, the ball, or at all events a portion of it, has escaped; but pieces of the clothes, &c. may still be lodged in the part. Care must be taken, however, not to confound with these cases others, in which the plurality of openings has been made by different balls.

"It is no uncommon thing (observes Dr. J. Thomson) for a ball, in striking against the sharp edge of a bone, to be split into two pieces, each of which takes a different direction. Sometimes it happens that one of the pieces remains in the place which it struck, while the other continues its course through the body. Of a ball split by the edge of the patella, I have known one half pass through at the moment of the injury, and the other remain in the joint for months, without its presence there being suspected. In the same manner, I have known a ball divided by striking against the spine of the scapula, and one portion of it pass directly through the chest from the point of impulse, while the other moved along the integuments till it reached the elbow-joint. But the most frequent examples of the division of bullets, which we had occasion to see, were those which were produced by balls striking against the spherical surface of the cranium. It sometimes happens that one portion of the ball enters the cranium, while the other either remains without, or passes over its external surface. [Or, a ball may be split against the edge of a fracture in the cranium, and one portion enter without leaving an opening, the depressed portion of bone rising into its place again. An interesting example of this occurred in the 19th regiment, before Sebastopol.]

"Not unfrequently, in injuries of the cranium the balls are lodged between its two tables, in some instances much flattened and altered in their shape, and in other instances, without their form being changed." From these facts it must be evident that even when a gunshot wound has two orifices the surgeon cannot be certain that the bullet has not been divided, and that no portion is lodged, unless the entire ball itself happen to be found. (See *Thomson's Obs. in Military Hospitals in Belgium*, p. 37, &c.) This part of the subject is noticed by all the best practical writers, and especially by Barons Larrey and Dupuytren. When a ball strikes against hard substances, it is liable, says Dupuytren, to be changed in its shape, flattened, or broken into fragments, so as to produce injuries not readily accounted for. Thus, in one case mentioned by him, the ball struck against the sharp edge of the right tibia, and was split into two pieces, each of which passed through the calf of that limb, and then lodged in the calf of the other. Thus five openings were made by a single ball. (*Dupuytren, Clin. Chir.* t. ii. p. 428.) In July 1830, a Swiss soldier was brought into the Hôtel-Dieu, wounded by a ball, which had fractured the right parietal bone, and been split into two pieces, one of which escaped through the scalp, whilst the other passed through the posterior lobe of the brain, and lodged upon the tentorium. About the same period, another individual was admitted into the same hospital, with the occiput fractured, by a ball which was split, but fixed with the margin of the bone in its cleft. (*Dupuytren, Clin. Chir.* t. ii. p. 444.) A single ball, though not split, may produce several openings. M. H. Larrey mentions a case in which a ball passed through the hand, then the skin of the groin, and next the left buttock, so as to cause six openings. (See *Hist. Chir. du Siége d'Anvers*, p. 67.) Mr. Guthrie once spoke to me of another instance, in which six openings were left by a single ball, that passed through both thighs and the scrotum.

As the ends of the vessels are contused and torn, gunshot wounds have generally at first little propensity to bleed seriously, unless vessels of importance happen to be injured. In the beginning there may even be little hæmorrhage; though a considerable artery be so hurt that it afterwards sloughs, and a dangerous or fatal bleeding arises. Thus (as I have already mentioned), in one of my own patients, who had received a musket-ball through the ham, the popliteal artery gave way about ten days after the injury, and compelled me to take up the femoral artery; and in the Elizabeth Hospital at Brussels, amongst the patients under the care of my friend Mr. Collier and myself, about a week after the battle of Waterloo, the cases of hæmorrhage on the loosening of the sloughs were numerous, not at all coinciding with a calculation that the proportion of such examples, requiring the ligature of arteries, is only three or four in a thousand. (*Guthrie on Gunshot Wounds*, p. 2, ed. 6.) In Holland the truth of Mr. Hunter's observation upon this point appeared to me to be completely confirmed.

It has long been known that a limb may be torn or shot off, even near to the trunk of the body, and hardly any hæmorrhage arise. We had numerous proofs of this fact after the battle of Waterloo. I had under my care a man of the rifle brigade, whose arm was shattered to pieces as high as the shoulder, yet there was no hæmorrhage. I amputated the thigh of a Dutch soldier, whose leg had been completely shot off by a cannon-ball; but there was no hæmorrhage before the operation. At Merksam, in 1814, I saw a case in which the greater part of the clavicle, scapula, and many adjacent parts had been carried away by a cannon-ball, and yet no bleeding of consequence occurred. The reason why a gunshot wound sometimes does not bleed much, though an artery of magnitude is torn, is because the vessel is nearly in the same state as when torsion has been practised; that is to say, the end of it has been violently stretched, so as to draw out the elastic external coat from the inner ones, which remain in the form of irregular folds within the mouth of the artery, constituting a kind of barrier against the escape of the blood. But if the artery be only partly torn through, this change is not sufficiently complete, and a profuse and fatal hæmorrhage may immediately follow the wound. The clot that forms within the vessel, is also an additional obstacle to the bleeding.

Sometimes, after a limb has been shot off, the large arteries do not bleed in amputation. "We saw a man (says Dr, Thomson), whose leg had been shot off by a cannon-ball; in amputating his limb above the knee, the arteries of the thigh were not perceived to bleed, nor did any of them afterwards require to be tied. A case, similar to this, also presented itself, in which the arm had been shot away close to the shoulder-joint."

Sometimes the contusion produced by a cannon-ball, or the passage of a bullet in the vicinity of a large artery, seems to cause a laceration of the inner coat of the vessel, and a subsequent obliteration of its cavity by the effusion of coagulable lymph. Facts in proof of this statement are recorded by Dr. Thomson. (See *Obs. in the Military Hospitals in Belgium*, p. 34, 35.)

In general, the most dangerous kind of hæmorrhage from gunshot wounds is that named *consecutive* or *secondary*. Either the artery has been totally or partially divided. In the first case, the slough immediately produced by the ball, the clot, which forms in the cavity of the vessel up to the first collateral branch, and (as I should add) the irregular folds of the inner coats, detached from the outer, put a stop to the bleeding. But frequently, as soon as the circulation acquires strength, these impediments are overcome, and hæmorrhage comes on. In other cases they continue to be efficient until the whole internal surface of the wound, and the lacerated and disorganised part of the artery are detached and loosened, as suppuration advances. But in this stage, if the end of the obliterated artery is too short, if the adhesive process is incomplete, or the patient moves about too much, the artery will give way. As Dupuytren observes, it is most commonly about the tenth, fifteenth, or even as late as the twentieth day, that these secondary hæmorrhages happen, without any particular symptom to give warning of their occurrence, excepting a thin bloody serosity, which is sometimes discharged from the wound. Hence the necessity for the utmost vigilance at the period when such bleedings are to be expected. They are infinitely more perilous than primary hæmorrhages, both on account of the patient's weakened state, and the condition of the arteries and surrounding textures, occasioned by the inflammation. In cases of primary hæmorrhage, the artery may be readily distinguished, taken hold of, and tied ; and the ligature does not separate before the expiration of several days, when the process of obliteration has been insured. But in secondary hæmorrhages, circumstances are different. The tissues are retracted and converted into a compact mass, and the vessel, which can hardly be discerned, is easily cut through by the ligature, or at all events, the latter falls off before the obliteration has acquired adequate strength. Hence bleeding frequently comes on again in the course of a few hours. In cases of this description, Dupuytren observes, there is no other resource but that of taking up the trunk of the artery at a greater or lesser distance from the accidental opening in it. (See *Clin. Chir.* t. ii. p. 465.)

Still later forms of secondary hæmorrhage occur in gunshot wounds, complicated with hospital gangrene, or bad compound fractures, which have been in the suppurative stage for weeks or months. In these last examples even small arteries may pour out at once, or by repetition, a quantity of blood, sufficient to bring the debilitated patient quickly to the grave. The blood does not issue from one individual vessel, but from the whole surface of the wound as from a sponge, and is so thin as to resemble blood and water.

Gunshot wounds, particularly those of the limbs, are frequently complicated with broken bones, which are a principal source of danger. The bones are seldom fractured merely in one place, but almost always splintered into numerous irregular pieces, which the violence of the shock often separates from the rest of the bone, and forces into the surrounding soft parts. If to such mischief be added that which the soft textures experience from the direct action of the projectile itself, the laceration of muscles, tendons, fascia, nerves, and blood-vessels, there will be exemplified, as Baron Dupuytren justly remarks, a combination of everything bad which a complicated fracture can be attended with. In no situation is the danger greater than in the leg and thigh ; in the former, on account of the thickness of the muscles and fasciæ ; in the latter, on account of the number and size of the bones. The immediate consequence of the fracture, and the presence of splinters, is a violent inflammation, commencing in the broken part, and propagating itself to the whole limb. The textures, most seriously contused, are frequently seized with gangrene ; and after the sloughs have been detached, extensive portions of bone are left exposed. This is very often noticed in fractures of the leg. The suppuration becomes profuse ; the fragments of bone lie inundated in pus, and becoming denuded, lose their vitality; and the pus itself passes by long sinuses between the layers of muscles, and along the surface of the bone, to a vast distance. If a fragment of bone lie near an artery, its pressure will sometimes cause ulceration of the vessel and a very late form of secondary hæmorrhage. This danger is principally observed in the leg and thigh. M. Pelletan relates a case in which the bleeding from this cause took place as late as the seventieth day. (See *Dupuytren, Clin. Chir.* t. ii. p. 455.)

TREATMENT OF GUNSHOT WOUNDS.

When the case is merely one of *contusion* without wound, or disorganisation of textures, the surgeon may sometimes keep the inflammation within due bounds. The cure may then be accomplished without any solution of continuity in the skin taking place. But more commonly, as Dupuytren observes, acute inflammation comes on, the parts are rapidly seized with gangrene, and if the mischief be extensive, death is almost sure to follow. Textures, whose organisation has been too much injured by contusion, cannot bear inflammation. The mortification sometimes reaches further than first appearances enable us to foresee, and it is only now that the alarming nature of the case is manifest. As for *wounds*, whether they implicate only the soft parts, or the bones also, they are of a kind which in general must unavoidably suppurate ; but the prospect of cure will be greater in proportion as their depth is less, as they are free from foreign bodies, and the general condition of the patient is satisfactory. (See *Dupuytren, Clin. Chir.* t. ii. p. 451.)

[The first point to decide upon when called to undertake the treatment of a gunshot wound of a limb, is to determine whether it be most advisable to amputate immediately or to defer it ; to excise the broken portions of bone, reserving the limb, or to attempt the cure of the injury without operation.] When a bone, especially at a joint, is very much shattered ; when the fleshy parts, particularly the great blood-vessels and nerves, are lacerated; when the whole limb has suffered a violent concussion, and is cold and senseless, there is no hope of preserving it. In this case it is the surgeon's duty to amputate at once, and not to delay till inflammation, fever, and mortification set in. But, besides this violent degree of injury, in which the propriety of amputation is obvious, several lower degrees occur, in which it is often a difficult thing to decide whether the operation be necessary or not. Here the surgeon must look not only to the injury, but also to the patient's constitution, and even to external circumstances, such as the possibility or impossibility of procuring good accommodation, rest, attendance, and pure air. But it is impossible to determine the necessity of amputation by general rules. In every individual case the surgeon must consider maturely the particular circumstances before he ventures to decide. The grounds against the operation are the privation of a limb, and frequent examples in which nature, aided by judicious surgery, repairs the most horrible wounds. The following are the reasons in favour of the operation. By it the patient gets rid of a dreadful contused wound, which threatens the greatest peril, and which is exchanged, as it were, for a simple incised one. In cases of gunshot wounds, the loss of the limb cannot be taken into the account; for the surgeon only undertakes the operation where he designs to save the patient's life by that privation, and anticipates that the part itself cannot be preserved. Even if he should deprive the patient of a limb that perhaps might have been preserved, there is this atonement,—that he can furnish him with an artificial leg, which often proves far more serviceable than the limb would have proved had it been preserved. Should the operation be fixed on, it is to be immediately performed above the wound. (*Richter.*)

[When neither amputation nor excision is deemed necessary, the wound should be cleansed, and all foreign bodies within reach, and removable, should be extracted, especially such as press on parts of importance. If there are any detached spicula of bone, these should all be carefully withdrawn. Dilatation and enlargement of the wound are to be avoided if possible, as recommended by Mr. Hunter, Hennen, Thomson, and Guthrie.] In these cases where the extraneous bodies are more deeply and firmly lodged in the wound, the surgeon should await suppuration and the detachment of sloughs ; and when the foreign bodies become moveable and apparent, he should extract them, with or without an incision, as circumstances may demand. The examination of the wound ought to be made as much as possible with the finger, which irritates less, and feels more distinctly than a probe. A great variety of instruments have been devised, either for ascertaining the position of balls and other foreign bodies in gunshot wounds, or for extracting them. But, however numerous and diversified bullet-drawers may be, they all admit of being divided into three kinds. The first are constructed on the principle of a pair of forceps ; others are shaped more or less like spoons ; and a third description are made on the plan of a corkscrew or worm. These last are only designed for cases in which the ball is fixed in the substance of a bone, and is quite immoveable ; for, if it were lodged in the soft parts, the pressure requisite for introducing the screw into it would injure and lacerate the parts at the bottom of the wound. Bullet-drawers constructed on the plan of forceps have the inconvenience of not being adapted for seizing the ball, unless their blades can expand, which always stretches the wound and creates a great deal of irritation. Forceps have been contrived with blades, which may be introduced separately, and then joined together with a screw. When a ball lies superficially, the fingers, or a small pair of forceps, will extract it most conveniently. And, with respect to bullet-extractors, as Dr. Hennen has justly observed, they are completely superseded by the common forceps, or that of Baron Percy, though unfortunately the aid of instruments is most required in tortuous deep passages, where we can least make use of them. (*Principles of Military Surgery*, p. 76, ed. 3.)

[These instruments are but little in favour with most military surgeons; they are seldom used and but little required, except for the extraction of deeply-seated bullets. The best form is that where the blades can be introduced separately, and afterwards made to lock into each other like the midwifery forceps ; an instrument of this kind has been constructed by Mr. Blaise, which, with slight curvature in the blades, would answer their purpose very well.]

The event of the treatment above recommended, is various. Extraneous substances remaining in the wound, either loosen gradually, and come into view, so as to be easily removeable ; or they continue concealed, prevent the cure, and give birth to a fistulous ulcer. In some instances the wound closes, and the foreign bodies remain in the limb during life without inconvenience ; and in other cases, after a time, they bring on a renewal of inflammation and suppuration. Sometimes a foreign body varies its situation, sinking down, and afterwards making its appearance at a different part, where it may excite inflammation and suppuration. It may change its place slowly, or quickly; when quickly, it leaves no trace of its passage in the textures which it travels through ; when slowly, it becomes enveloped in a serous cyst. This disposition to change of place appertains not only to sharp, smooth, oblong bodies, but also to globular ones ; though it is generally less in proportion, as they have more of the spherical shape. As Dupuytren observes, these facts should not be lost sight of by the surgeon; for it often happens that a foreign body, which is distinctly felt on one day at a certain point, may be very far from it on the next. Hence, incisions for the extraction of a ball are never to be made but from the information acquired respecting its situation. (See *Dupuytren, Clin. Chir.* t. ii. p. 434.)

When the ball lodges in the wound, it is usually difficult to trace it, as the parts collapse after its passage, and leave an opening in the skin much smaller than the ball itself. The ball does not regularly take a straight direction through the injured part, but often a very tortuous one, particularly when the ball is nearly spent. In every case in which it is not easily discoverable, all painful examinations should be abandoned, and the foreign body left in its situation until its place is better known, and the first inflammation is over.

[When a ball nearly traverses a limb and lodges under the skin of the opposite side, and can be readily felt, it should be cut down upon and removed, as no inconvenience ensues.] But when the ball lies three or four inches from the surface, and cannot be distinctly felt, no incision should at first be made with the view of extracting it. (*On Gunshot Wounds*, p. xii. ed. 6.)

Sometimes the ball penetrates the spongy part of a bone and lodges firmly in it. When it has only entered superficially, it may sometimes be loosened and extracted by means of an elevator, with a thin and somewhat curved extremity; and when it is more firmly fixed, a screw bullet-drawer will sometimes serve for its removal. Should the attempt fail, the employment of a trephine for the removal of the ball is recommended by some writers ; while others, fearful of the irritation, difficulty, and effects of such an operation, and recollecting that balls have sometimes remained fixed in bones for many years, without any serious inconvenience, condemn that practice. On the contrary, Mr. Guthrie lays it down as a general rule, subject to a few exceptions, that a ball should never be allowed to remain in a bone ; for, says he, "if a ball lodge in the head of a bone, and is not removed, it generally causes caries of the bone, disease of the joint, amputation, or death. If in the shaft of a long bone, necrosis for the most part follows, with months and years of misery. On a flat bone, caries is equally the result, and if it be surrounded by large muscles, sinuses form in various directions, contractions of the limb take place, and the patient drags on for years, careless of life, and ready to submit to anything to obtain relief. (*On Gunshot Wounds*, p. 144, ed. 6.) In many of these cases, one thing deserves to be recollected, however, that the necrosis, abscesses, and sinuses are less the effect of the lodgment of the ball, than of the violence originally committed on the parts against which it has struck. Although Baron Larrey only sanctions the attempt to remove balls with a trephine, when they actually produce dangerous effects (*Mém. de Chir. Mil.* t. iv. p. 185), I am disposed to believe, that whenever the situation of the ball is such that it can be removed at once from a bone with tolerable certainty, and without too much irritation, the practice is commendable.

As soon as the requisite incisions have been made, and foreign bodies extracted, the prime objects in the treatment of gunshot wounds are accomplished; and the rest is, in reality, not different from the surgery of other wounds.

With regard to probing gunshot wounds, when it is evident that the shot has passed out, and no particular object can be fulfilled with the probe, it is often better to dispense with such examination, at least till suppuration has come on. The needless use of a probe causes unnecessary pain and irritation. But when the ball, or any other extraneous substance, has lodged in the wound, and its situation is not immediately evident, it will often be advisable to search for it at once, in order that it may be extracted, if its situation will allow, before inflammation begins. The surgeon, therefore, considering all the circumstances which can assist him in forming a reasonable conjecture of the course of the wound, must give to a probe that curvature, or form, which he thinks most likely to pass readily along it, and must then proceed to make the examination. But when this is very painful, and the course of the wound obscure, it will often be better to desist, and renew the search when suppuration has taken place, in which stage it can be undertaken with more ease, and a greater prospect of success. When gunshot wounds are inflamed, the tenderness and swelling of the parts are peculiarly strong reasons against painful probings, or efforts to extract foreign bodies, as long as this state lasts. (See *Chevalier on Gunshot Wounds*, p. 67, 68. ed. 3.)

[The external means of treatment applied to gunshot wounds in the present day are as simple as possible. A piece of linen or lint moistened with warm or cold water, and covered with oil silk or gutta percha tissue, and retained on the part by a fold or two of linen bandage lightly applied, is all that is necessary. I never used any other in any of the cases that I had occasion to treat before Sebastopol, and I never had any reason to regret the practice. Ointments, pledgets of lint, adhesive plasters, are all generally unnecessary. When suppuration has been established, a bread poultice may be then usefully substituted, and should the discharge be fetid and the surface of the wound or stump foul, pulverised charcoal should be sprinkled over it. A yeast or carrot poultice is a good application in such condition of wounds; but these cannot be always obtained on the field. The poultices should be frequently renewed. When the discharge has diminished, and the surface of the wound or stump has assumed a healthy character, the cold water dressing is to be re-applied and the poultice discontinued. One has rarely to have recourse to strong antiphlogistic measures in these injuries; but they must be resorted to if necessary, as in other wounds. Care, however, should be taken that the patient's strength is not too much reduced, lest it be inadequate to support the very frequently copious and long-continued suppuration which often ensues upon these wounds.]

Gunshot wounds, in crowded military hospitals, especially when they are established in unhealthy, low, damp situations, and due attention is not paid to ventilation and cleanliness, are liable to be attacked by hospital gangrene, a most serious and dangerous complication. (See Hospital Gangrene.) Another formidable and generally fatal complication, is traumatic tetanus. (See Tetanus.) A third dangerous complication is *erysipelas*, particularly the phlegmonous kind.

For a few days, the matter seldom assumes a healthy appearance; but as soon as the sloughs separate, it then becomes of a proper quality, and is to be treated as an ordinary wound. As Dupuytren remarks, when the patient has got through all the dangers of the earlier stages of gunshot wounds, hæmorrhage, gangrene, phlegmonous erysipelas, tetanus, and other perils, still await him. The fractured bones unite with difficulty; sinuses and deep abscesses form in the limb; the periosteum becomes detached; the bones denuded; and attacked by necrosis. Nor is this all the mischief: fractures of bones abounding in spongy texture are liable to be complicated with inflammation of the cellulo-vascular membrane, investing the areolæ of that texture, and its numerous veins. This inflammation, which is always followed by necrosis, sometimes extends a great distance, and this more especially in cases where the ball has occasioned a violent concussion of the bone.

Sometimes the healing process does not commence, though suppuration has prevailed a considerable time. On the contrary, notwithstanding the exhibition of tonics, and a generous diet, the suppuration ceases to proceed favourably, and the wound becomes unhealthy and the matter thin. The bones show no disposition to unite, and the patient, reduced by hectic symptoms, is rapidly approaching dissolution. In this state, life may sometimes be preserved by amputation.

Of Amputation in Gunshot Wounds.

The second edition of this Dictionary, published in 1813, contained all the valuable observations of Baron Larrey in favour of *immediate* amputation, in every instance in which the operation is considered indispensable. Since then, the public have been favoured with several good practical books, in which the propriety and necessity of early or immediate amputation in such cases are urgently inculcated, and the truth of the doctrine is illustrated by additional facts. It is to be observed, however, that for the last two hundred years, there have always been some advocates for this judicious practice. "Du Chesne (says Dr. J. Thomson) is the first writer on military surgery in whose works I have found the recommendation to amputate in the severer injuries of the extremities; and it is worthy of remark, that *he directs the operation to be performed before inflammation and other constitutional symptoms* shall have supervened." (See *Traité de la Cure générale et particulière des Arcbusades, par Jos. Du Chesne*, Paris, 1624, p. 143; and *Thomson's Report, &c.*, p. 160.) Wiseman not only recommended and practised immediate amputation, but the same thing was not unfrequently done by the military surgeons of his time. (*Chirurgical Treatises, by R. Wiseman*, 3d ed. Lond. 1696, p. 410.) The celebrated Le Dran, in his excellent little manual of military surgery, declared himself an advocate for *immediate* amputation, in all cases in which that operation from the first appears to be indispensable. Le Dran has, at the same time stated briefly, but most distinctly, the comparative advantages of that practice, with those which may be expected by delay. (See *Traité, ou Réflexions tirées de la Pratique sur les Plaies d'Armes à feu, par H. F. Le Dran*, à Paris, 1737.) Ranby, who was serjeant-surgeon to King George II., entertained similar opinions to those of Le Dran, with regard to the utility of immediate amputation. In order to give immediate relief to the wounded, and to facilitate the performance of the necessary operations, Ranby proposed that the surgeons, during battle, should be collected into small bodies, and stationed in the rear of the army. (See *The Method of treating Gunshot Wounds, by John Ranby*, ed. 3. p. 29. Lond. 1781.) Schmucker, who was many years surgeon-general to the Prussian armies, published in 1776 an essay on amputation, in which he particularly mentions that, during his stay at Paris, in 1738, the surgeons of the Hôtel-Dieu had been in the habit of performing immediate amputation in severe injuries of the extremities. *He also declares himself an advocate for operating immediately in all cases in which amputation from the first appears to be necessary*, and insists, in a particular manner, on the increased danger which he had seen arise from the operation during the second period. He gives (as Dr. J. Thomson has observed) a minute and circumstantial enumeration of those injuries, both of the upper and lower extremities, in which he conceived amputation to be necessary, and in many of which he had actually performed it with great success. Schmucker appears to Dr. Thomson to have given a better account than any preceding military surgeon, of the injuries of the thigh; and from the results of his experience, he was led to believe that, *though compound fractures of the lower part of the thigh-bone might, in favourable circumstances, be cured, without amputation, yet that this operation is peculiarly necessary in all cases in which the fracture is situated in or above the middle of that bone.* (*J. L. Schmucker, Vermischte Chirurgische Schriften*, b. i. Berlin, 1785.) With the foregoing high authority we have to join one of not less celebrity, namely, that of Baron Larrey, who has proved most convincingly, that when amputation is to be done in cases of gunshot wounds, nothing is so pernicious as delay. (See *Mém. de Chir. Mil.* t. ii. p. 451, &c.)

The principles inculcated by Baron Larrey are, in point of fact, the same as those which were so strenuously insisted upon by Pott, whose principal remarks on the necessity of amputation in certain cases are detailed in another part of this publication. (See AMPUTATION.) Pott, indeed, was not an army-surgeon, and what he says was not particularly designed to apply to military practice: but he has represented, as well as any body can do, the propriety of immediate amputation for injuries which leave no doubt that such operation cannot be dispensed with.

Mr. John Bell, amongst the moderns, appears likewise to have much merit for the able manner in which he defended the propriety of early amputation, long before the sentiments of later writers were ever heard of. He distinctly states that "amputation should, in those cases where the limb is plainly and irrecoverably disordered, be performed upon the spot." (See *Discourses on the Nature, &c., of Wounds*, p. 488. edit. 3.) In short, notwithstanding all the modern pretensions to novelty upon this interesting topic, we must acknowledge, with Dr. Thomson, that the evidence in favour of the advantages of immediate amputation has always preponderated over that for delay. (See *Report of Obs. &c.* p. 225.)

The strongest body of evidence upon this matter is undoubtedly adduced by Baron Larrey, whose situation at the head of the surgical department of the French armies afforded him most numerous opportunities of judging from actual experience. "Upon this subject (says he), now that twenty years of continual war have carried our art to the highest pitch of perfection, there can only be one opinion. It is after having incessantly directed the medical service all this time, in the quality of head-surgeon and inspector-general of the armies, that I proceed to discuss the different opinions delivered in the Academy, and to settle definitely this great question, which I regard as the most important in military surgery.

"If we are to be told that the amputation of a limb is a cruel operation, dangerous in its consequences, and always grievous for the patient, who is thereby mutilated; that, consequently, there is more honour in saving a limb than in cutting it off with dexterity and success; these arguments may be refuted by answering that amputation is an operation of necessity which offers a chance of preservation to the unfortunate, whose death appears certain under any other treatment; and that, if any doubt should exist of amputation being absolutely indispensable to the patient's safety, the operation is to be deferred till nature has declared herself, and given a positive indication for it. We are also justified in adding that this chance of preservation is at the present day much greater than at the epoch of the Academy of Surgery. We learn from M. Faure that of about three hundred amputations performed after the battle of Fontenoy, only thirty were followed by success, whilst on the contrary (says Baron Larrey) we have saved more than three-fourths of the patients on whom amputation has been done, and some of whom also had two limbs removed." This improvement is ascribed by Larrey, 1. To our now knowing better how to take advantage of the indication and favourable time for amputating. 2. To the better method of dressing. 3. To the mode of operating being more simple, less painful, and more expeditious than that formerly in vogue.

To the preceding authorities against delaying amputation in cases of gunshot wounds requiring such operation, I have to add Mr. Guthrie, whose opportunities of observation during the late war in Spain were particularly extensive. In his work he has detailed the opinions of many eminent foreign and British surgeons respecting the propriety or impropriety of the doctrine of immediate amputation, and he has introduced some good criticisms particularly on Bilguer's statement of the success which was experienced in the Prussian hospitals from not performing the operation. Mr. Guthrie, however, does not recommend amputation to be done immediately, if the patient be particularly depressed by the shock of the injury directly after its receipt; a piece of advice which I believe has, in reality, been at all times followed, not only in respect to amputations in cases of gunshot wounds, but all other severe local injuries. "I believe it to be (says Mr. Guthrie), a stretch of fancy in those surgeons who conceive that if the knife followed the shot in all cases the patient would have the best chance of success. No one will deny that if the shot performed a regular amputation, it would not be better than to have to do it afterwards: but if they mean to say the operation should in general be performed immediately after the injury, I can only oppose to them the facts above stated, and the general results of my experience, which is decidedly in favour of allowing the first *moments* of agitation to pass over before anything be done; a period extending from that to one, six, or eight hours, according to the difference of constitution and the different injuries that have been sustained. But, *from one to three hours* will, in most cases, be found sufficient." (*Commentaries on the Surgery of the War*, 6th ed. p. 41.)

So far as my experience goes, when the necessity of amputation is undoubted, all delay is improper beyond the short period during which the faintness immediately arising from the injury usually lasts. In the campaign in Holland, 1814, the most successful amputations were those done in the field-hospitals directly after the arrival of the patients, or rather, as Dr. Hennen has expressed it, with as little delay as possible. "While hundreds are waiting for the decision of the surgeon, he will never be at a loss to select individuals who can safely and advantageously bear to be operated upon as quickly as himself or assistants can offer their aid; but he will betray a miserable want of science indeed, if, in this crowd of sufferers, he indiscriminately amputates the weak, the terrified, the sinking, and the determined. While he is giving his aid to a few of the latter class, encouragement and a cordial will soon make a change in the state of the weakly or the terrified; and a longer period and more active measures will render even the sinking proper objects for operation." (*On Military Surgery*, p. 45, ed. 3.) It appears from some returns collected by Mr. Guthrie, that in the Peninsula the comparative loss, in secondary or delayed operations, and in primary or immediate amputations, was as follows:—

	Secondary.		Primary.
Upper extremities . . .	12	to . .	1
Lower extremities . . .	3	to . .	1

The great success attending amputation on the field of battle was also convincingly proved after the battle of Toulouse. Here, of 47 immediate amputations, 38 were cured; while of the 51 delayed operations on that occasion, 21 had fatal terminations. After the attack on New Orleans, out of 45 primary amputations 38 patients recovered, while only 2 of 7 secondary amputations terminated in the preservation of the patients. (*Commentaries*, edit. 6, p. 154 to 157.)

[This interesting historical account of the propriety of performing primary in preference to secondary amputation for gunshot wounds of the extremities, is amply confirmed by the results of the practice in the British Hospitals in the Crimean War, as will be seen by the following tables.

Relative mortality of primary and secondary amputations in the Crimean Hospitals, from 1st April, 1855, to the end of the war.

Primary.		Secondary.	
Total.	Died.	Total.	Died.
654	165	78	36

A similar return from the Hospitals on the Bosphorus, from 26th September to the 27th November, 1854, shows corresponding results:—

Primary.				Secondary.			
Total.	Died.	Remained under Treatment.	Invalided to England.	Total.	Died.	Remanded under Treatment.	Invalided to England.
150	17	40	93	64	41	7	16

This long-agitated question as to the preference of primary or secondary amputation for severe gunshot wounds of the extremities, seems now unequivocally decided by the more recent experience of French and English military and naval surgeons in favour of the former, in all cases where the operation is indispensably necessary; and the earlier the operation is performed after faintness and shock have disappeared, the better will be the chance of a favourable issue.]

Of Immediate Amputation.

When a limb that has received a gunshot wound cannot be saved, amputation should be immediately practised. The first four-and-twenty hours, Baron Larrey observes, is the only period that nature remains tranquil (I should say, she does not remain quiet so long), and we must hasten to take advantage of this period.

In the army, a variety of circumstances make the urgency for amputation still greater. 1. The inconvenience attending the transport of the wounded from the field of battle to the military hospitals, in carriages badly suspended, the jolting of which would produce such disorder in the wound, and in the whole body, that most patients would die in the journey, especially if it were long, and the weather either extremely hot or cold.

2. The danger of a long continuance in the hospitals; a danger which amputation materially diminishes, by changing a gunshot injury into a wound that may be speedily healed, and reducing the causes of fever, and hospital gangrene.

3. The cases in which there is a necessity for abandoning the wounded. In this circumstance, it is of importance to have amputated; for, after the operation, the patients may remain some days without being dressed, and the dressings are afterwards more easy.

Of Cases in which Amputation should be Performed Immediately.

First case.—A limb carried away by a cannon-ball, or the explosion of a shell, requires amputation without loss of time, in order to procure the patient an even, smooth incision, instead of an irregular, jagged, and highly dangerous wound. As the limb has commonly suffered a violent concussion, is almost bereft of sense and power of motion, and the bone frequently has a fissure extending some way upward, amputation is sometimes recommended to be done, if possible, above the nearest joint. Hæmorrhage, says Baron Larrey, an accident much more to be apprehended than has been supposed, often comes on a few moments after the injury, and if prompt succour were not afforded, would put a period to the patient's existence. "I can even declare that, had it not been for the activity of the train of light surgical carriages (*ambulances volantes*) by means of which the wounded have always been dressed upon the field of battle, many soldiers would have perished from this accident alone."

If the operation is not speedily done, pain commences, fever occurs, and the functions of the system become disordered; the irritation then increases, and convulsive motions take place. If the patient should not be a victim to these first symptoms, gangrene of the stump follows, the fatal consequences of which it is extremely difficult to prevent.

At Strasburg, during the bombardment of the fort of Kell, in 1792, three volunteers, says Baron Larrey, had limbs shot off by the explosion of shells: one, an arm; another, a fore-arm; and the third, a leg. They were conveyed to the hospital for the wounded in that town, which was superintended by M. Boy. Several days were suffered to elapse before amputation was performed; not one of the patients escaped. At Mentz, after the retreat from Frankfort, several of the wounded, who had had limbs shot off, did not have amputation performed till some time afterwards, and not one of them recovered. At Nice, after the taking of Saourgio, two amputations were practised at the hospital, No. 2, one of the forearm, the other of the arm, nine or ten days after the receipt of the injuries; both the patients died. At Perpignan, Baron Larrey visited two soldiers on whom amputation had been done seven or eight days after the receipt of gunshot injuries in the action of the 14th of July, 1794. One had had a leg shot off, and the other his right arm. Notwithstanding Larrey's utmost care, he could not save their lives; one died of tetanus, the other of gangrene.

Second Case.—When a body, propelled by gunpowder, strikes a limb in such a manner as to smash the bones, violently contuse, lacerate, and deeply tear away the soft parts, amputation ought to be immediately performed. If this measure be neglected, all the injured parts will soon be seized with gangrene: and besides, as Larrey has explained, the accidents which the gravity of the first case produces, will also here be excited.

Third Case.—If a similar body were to carry away a great mass of the soft parts, and the principal vessels of a limb (of the thigh, for instance), without fracturing the bone, the patient would be in a state demanding immediate amputation; for, independently of the accidents which would originate from a considerable loss of substance, the limb must inevitably mortify. Mr. Guthrie also says, "A cannon-shot destroying the artery and vein, on the inside (of the thigh), without injuring the bone, requires amputation." (P. 185.) When, however, the femoral artery or vein is injured by a musket-ball, or small canister-shot, this gentleman recommends tying the vessel above and below the wound in it, if the nature of the case be evinced by hæmorrhage. But he believes that when both vein and artery are injured, amputation is necessary. (P. 186.) With respect to bleeding from the femoral vein, as it may easily be stopped by moderate pressure, the propriety of using any ligature at all is questionable.

"An injury of the femoral artery (observes Mr. Guthrie), requiring an operation, accompanied with fracture of the bone of the most simple kind, is a proper case for immediate amputation; for, although many patients would recover from either accident alone, none would, I believe, surmount the two united; and the higher the accident is in the thigh, the more imperious is the necessity for amputation." (*Guthrie, On Gunshot Wounds,* p. 187.)

Fourth case.—A grape-shot strikes the thick part of a member, breaks the bone, divides and tears the muscles, and destroys the large nerves, without, however, touching the main artery. According to Larrey this is a fourth case requiring immediate amputation.

Mr. Guthrie seems to coincide on this point with Larrey: "If a cannon-shot strike the back part of the thigh, and carry away the muscular part behind, and with it the great sciatic nerve, amputation is necessary, even if the bone be untouched, &c. In this case I would not perform the operation by the circular incision, but would preserve a flap from the forepart, or sides, as I could get it, to cover the bone, which should be short." (*Guthrie, On Gunshot Wounds of the Extremities,* p. 184.)

Fifth case.—If a spent cannon-shot, or one that has been reflected, should strike a member obliquely without producing a solution of continuity in the skin, as often happens, the parts which resist its action, such as the bones, muscles, tendons, fasciæ, and vessels, may be ruptured and crushed. The extent of the internal disorder is to be examined; and if the bones should feel through the soft parts as if they were smashed, and if there should be reason to suspect from the swelling, and a sort of fluctuation, that the vessels are lacerated, amputation ought to be immediately practised. This is also the advice of Baron Percy. Sometimes, however, the vessels and bones escape injury, and the muscles are almost the only parts disordered. In this circumstance, we are enjoined to follow the counsel of De La Martinière, who recommended making an incision through the skin. By this means a quantity of thick blackish blood will be discharged, and the practitioner must await events.. According to Larrey, such incision is equally necessary in the preceding case, previously to amputation, in order to ascertain the extent of mischief.

Sixth case.—When the articular heads of bones are much broken, especially those which form the joints of the foot, or knee, and the ligaments which strengthen these articulations are lacerated by the fire of a howitzer or a grape-shot, or other kind of ball, and the integuments are too much bruised and lacerated to attempt excision of the joint, immediate amputation is indispensable. (See also *Guthrie, On Gunshot Wounds,* p. 197.)

Fractures extending into the joints, and accompanied with great laceration of the ligaments and integuments, are cases of gunshot injuries indispensably requiring immediate amputation.

It is evident, says Larrey, that in this case, if we wish to prevent the patient from dying of the subsequent symptoms, amputation should be performed before twelve, or at most twenty-four, hours have elapsed. (*Mém. de Chir. Militaire*, t. ii.)

With respect to wounds of the knee, the sentiments of Mr. Guthrie nearly coincide with those of Larrey. "I most solemnly protest (says Mr. G.) I do not remember a case do well, in which I knew the articulating end of the femur, or tibia, to be fractured by a ball that passed through the joint, although I have tried great numbers, even to the last battle of Toulouse. I know that persons wounded in that way have lived; for a recovery it cannot be called where the limb is useless, bent backward, and a constant source of irritation and distress, after several months of acute suffering, to obtain even this partial security from impending death; but if one case of recovery should take place in fifty, is it any sort of equivalent for the sacrifice of the other forty-nine? Or is the preserving of a limb of this kind an equivalent for the loss of one man?" (*On Gunshot Wounds*, p. 196.)

In the attack of the village of Merksam near Antwerp, early in 1814, a soldier of the 95th regiment was brought to our field hospital, having received a musket-ball through the knee-joint. The staff-surgeons on duty, and Mr. Curtis, surgeon of the 1st Guards, were preparing to amputate the limb, when a surgeon attached to the 95th urgently recommended deferring the operation. Superficial dressings were applied, and the patient sent to the rear. He lived several months after the accident, at times affording hopes of a perfect recovery; but in the end he fell a victim to hectic symptoms.

Indeed, such is the general unfortunate result of these cases, that Dr. Hennen lays it down as a rule in military surgery, that no lacerated joint, particularly the knee, ankle, or elbow, should ever leave the field unamputated, where the patient is not obviously sinking. (*On Military Surgery*, p. 41, ed. 3.)

According to Mr. Guthrie, fractures of the patella, without injury of the other bones, admit of delay, provided the bone is not much splintered.

Seventh case.—Larrey observes, that if a grape shot, a small cannon-shot, or a piece of a shell, in passing through the substance of a member, should have extensively denuded the bone, without breaking it, amputation is equally indicated, although the soft parts may not appear to have particularly suffered. Indeed, the violent concussion produced by the accident has disorganised many parts; the medullary substance is injured, the vessels are lacerated, the nerves immoderately stretched, and thrown into a state of stupor; the muscles are deprived of their tone; and the circulation and sensibility in the limb are obstructed. Before we decide, however, Barron Larrey cautions us to observe attentively the symptoms which characterise this kind of disorder. The case can be supposed to happen only in the leg, where the bone is very superficial, and merely covered at its anterior part with the skin.

The following are described as the symptoms: the limb is insensible, the foot cold as ice, the bone partly exposed, and, on careful examination, it will be found that the integuments, and even the periosteum, are extensively detached from it. The commotion extends to a considerable distance; the functions of the body are disordered; and all the secretions experience a more or less palpable disturbance. The intellectual faculties are suspended, and the circulation is retarded. The pulse is small and concentrated; the countenance pale; and the eyes have a dull moist appearance. The patient feels such anxiety that he cannot long remain in one posture, and requests that his leg may be quickly taken off, as it incommodes him severely, and he experiences very acute pain in the knee. When all these characteristic symptoms are conjoined, says Larrey, we should not hesitate to amputate immediately; for otherwise the leg will be attacked with sphacelus, and the patient certainly perish.

Larrey adduces several interesting cases in support of the preceding observations.

Eighth case.—When a large ginglymoid articulation, such as the elbow, or especially the knee, has been extensively opened with a cutting instrument, and blood is extravasated in the joint, Larrey deems immediate amputation necessary. In these cases, the synovial membranes, the ligaments and aponeuroses, inflame, the part swells, erethismus rapidly takes place, and acute pains, abscesses, deep sinuses, caries, febrile symptoms, and death, are the speedy consequences. Larrey has seen numerous subjects die of such injuries, on account of the operation having been postponed through a hope of saving the limb. In his *Mém. de Chir. Militaire*, t. ii. some of these cases are detailed. Several facts of the same kind are candidly recorded by M. Velpeau. (See *Nouv. Elém. de Méd. Opér.* t. i. p. 284.) [Many of these cases, where the integuments are not too much injured, admit of excision of the ends of the bones forming the joint, whereby the limb may be preserved.]

Although a wound may penetrate a joint, yet, if it be small and unattended with extravasation of blood, M. Larrey informs us, it will generally heal, provided too much compression be not employed.

When two limbs have been at the same time so injured as to require amputation, we should not be afraid of amputating them both immediately, without any interval. We have, says Larrey, several times performed this double amputation with almost as much success as the amputation of a single member. He has recorded an excellent case in confirmation of this statement. (*Mém. de Chir. Militaire*, t. ii. p. 478.)

When a limb is differently injured at the same time in two places, and one of the wounds requires amputation (suppose a wound of the leg with a splintered fracture of the bone, and a second of the thigh, done with a ball, but without any fracture of the os femoris or other bad accident), Larrey recommends us first to dress the simple wound of the thigh, and amputate the leg immediately afterwards, if the knee be free from injury. When it is necessary to amputate above this joint, the less important wound need not be dressed till after the operation, provided it can be comprehended in the section of the member, or be so near the place of the incision as to alter the indication. When the wound demanding amputation is the upper one, the operation of course is to be done above it, without paying any regard to the injury situated lower down.

Ninth case.—To the foregoing species of gunshot wounds, pointed out by Baron Larrey as urgently requiring immediate amputation, my own experience, and the observations of Dr. Thomson, justify me in adding compound fractures of the thigh from gunshot violence. I am particularly glad that the latter gentleman has devoted a proper degree of attention to these cases; for the opportunities which I had of judging when abroad, incline me to believe that military surgeons are hardly yet sufficiently impressed with the propriety of immediate amputation in gunshot fractures of the thigh. There were brought into my hospital at Oudenbosch, in 1814, about eight of such cases, all in the worst state for an operation, because several days had elapsed after the receipt of the injuries. All these patients died, excepting one, whose fracture was not far above the condyles, and I do not know that he ever regained a very useful limb. Another had indeed been rescued by amputation from the dangers of the injury, but was, unfortunately, lost by secondary hæmorrhage about three days after the operation. The bleeding was almost instantly suppressed; yet such was the weakness of the patient, that the irritation of securing the vessel, and the loss of blood together, destroyed at once every hope of recovery. Were I to judge, then, from my own personal observations in the army, and from some other cases which I saw under my colleagues, I should, without hesitation, recommend immediate amputation in all cases of compound fractures of the thigh caused by grape-shot, musket-balls, &c. If there are any exceptions to this advice, they are such as are specified in the article AMPUTATION.

"Gunshot fractures of the thigh (says Dr. J. Thomson) have been universally allowed to be attended with a high degree of danger; indeed, till of late years, very few instances have been recorded of recovery from these injuries. Ravaton acknowledges that in his long and extensive experience he had never seen an example of recovery from a gunshot fracture of the thigh; and Bilguer, in his calculations with regard to those who recover from gunshot fractures, sets aside those of the thigh-bone as being of a nature altogether hopeless. In the present improved state of military surgery, instances sometimes occur of recovery from this fracture; but of these the number will be found, I believe, to be exceedingly small in comparison with those who die, particularly when the fracture has had its seat above the middle of the bone."

According to the observation of Percy, scarcely two of ten recover who have suffered gunshot fractures of the thigh-bone. Mr. Guthrie, who seems to have paid great attention to this subject, says that "upon a review of the many cases which I have seen, I do not believe that more than one-sixth recovered so as to have useful limbs; two-thirds of the whole died either with or without amputation; and the limbs of the remaining sixth were not only nearly useless, but a cause of much uneasiness to them for the remainder of their lives." (See *Guthrie, On Gunshot Wounds*, p. 191.)

"In fractures by musket-bullets of the lower part of the thigh-bone (says Dr. Thomson) recovery not unfrequently takes place; and both Schmucker and Mr. Guthrie conceive that they are injuries in which amputation may be delayed with safety. It would be very agreeable that this opinion should be confirmed by future experience; but it appears to me that before it can be received as a maxim in military surgery, much more extensive and accurate observation than we yet possess will be required, with regard to the proportion of those who recover without amputation, or after secondary operations, and of those who recover after primary amputation. Of those who had suffered this injury, we saw comparatively but a small number recovering in Belgium, and they had been attended with severe local and constitutional symptoms." (See *Obs. made, &c. in Belgium*, p. 247, *et seq.*)

In the article AMPUTATION, I have described the manner in which balls produce fissures of several inches in length in the thigh-bone. This state of the bone, observes Dr. Thomson, must be very unfavourable to recovery, and his conclusion is, that in general, even in fractures of the lower part of the thigh-bone, a greater number of lives will be preserved in military practice by immediate amputation, than by attempting the cure without that operation. "When the bone appears, on a careful examination, to be broken without being much splintered, and when the patient can be removed easily to a place of rest and safety, it may be right to attempt to preserve the limb; but if the bone be much splintered, or if the conveyance is to be long or uncertain, it will, in most instances, I am convinced, be a much safer practice, even in fractures of this part of the thigh-bone, to amputate without delay.

"Musket-bullets, in passing through the femur, near to the knee-joint, produce fissures of the condyles, which generally communicate with the joint. These cases, like those in which the bullets have passed directly through the joint, require either excision of the joint or amputation.

"The writings of military surgeons contain but few histories of cases in which the thigh-bone had been fractured above its middle by the passage of musket-bullets. These are cases, I believe, which have generally had a fatal termination; and the danger attendant upon the amputation which they require, seems long to have deterred surgeons from attempting to ascertain what advantages might be derived from the employment of that operation. Schmucker recommends, and states that he had practised with success, immediate amputation in those cases in which a sufficient space was left below the groin for the application of the tourniquet. It is curious to remark, in the history of amputation, how long surgeons were in discovering the ease and safety with which the femoral artery might be compressed by the fingers, or pads, in its passage over the brim of the pelvis. M. Boy, from the immediate danger, protracted suffering, and ultimate want of success, which he had observed to follow this kind of injury, urges strenuously the propriety of immediate amputation. Mr. Guthrie's opinion, with regard to the dangerous nature of these injuries, and the advantages to be derived in them from immediate amputation, coincides in every respect with those of Schmucker and Boy. He observes, that those whose thigh-bone has been fractured in its upper part by a musket-bullet, generally die, with great suffering, before the end of the sixth or eighth week, and that few even of those escape in whom the bone has been fractured in its middle part. Of the few whom we saw, who had survived gunshot fractures in the upper part of the thigh-bone, in Belgium, scarcely any one could be said to be in a favourable condition. In all the limbs were much contracted, distorted, and swollen, and abscesses had formed round and in the neighbourhood of the fractured extremities of the bones. In some instances, these abscesses had extended down the thigh; but more frequently they passed upwards, and occupied the region of the hip-joint and buttocks. In several instances, in which incisions had been made for the evacuation of matter, the fractured and exfoliating extremities of the bones, sometimes comminuted, and sometimes forming the whole cylinder, could be felt bare, rough, and extensively separated from the soft parts which surrounded them. In other instances, these extremities were partially enclosed in depositions of new bone, which, from the quantity thrown out, seemed to be present in a morbid degree. It was obvious that, in all of these cases, several months would be required for the reunion of the fractured extremities; that, in some, much pain and misery was still to be endured from the processes of suppuration, ulceration, exfoliation, and ejection of dead bone; that, in some cases, the patients were incurring great danger, from hectic fever, and from diarrhœa; that the ultimate recovery in most of them was doubtful, and that, of those in whom this might take place, there was but little probability that any would be able to use their limbs! The sight of these cases (says Dr. Thomson) made a deep impression upon my mind, and has tended to increase my conviction that this is, of all others, the class of injuries in which immediate amputation is most indispensably required." (See *Obs. &c. in Belgium*, p. 254—258.)

Dr. Thomson adds, that what has been said of the danger of fractures, produced by musket-bullets, in the upper part of the femur, is true in a still greater degree of those which have their seat in the neck or head of that bone. In such instances, Dr. Thomson joins the generality of modern army surgeons in strongly recommending amputation at the hip-joint, a subject of which I have already spoken. (See AMPUTATION.)

[The more recent experience of the Crimea has confirmed the dangerous nature of these severe injuries of the thigh-bone, and the amputations which many of the cases underwent were followed by scarcely better results. In amputations of the upper third of the thigh there were few recoveries. The French and Russians eventually almost abandoned operations on this portion of the limb. Amputations at the middle and lower third were much more successful. The following table, extracted from the *History of the Crimean War*, from the 5th of April 1855 to the close of the war, the only period in which the returns distinguish the results at the upper middle and lower third, shows the relative mortality of each.]

	PRIMARY.			SECONDARY.		
	Operations.	Deaths.	Ratio per Cent.	Operations.	Deaths.	Ratio per Cent.
Upper third	38	33	86·8	1	1	100
Middle third	56	31	55·3	9	7	77·7
Lower third	46	23	50·0	14	10	71.4

On Gunshot Wounds in which Amputation may be deferred.

If, says Baron Larrey, it be possible to specify the cases in which amputation ought to be immediately performed, it is impossible to determine *à priori* those which will require the operation subsequently. One gunshot wound, for example, will be cured by ordinary treatment, while another, that is at first less severe, will afterwards render amputation indispensable, whether this be owing to the patient's bad constitution or the febrile disturbance induced. However this may be, the safe rule for fulfilling the indication that presents itself, is to amputate consecutively only in circumstances in which every endeavour to save the limb is manifestly in vain. Upon this point Larrey's doctrine differs from that of Faure.

The latter practitioner admits cases, which he terms cases *of the second kind*, in which he delays amputation, not with any hope of saving the limb, but in order to let the first symptoms subside. The operation, done between the fifteenth and twentieth day, appears to him less dangerous than when performed immediately after the receipt of the injury. At the above period, according to M. Faure, the commotion occasioned by the gunshot injury is dispelled; the patient can reconcile himself to amputation, the mere mention of which fills the pusillanimous with terror in a greater or lesser degree; the debility of the individual is no objection; and it is laid down as an axiom "that the consequences of every amputation, done in the first instance, are in general extremely dangerous." In support of this theory M. Faure adduces ten cases of gunshot injuries, in which, after the battle of Fontenoy, the operation was delayed, in order that it might afterwards be performed with more success: a plan which, according to the author, proved completely successful. (See *Prix de l'Acad. de Chir.* t. viii. éd. in-12.)

This division of cases for amputation into two classes, not consistent with nature, Larrey conceives has been the cause of a great deal of harm. Very often the partisans of M. Faure have not dared to resort in the first instance to amputation, the dangers of which they exaggerate; while on other occasions they have amputated consecutively without any success.

Larrey argues that the effects of commotion, instead of increasing, gradually diminish and disappear after the operation. He will not even admit that the patient's alarm ought to be a reason for postponing the operation, because the patient, just after the accident, will be much less afraid of the risk which he has to encounter than at the expiration of the first four-and-twenty hours, when he has had time to reflect upon the consequences of the injury, or of amputation, a remark made by the illustrious Paré.

"Experience agreeing with my theory (says Baron Larrey) has proved both to the army and navy surgeons, that the bad symptoms which soon follow such gunshot injuries as must occasion the loss of a limb, are much more to be dreaded than those of immediate amputation. Out of a vast number of the wounded, who suffered amputation in the course of the first four-and-twenty hours after the memorable naval battle of the 1st of June 1794, a very few lost their lives. This fact has been attested by several of our colleagues, and especially by M. Fercoc, surgeon of the ship *Le Jemmapes.*"

The following is said to be an extract from one of his letters:—

"After the naval engagement of the 1st of June 1794, a great number of amputations were done immediately after the receipt of the injuries. Sixty of the patients whose limbs had been thus cut off were taken to the naval hospital at Brest, and put under the care of M. Duret. With the exception of two who died of tetanus, all the rest were cured; and there was one who had had both his arms amputated. The surgeon of the *Téméraire*, which ship was captured by the English, was desirous, in compliance with the advice of their medical men, to defer the operation which many of the wounded stood in need of, till his arrival in port; but he had the mortification to see them all die during the passage," &c.

Larrey next acquaints us that when he was sent to the army of Italy, in 1796, he had also the pain of seeing in the hospitals great numbers of the wounded fall victims to the confidence which many of the surgeons of that army placed in the principles of M. Faure. Buonaparte saw that the *ambulance volante* was the only thing that, in the event of fresh hostilities, could prevent such accidents, and in consequence of his orders Larrey formed the three *division d'ambulance*, which are described in his *Mémoires de Chirurgie Militaire*.

Since this period it has always been customary in the French armies on the day of battle to make every preparation for performing amputations as speedily as possible. The mere sight of these *ambulances* (always attached to the advanced guard), says M. Larrey, encourages the soldiers, and inspires them with the greatest courage. On this occasion the following anecdote is cited from Ambrose Paré:—This famous surgeon having been urgently sent for by the Duke de Guise, besieged in Mentz, to attend the wounded of his army who were in want of assistance, Ambrose Paré was shown to the frightened soldiers at the breach. Upon this they immediately filled the air with shouts of the most lively joy, and cried out, "*Nous ne pouvons plus mourir, s'il arrive que nous soyons blessés, puisque Paré est parmi nous.*" Their courage revived, and their confidence in this skilful surgeon contributed to the preservation of a place before which a formidable army was destroyed.

Larrey desires us to interrogate the invalids who have lost one or two of their limbs, and nearly all will tell us that they suffered amputation a few minutes after the accident, or in the first four and twenty hours. "If Faure now retains any partisans," says Larrey, "I recommend them to repair to the field of battle the day after an action: they would then soon be convinced that, without the prompt performance of amputation, great numbers of soldiers must inevitably lose their lives. In Egypt this truth was particularly manifested."

The following communication upon this point was made to Baron Larrey by M. Masclet, a French surgeon on duty at Alexandria:—

"In the naval hospital of this port, I have seen eleven soldiers, or sailors, who were wounded in the naval action off Aboukir, and who had suffered amputation in the first four and twenty hours. In five of these cases the operation had been done on the arm; in two, on the thigh; and in three others, on the leg. All these men are recovering. In the army hospital there have been only three thigh amputations, which we performed seven or eight days after the battle, and these three patients died a few days after the operation, although the operation was done methodically, and no grave symptoms prevailed at the time of its performance. You see, sir, experience has, in this instance, quite confirmed your principles."

In 1780, during the American war, as we are informed by Larrey, the surgeons of the French followed the maxim then generally adopted in France, that the operation should not be undertaken till after the subsidence of the first symptoms. Almost all the patients thus treated died after the operation. On the contrary, the Americans, who had the boldness to amputate immediately (or in the first four-and-twenty hours) upon many of their wounded countrymen, lost only a very few. Yet M. Dubor, at that time surgeon to the Artois dragoons, and from whom Larrey has collected this fact, states that the situation of the hospital for the French wounded was, on many accounts, the most advantageous. (*Dubor, Thèse Inaugurale, soutenue* 16 *Sept.* 1803, *à l'Ecole de Strasbourg.*)

Admitting that, by a concurrence of fortunate circumstances, which are not always to be calculated upon, some patients escape the danger of the first symptoms, as Larrey remarks, this proves nothing in favour of doing the operation afterwards; it must be seen what nature will do towards the event of the case. If, at the end of twenty or thirty days, the prognosis is as bad as it was previously, amputation cannot be avoided. Thus all the sufferings which the patient has endured have been undergone for nothing, and the operation will now be attended with considerable risk, inasmuch as the patient is in a dangerously weakened state. If nature revives at all, no doubt the success of the operation becomes more probable; but, in this case, the surgeon, instead of having recourse to amputation, should redouble his efforts to preserve the limb.

CASES DEMANDING AMPUTATION CONSECUTIVELY.

First case. A spreading Mortification.—If the disorder were owing to an internal and general cause, it would be rashness to amputate before nature had put limits to the disease. Larrey describes this species of gangrene as being distinguished from that kind which is named *traumatic* by the symptoms which precede and accompany it. These symptoms are similar to those which are observed in nervous and typhoid fevers. Here the operation ought to be deferred, and endeavours made to combat the general causes with regimen and internal medicines.

But when gangrene is *traumatic*, Larrey advises the limb to be immediately cut off above the disorganised part. Several facts in support of this doctrine are related by this experienced surgeon in his *Mém. sur la Gangrène Traumatique.* (See MORTIFICATION.)

In that part of the Dictionary will be found additional observations in favour of the practice adopted and recommended by Larrey, which is so opposite to that inculcated by Sharp, Pott, and the generality of writers.

In the article AMPUTATION, I have noticed a particular case of gangrene, which has been pointed out by Mr. Guthrie as demanding the early performance of amputation, and a deviation from the old rule of waiting till the mortification has ceased to spread. (*On Gunshot Wounds of the Extremities*, p. 63, &c.)

Second case. Bad State of the Wound.—It often happens that, in gunshot wounds complicated with fractures, notwithstanding the most skilful treatment, the discharge becomes of a bad quality; the fragments of bone lie surrounded with the matter, and have not the least tendency to unite; the patient is attacked with hectic fever, and a colliquative diarrhœa. Under these circumstances, life may sometimes be preserved by amputation.

[Secondary amputation may become necessary on gangrene setting in after ligature of a main vessel of a limb, or a vessel may be secondarily injured by a fractured bone where it may be impossible to secure both ends of the bleeding vessel, and the hæmorrhage cannot be arrested in any other way: in such a case, amputation must be had recourse to as a last resort.]

Third case. Bad State of the Stump.—In hospitals, the cure of amputation is sometimes prevented by a fever of a bad character. The stump swells, the integuments become at first retracted, and then everted and diseased a good way upwards. The wound changes into a fungous ulcer, the cicatrisation of which is hindered by the deep disorder of the bone and the ulceration of the soft parts. The extremity of the bone projects. In order to remedy this last evil, it has been proposed to saw off the projecting part of the bone, and, with this, even to amputate all the flesh beyond the level of the skin. Larrey condemns such practice as unnecessary and dangerous, and he recommends giving nature time to bring about exfoliation. (See *Mém. de Chir. Militaire*, t. ii.) Exceptions to this advice, however, are met with.

[Larrey was of opinion that secondary amputation, performed on the very first appearance of acute tetanus, or for the chronic form of that disorder, checked the disease. One of his patients recovered after undergoing the operation, and a few other cases are recorded where beneficial results followed. This doctrine is, however, entirely renounced both by the modern French and English surgeons; and no one, that I am aware of, now recommends amputation for the acute form of that malady.

In certain, though rare instances, secondary amputation may be demanded, where hæmorrhage persists from a wound or compound fracture in which all other means have failed to restrain it. Styptics, pressure either on the wound, or compression of the main artery, or ligature, ought to be resorted to previous to having recourse to amputation; and this measure should only be adopted as a last resource for the preservation of the life of the patient. Such a case, I believe, only once occurred in the campaign before Sebastopol.]

[RETURN showing the number and results of Amputations in Non-commissioned Officers and Privates in the Crimean War, from 1st of April 1855 to the close of the War.]

			Total treated.	DIED.			Total died.	Discharged to duty.	Discharged and re-admitted under the head amputation or resection.	Invalided.
				In regimental hospitals.	In secondary hospitals.	Of other diseases while under treatment for wounds.				
Upper Extremity.		Shoulder-joint . .	39	12	1	0	13	0	0	26
		Arm	102	23	2	2	27	0	0	75
		Forearm	59	1	2	0	3	0	0	56
		Hand at Wrist-joint .	1	0	0	0	0	0	0	1
		Thumb	20	0	0	0	0	1	0	19
		Fingers	193	1	0	0	1	22	1	169
Lower Extremity.	Thigh	Upper third . .	39	32	2	0	34	0	0	5
		Middle third .	65	36	2	1	39	0	0	26
		Lower third . .	60	28	5	1	34	0	0	26
		At Knee-joint . . .	7	3	1	0	4	0	0	3
		Leg	101	29	7	0	36	0	1	64
		Ankle-joint	12	2	0	0	2	0	1	9
		Medio-tarsus . . .	7	1	0	0	1	0	0	6
		Tarso-metatarsus . .	4	0	0	0	0	0	0	4
		Toes	8	0	0	0	0	4	0	4
Double Operations.		Both Arms	1	0	0	0	0	0	0	1
		Both Thighs . . .	2	2	0	0	2	0	0	0
		Both Legs	1	0	0	0	0	0	0	1
		Thigh and Arm . .	2	1	0	0	1	0	0	1
		Thigh and resection of Elbow	1	1	0	0	1	0	0	0
		One Leg and one Foot	1	0	0	0	0	0	0	1
		Total . . .	725	172	22	4	198	27	3	497

[RETURN showing the number and results of Amputations performed from the commencement to the close of the Crimean War in Commissioned Officers.]

			Total treated.	Total died.	Invalided.
Upper Extremity.	Shoulder-joint		6	2	4
	Arm		7	1	6
	Forearm		4	0	4
	Thumb		2	1	1
	Fingers		6	0	6
Lower Extremity	Hip-joint		2	2	0
	Thigh	Upper third	5	4	1
		Middle third	2	1	1
		Lower third	5	3	2
	Leg		5	1	4
Double Operations.	One Leg and one Foot		1	0	1
		Total	45	15	30

[GUNSHOT WOUNDS OF THE HEAD.]

[A considerable proportion of the wounds and injuries received in action, and more especially in sieges, occur in this region. Many of them are superficial, affecting only the scalp; and when this is extensively torn and stripped from the bone, it becomes a severe, if not a dangerous, injury. But very commonly the bone itself is fractured and even depressed, and the membranes become separated from the bone or lacerated, and the brain itself implicated. Bullets having little velocity fracture and depress a circumscribed portion of bone; with greater velocity they perforate, and even pass out again, very often extensively fracturing the cranium in doing so. The danger of these latter injuries is due more to the lesion or disturbance of the brain and its membranes than to the mere fracture of the bone itself; and this danger may be primary, owing to extravasation of blood, or to a portion of the skull having been forced inwards, thereby compressing the brain; or serious symptoms may be excited by the lodgment of a part or the whole of the missile, or by spicula of bone, or other foreign substance which the ball has carried in along with it. The secondary evils to be apprehended arise either from inflammation of the membranes or the substance of the brain itself.

Gunshot injuries in this region differ from those occurring in civil life, inasmuch as their most frequent seat is at the upper, lateral, anterior, or posterior parts of the skull, while those produced in civil life, most generally arising from falls, affect the base. Bullets perforating the brain, or penetrating and lodging deeply in it, are almost always attended with fatal results. Some extraordinary instances of recovery are related by Larrey and by Mr. Guthrie, both after removal of the ball and without. (*Commentaries of Surgery*, edit. 6.) These injuries are so fully treated of in the article "HEAD, *Injuries of the*," in which the subject of gunshot wounds is included, that I refer the reader to it for more detailed information, and for the treatment, and content myself with appending the results of injuries to the head occurring at the siege of Sebastopol.]

[TABLES showing the number and results of the cases of Gunshot Injury to the Head treated from the 1st of April 1855 to the close of the Crimean War.]

Non-commissioned Officers and Privates.

		Total treated.	DIED.			Total died.	Discharged to duty.	Invalided.
			In the regimental hospitals.	In the secondary hospitals.	Of other diseases while under treatment.			
Simple flesh contusions and wounds	slight	441	0	0	0	0	427	14
	severe	189	7	0	1	8	131	50
With contusion and fracture of bones of cranium without known depression		61	20	3	0	23	27	11
With contusion and fracture of bones of the cranium with depression		74	46	7	0	53	9	12
Penetrating the cranium		67	65	1	1	67	0	0
Perforating the cranium		19	19	0	0	19	0	0
Total		851	157	11	2	170	594	87

Commissioned Officers.

		Total treated	Total died.	Discharged to duty.	Invalided.
Simple flesh contusions and wounds	slight	25	0	22	3
	severe	13	0	7	6
With contusion and fracture of bones of the cranium without known depression		2	1	0	1
With contusion and fracture of bones of the cranium with known depression		2	2	0	0
Penetrating the cranium		5	5	0	0
Perforating the cranium		0	0	0	0
Total		47	8	29	10

[GUNSHOT WOUNDS OF THE FACE.]

[Wounds of this region are not often fatal, nor even in the large majority of cases are they to be considered dangerous. During the war in the Crimea only 18 terminated unsuccessfully out of 751 examples of this injury; and one of these was from tetanus; two from inflammation of the membranes of the brain supervening, where the eye had been destroyed; and two from the same cause, where no injury to this organ had taken place; and two were complicated with extensive burns from explosion. Among the officers no fatal case occurred.

When caused by grapeshot or fragments of shell they are frequently followed by profuse hæmorrhage, either as an immediate consequence of the injury, or on the detachment of sloughs, or separation of dead bone. This bleeding it is often very difficult to restrain, especially where the injured vessel is deep and contained in long canals. The same troublesome bleeding not unfrequently occurs after bullet wounds.

Great distress is occasioned by the pain, swelling, and high inflammatory symptoms that follow upon severe injuries of this part, and they frequently lead to great deformity. The sinuses of the face are very often perforated, and occasionally balls lodge in them. The spherical bullets may sometimes be split by contact with the edges of the bones, or they may be flattened against the surface of them. Penetration of the frontal sinuses occasionally occurs, and not unfrequently leads to fistulous openings of these cavities; or bullets may lodge in them without fracturing or otherwise injuring their inner wall, and consequently without disturbance of the brain; or they may become so impacted in them as to be incapable of removal, except by means of an elevator, or the opening in the external table will sometimes require to be enlarged before they can be extracted.

The globe of the eye may be destroyed, or vision become impaired, or altogether lost, where there is no apparent injury to the organ itself. In other cases amaurosis may be the result of the injury without there being any lesion of the optic nerve. The lodgment of bullets in the orbital fossæ, in rear of the eyeball, will occasion protrusion, inflammation, and suppuration of that organ, and even after extraction we must not always expect the sight to be restored.

When the nose or forepart of the face is carried away by grape or other large shot, whereby the cavities of the nostrils and the maxillary sinuses are exposed, violent inflammation of the lining membrane of these cavities as well as of the integuments of the face is sure to supervene. The duct of the parotid gland is liable to division by wounds in its neighbourhood; if the cavity of the mouth is not penetrated, this injury will in all probability be followed by a salivary fistula. Mr. Guthrie recommends in such a case, that the wound should be extended into the mouth, and the external opening be made to heal before the internal, which latter must be kept open, so as to prevent the occurrence of a fistula. (*Commentaries*, edition 6, p. 524.) Wounds in this part of the face sometimes implicate the trunk, or some of the large branches of the portio dura nerve, thereby producing more or less complete paralysis of the muscles of that side of the face.

Should the lachrymal bones or sac be injured by balls or sword-cuts, the tears usually continue through life to run over the face, and cause much inconvenience; much good may however be effected by early attention to such accidents.

Wounds of the upper jaw are attended with great suffering and distress. Bullets entering the mouth generally break the teeth and fracture the bones of this or the lower jaw, as well as wound the tongue and soft palate. Considerable portions of the tongue may be destroyed without the speech being much affected. Extraction of loose fragments of bone require very generally to be made after these wounds, and sometimes larger portions which are fixed render their removal necessary, owing to their projection into, and encroachment on, the cavity of the mouth.

Injuries of the lower jaw are very common, more so even than those of the upper, and are very troublesome and difficult to treat, as well as tedious in their progress; many of them end in great deformity. M. Baudens, in some severe cases, cut down upon the fractured bone and sawed off the broken, irregular, and pointed ends; the cases did very well, the wounds becoming speedily healed. (*Clinique des Plaies d'Armes à feu.*)

A very interesting case of this injury is detailed in the *History of the British Army in the Crimea*, p. 305, where the whole of the lower jaw included between the angles was so comminuted by grapeshot that the fragments were entirely removed. Owing to the tongue having lost its bony support in front, it had a tendency to fall backwards and close the opening of the glottis. To remedy this, the man of his own accord lay in a position so as to have the face in the prone posture as much as possible, in order that the weight of the organ might assist in keeping it in its proper position.

Musket balls, and this observation refers more particularly to the spherical form, sometimes take a devious course in the region of the face, such as entering at the external meatus of the ear and passing out at the nose, or passing in at the frontal sinus and escaping by the mouth. (*Hennen's Military Surgery.*)

TABLE showing the number and results of cases treated from the commencement to the end of the Crimean War.

Commissioned Officers.

		Total treated.	Total died.	Discharged to duty.	Invalided.
Simple flesh contusions and wounds.	slight	25	0	25	0
	severe	8	0	3	5
Penetrating or perforating the bony structures		6	0	1	5
With lesion of	one eye.	1	0	0	1
	both eyes.	0	0	0	0
Total		40	0	29	11

TABLE showing the number and results of cases treated from 1st of April 1855 to the end of the Crimean War.

Non-commissioned Officers and Privates.

		Total treated.	DIED.			Total died.	Discharged to duty.	Invalided.
			In the primary or regimental hospitals.	In the secondary hospitals.	Other diseases while under treatment.			
Simple flesh contusions and wounds	slight	274	0	0	0	0	267	7
	severe	108	1	0	0	1	96	11
Penetrating or perforating the bony structure		107	9	1	0	10	58	39
With lesion of	one eye	42	3	0	0	3	24	15
	both eyes	2	0	0	0	0	0	2
Total		533	13	1	0	14	445	74

Treatment.—For restraining the hæmorrhage, which is often a matter of much moment and considerable difficulty, styptic applications or plugs of lint pressed into the wound are necessary. Perchloride of iron, tincture of matico, and acetate of lead, have all been found useful, or lumps of ice placed in the wound. As a last resource, when these means and pressure have failed, the external carotid artery may be required to be ligatured for wounds of one or more of its branches, for it is seldom in deep wounds that you can get at the bleeding vessel or vessels themselves.

To diminish the swelling and inflammation following upon wounds of the tongue, it will be necessary to apply leeches, or scarify, or make incisions, and to freely administer antimonials and mercury. For adjustment of the soft parts in these wounds of the face, especially after shell injuries, the use of sutures is found very beneficial.

"In fractures of the bones of the face from gunshot, we make an exception to the general rule of removing fragments which are nearly detached. The large supply of blood which is sent to every structure in this region, enables pieces of bone to resume their full connection with the other tissues, when detached, in a way that would be fatal to similarly placed portions in other parts. Hence the rule, not to extract any spicula whose attachment has not been completely destroyed, and whose direction is not opposed to a proper union of the broken parts. The exfoliation which follows in injuries of the bones of the face, is slight as compared with those of other parts." (*Macleod, Surgery of the Crimean War*, p. 222.)

In wounds of the eyelid and its appendages, great care is necessary for the nice adjustment of the divided portions; the use of fine sutures for this purpose is absolutely necessary.]

GUNSHOT WOUNDS OF THE NECK.

[Superficial wounds of this region do not differ from the corresponding injuries inflicted on other parts of the body, and require no particular description or peculiar treatment. When the deeper and more important structures are implicated in the injury, we usually have them followed by restlessness, cough, oppressed breathing, nausea, great irritability of the stomach, and sundry nervous affections, the consequence of injury to the communicating nervous distributions so abundant in this situation. (*Hennen's Military Surgery*, edition 3, p. 361.)

In no wounds are there more remarkable escapes for the main blood-vessels than in injuries occurring in this region. Musket-balls frequently traverse close to the vessels, even between the artery and vein without wounding either. A case of this kind came under my notice in the campaign before Sebastopol, where a full sized Minié bullet passed between the subclavian artery and vein, separating them slightly, but without wounding in any degree the coats of either.

Wounds of the larynx are not uncommon, as might be expected from its size, prominence, and superficial position; more or less complete aphonia is a necessary consequence of such injury. This failure of the voice lasts for a considerable period, but is eventually restored when the wound heals. A troublesome and continued cough very generally accompanies these wounds, often leading to marasmus, and symptoms closely allied to phthisis. In some instances an aggravated form of inflammation ensues, which spreads to the lungs and threatens the life of the sufferer. Dyspnœa is often very urgent, and renders the operation of tracheotomy absolutely necessary for its relief. Emphysema is not an uncommon attendant of wounds of this organ and the trachea. The cartilages sometimes become thickened and eroded, and portions exfoliate. All injuries involving the larynx and trachea must be looked upon as dangerous; they are attended with much suffering and distress to the patient, require much attention and careful treatment, and the cure is often tedious and prolonged.]

The practice of Baron Larrey furnishes a curious example, in which the epiglottis of a French soldier was shot off at the battle of Alexandria, on the 21st of March 1801. The ball entered at the angle of the jaw, crossed the throat obliquely, and came out at the opposite side of the neck. The base of the tongue was grazed, and the epiglottis shot away; the patient spat it up after the accident, and showed it to the surgeon who first saw him.

The patient was not in much pain; but his voice was hoarse, feeble, and scarcely audible.

When he first attempted to swallow, he was seized with a convulsive suffocating cough, attended with vomiting. Annoyed by thirst, which the extreme heat of the weather and the irritation of the wound excited, he incessantly repeated his attempts to drink; but always with the same result. Four days were passed in this deplorable condition. He already experienced violent complaints in his stomach; continued loss of sleep; he had a small accelerated pulse; and was beginning to look thin.

If the patient had been abandoned to the resources of nature, he would have died in the course of a few days. The most urgent indication was to appease the hunger and thirst. An elastic gum tube was introduced into the pharynx, and by means of it the patient was given some drink, which relieved him much, and afterwards some rich broth. The patient was fed in this manner for six weeks, at the end of which time he was able, without the assistance of the tube, to swallow thick panado, and thickened rice, made into little balls. The power of speech and deglutition in time became more perfect, in consequence, as Larrey imagines, of an enlargement of the arytenoid cartilages, and an expansion of that part of the base of the tongue which lies next to the glottis having formed a sort of substitute for the epiglottis. (*Mém. de Chir. Militaire*, t. ii. p. 145—149.)

The foregoing case illustrates the utility of elastic gum tubes for conveying nourishment and medicines down the œsophagus in some wounds of the throat. All practitioners should be duly impressed with the necessity of having such instruments always at hand. The patient, whose case is above recited, owed his preservation altogether to this means, without which he must have been starved to death.

In the 4th vol. of the above work, p. 247, is recorded another case, in which a gunshot wound, that took away the epiglottis, and broke the os hyoides, was successfully treated.

[Wounds of the pharynx not unfrequently occur in common with the larynx; the same musket-ball passing through both structures. Many of these injuries are produced by a bullet entering some part of the face and escaping at the neck. Difficult deglutition is the most prominent symptom of this lesion.

The œsophagus is much more rarely wounded. Baron Larrey records only one example of this injury which fell under his notice during an extensive experience of more than thirty years. The symptoms manifested in this lesion are an ardent and inextinguishable thirst, arising from injury to the pneumogastric plexus of nerves, and the food or drink swallowed passing out of the wound. The patient therefore requires to be supported by liquid nourishment introduced through a flexible tube, and care should be employed in doing this that the instrument does not pass through the wound, or re-open it if it is partially closed. Larrey recommends that the thirst should be allayed by lavements and slightly tepid baths, and the lips be constantly moistened. He narrates the case which fell under his care, a very interesting and instructive one, though it terminated fatally; the wound having been unfortunately re-opened after closure, from the patient freely partaking of solid food and drink before the union was sufficiently established.

Division or wounds of the carotid arteries mostly terminate fatally from hæmorrhage on the field. Should surgical assistance be speedily at hand, the vessel must be temporarily compressed above and below the wound, and afterwards both ends of the divided artery secured by ligature. As a consequence of the division or injury of some one or more of the cervical nerves, partial or complete paralysis of the upper extremity may ensue; this occurrence follows immediately upon the infliction of the wound in some instances, but not till after the lapse of some days in others; in general such injuries are accompanied with severe pain. The lodgment of balls deeply in the neck, near the large nerves, occasions, according to Baron Larrey, severe tetanic affections; sometimes, balls so lodged are observed occasionally to become encysted, but they are more generally followed by suppuration, and their removal becomes a matter of necessity, if there is a possibility of its being accomplished; as a rule, whenever they can be reached, extraction should be attempted, as they are oftener than not followed by troublesome consequences. Wounds of the posterior region of the neck are unattended with danger unless they penetrate to the spinal canal, fracturing the vertebræ, or, what is still more serious, injuring the spinal marrow and leading to a fatal result.

The treatment of these wounds generally should be antiphlogistic, especially where the larynx or trachea is concerned, and opiates should be prescribed to allay the frequent and harassing cough. For further information on this subject, and for the treatment, consult the article WOUNDS.]

[The following Table shows the number and results of cases of Gunshot Wounds of the Neck, treated from 1st April 1855 to the end of the Crimean War.]

Non-commissioned Officers and Privates.

		Total treated.	DIED.			Total died.	Discharged to duty.	Invalided.
			In the regimental or primary hospitals.	In the secondary hospitals.	Of other diseases while under treatment for wounds.			
Simple flesh contusions and wounds	slight	47	0	0	0	0	47	0
	severe	76	2	0	1	3	60	13
With lesion of the	Pharynx	1	1	0	0	1	0	0
	Larynx	2	0	0	0	0	1	1
	Larynx and œsophagus	1	0	0	0	0	0	1
	Trachea	1	0	0	0	0	0	1
Total		128	3	0	1	4	108	16

[Shows the number and result of cases treated from the commencement to the close of the Crimean War.]

Commissioned Officers.

		Total treated.	Total died.	Discharged to duty.	Invalided.
Simple flesh contusions and wounds	slight	4	0	4	0
	severe	12	0	4	8
With lesion of the Larynx or Trachea		3	2	0	1
Total		19	2	8	9

GUNSHOT WOUNDS OF THE CHEST.

Wounds of the lungs, abstracted from other mischief, are not always fatal. Balls have been found in the substance of the lungs after having lodged there twenty years, during the whole of which time the patients were healthy, and free from symptoms indicative of the case. (*Percy, Manuel, &c.* p. 25.) Mr. Hunter had some reason to believe that wounds of the lungs produced by balls were generally less dangerous than such as were made with sharp-pointed instruments; for he had seen several patients recover after they had been shot through the lungs, while other persons died of very small wounds of those organs, made with swords and bayonets. Perhaps one cause of this fact may be owing to the circumstance of gunshot wounds generally bleeding less than other wounds, so that there is not so much danger of blood being effused in the cavity of the chest, or the cells of the lungs. The indisposition of the orifice of a gunshot wound to heal quickly, is also another circumstance that must lessen the hazard, as whatever matter happens to be extravasated has thereby an opportunity of escaping.

But, from what has been stated, it must not be inferred that gunshot wound of the lungs are not accompanied with a serious degree of danger. Frequently the patient expires instantly, being suffocated in consequence of profuse hæmorrhage from those organs; for, though it be true, that gunshot wounds generally do not bleed much, when the injured vessels are under a certain size, yet the contrary is the case when the wounded vessels are like those situated towards the root of the lungs. Gunshot wounds of the chest often prove fatal by the inflammation excited within the cavity.

Appearances sometimes create a belief that a ball has passed completely through the chest and lungs, when the fact is otherwise. "Thus (as Dr. Hennen observes), I have traced a ball by dissection, passing into the cavity of the thorax, making the circuit of the lungs, penetrating nearly opposite the point of entrance, and giving the appearance of the man having been shot fairly across, while bloody sputa seemed to prove the fact, and, in reality, rendered the same measures, to a certain extent, as necessary as if the case had been what was suspected. The bloody sputa, however, were only secondary, and neither so active nor so alarming as those which pour out at once from the lungs when wounded." (*Military Surgery*, p. 368, ed. 3.) A second cause of deception is the frequent long course of a ball, round the chest under the skin and muscles previous to its exit, thereby assuming the appearance of the patient having been shot through the lungs.

Another source of deception, as to the actual penetration of balls, is "where they strike against a handkerchief, linen, cloth, &c., and are drawn out unperceived in their folds, a peculiarity which has not escaped M. Larrey, who gives an interesting notice of it in the *Bulletins de la Faculté de Méd.* Paris, 1815, No. 2. I have also given an instance in the preceding pages." (*Hennen*, loc. cit.) In these cases, the absence of bloody expectoration directly after the injury, the undisturbed state of respiration, and the greater freedom from oppression, anxiety, syncope, and other bad symptoms, than in cases where the lungs are injured, form grounds for a correct opinion on the true nature of the accident.

[Hæmorrhage from the lungs by the mouth, or bloody expectoration as it is termed, is by no means a certain sign of wound of those organs. Several cases of decided wound of the lung (as shown afterwards by post-mortem examination) that occurred before Sebastopol were marked by the absence of such bloody sputa, and Dr. Frazer in a recent monograph states it as his opinion that "spitting of blood" is a very deceptive diagnostic sign of lung wound ; out of nine fatal cases that he has collected together, only one had hæmoptysis; and in seven cases in which the lung was unwounded, two only had hæmoptysis. In some experiments which he performed upon dogs, to see what would be the effects that would ensue, in none of them did he find hæmoptysis appear.

M. Appia also states that bloody expectoration is not a pathognomonic character of penetration of the lung. He has often seen it accompanying simple contusions or superficial wounds.]

It cannot be supposed that adhesions always take place round the opening of a gunshot wound in the chest, because the lung sometimes collapses, and becomes considerably distant from the pleura, especially when the communication established between the atmospheric air and the cavity of the thorax is free and direct. However, as adhesions are extremely common between the outer surface of the lung and the inner surface of the pleura costalis, they must, in many instances, exist before the receipt of a wound, and, of course, prevent the usual collapse of the lung.

[It is necessary, with reference to exactitude in our comparison of gunshot wounds of the chest, to arrange them into classes.

First. With regard to those in which the soft external parietes only are concerned, such as skin and muscles, simple injuries like these do not afford any peculiarity distinguishing them from similar wounds of other regions, but occasionally you have inflammation of the contused organs set up, where no primary injury of them could be discovered. Two deaths from this cause appear in the Sebastopol returns, where fatal pleuropneumonia supervened on bullet wounds of the walls of the chest, though in neither instance, as the post-mortem examination revealed, had the pleura been opened.

Secondly. Wounds complicated with injury to the bony or cartilaginous portion of the parietes. Although these are serious cases, yet, when the cavity of the chest has escaped injury, they do not appear to be of a very fatal character: only one death is recorded in this class from among twenty-four cases occurring before Sebastopol ; it was followed by acute inflammation of the pleura of the injured side, which extended to the lung and pericardium.

Thirdly. Those that produce lesion of the contents without opening the cavity. This form of injury, although not often occurring, does sometimes follow as a direct consequence of the external violence, without the bony or cartilaginous walls being broken, and without penetration of the cavity. It cannot at first always be distinguished from those of the second class ; hence our prognosis should be guarded. The symptoms denoting this complication do not always take place immediately, but after a time severe hæmoptysis may come on, or pleuropneumonia may supervene.

Fourthly. Penetration of the cavity, which may or may not be aggravated by lodgment of the missile, the lung being unwounded. This kind of wound may be effected by a lance, bayonet, bullet, or fragment of shell. The danger of these injuries is very often primary, where a large vessel of the parietes, such as an intercostal artery, is divided, which however, practically, seems to be a rare occurrence, or death may be the consequence of violent pleuropneumonia coming on. In clean cut lance or bayonet wounds, in which there is but little bleeding, the lips of the wound must be nicely adjusted and brought together, and in fortunate cases only a sufficient amount of lymph may be thrown out necessary to agglutinate the edges of the wound of the pleura and surface of the lung. The same happy result may and does follow upon bullet wounds. Lodgment of the missile in the cavity of the pleura is in the very large majority of instances fatal; indeed it has been stated to be a much more dangerous wound than where the cavity has been completely perforated, and the ball has made its escape. Such a conclusion appears to be justified by the result of 41 cases returned in the latter half of the Crimean war: 38 died and 3 were invalided, and some doubts were entertained as to whether the ball had really lodged in these three cases of recovery.

Fifthly. Penetration of the pleura with perforation or lodgment of the missile in the lung. A large number of these cases never come under treatment at all. They die, many of them almost instantly, on the field of battle, from hæmorrhage poured out from a large vessel or vessels in, or near the root of, the lung, or from suffocation, when the large bronchial tubes are opened and become choked with blood. Others again only survive a short period after admission into hospital, dying from repeated and copious bleeding, either from the mouth or the wound, or from both. This hæmorrhage may arise from a wound of an artery of the chest walls, either produced by the missile or by the fractured bone, or from the wounded lung itself, and this may be done by the ball or subsequently by the fractured rib. One-twelfth of the deaths after an action in the field are calculated to arise from wounds of the chest, according to M. Scrive, and one-twentieth after a siege. In those cases that survive for a longer period, the danger will be primary, from hæmorrhage; secondarily, from inflammation; and lastly, from extensive suppuration. Neither emphysema nor secondary hæmorrhage appears to have led to a fatal termination in any instance before Sebastopol. It rarely happens that a ball enters the cavity of the chest without fracturing one or more ribs, and frequently a fragment or fragments of the broken bone, or some portion of the clothing or accoutrements, is carried in along with the ball.]

As the general symptoms and treatment of wounds of the chest are detailed in the article Wounds, I shall not here detain the reader long upon the subject. When a patient has been shot in the chest, the most important indication in the first instance is to check the hæmorrhage, should it exist. It is this which, in many instances, threatens the life of the sufferer, and which must be the first attended to ; the second point is to prevent and subdue inflammation of the lungs and pleura. In few other cases can repeated and large bleedings be so advantageously practised. Here there will not be so much danger of an extravasation of blood as in stabs; and, even if an effusion of that fluid were to happen within the cavity of the pleura, the opening would generally be sufficient for its escape.

In this last kind of case, when attended in the beginning with bleeding, Baron Larrey particularly insists upon the advantage of immediately bringing the edges of the wound together with adhesive plaster, instead of leaving it open as advised by the generality of writers; and he endeavours to prove, that this immediate closure of the wound has great effect in stopping the hæmorrhage from the pulmonary vessels. Supposing an extravasation of blood in the chest were to follow, he argues, that it would be better to let it out afterwards by a suitable incision, than to suffer the patient to perish of hæmorrhage at once by not closing the wound. (*Mém. de Chir. Mil.* t. iv. p. 151, &c.) Dr. Hennen is in favour of the same practice. (*On Military Surgery*, p. 373, ed. 3.) [Mr. Guthrie is of the same opinion. In large penetrating wounds of the chest, with injury of the lung, he says, "It has been observed that the patient breathes most easily when the external wound has been covered, and has been hardly able to breathe when it was opened, which is attributed to the air getting into that side of the thorax in inspiration, instead of entering the lung by the trachea. If the wound admit of being well closed, the difficulty of breathing diminishes; adhesion may take place, and the inflammatory action within the chest may terminate." Writers generally are of the same opinion, and it would appear to be the established and correct line of procedure to adopt in all cases, in the first instance. (*Vide Commentaries,* edit. 6, f. 453.)] In a penetrating gunshot wound of the chest the surgeon should extract all extraneous substances, and splinters of bone within reach, and even dilate the external wound for this purpose, if necessary. Light unirritating dressings are then to be applied. The patient may now be (comparatively speaking) easy, until the spitting of blood, and danger of suffocation, from inward hæmorrhage, come on, when the lancet must be employed; "and if, by this treatment, repeated as often as circumstances demand, the patient survives the first twelve hours, hopes may begin to be entertained of his recovering from the immediate effects of hæmorrhage," and until this danger is over, as Dr. Hennen truly observes, the lancet is the only thing which can save life. Afterwards, when the paroxysms of pain, the sense of suffocation, and the return of hæmorrhage, have become more moderate, digitalis may be prescribed with the most beneficial effect; and if the cough be very troublesome, no medicine is more useful than the spermaceti mixture with opium.

[Opinions seem to have undergone great change with reference to the large amount of bleeding necessary in gunshot wounds of the chest. The old Peninsular surgeons seemed to have reduced their patients to the last stage of weakness by repeated bleedings. Amongst the moderns we find Dr. Frazer (see *Penetrating Wounds of the Chest*, p. 126, 127) adducing strong arguments to show that bleeding is not only not necessary, but very often injurious; and I cannot forbear quoting the following remarks from *The Surgical History of the Crimean War, by Dr. Mathew*, on this subject. The whole article is replete with masterly observations. He says, "Supposing the first danger of death by excessive loss of blood not to have arisen, in consequence of no large vessel having been wounded, or this danger to have passed over, the means adopted by nature to repair the mischief appear to be the exudation of plastic material glueing the various parts involved in the injury together, and thus isolating them; and the more effectually and perfectly she does this, the greater is the chance of safety to the patient; and, as before stated, in discussing the subject of wounds of the head, we believe venesection (for any other purpose than that of a styptic, as pointed out above) to be not only useless, but positively and actively injurious, as tending to prevent or render less perfect the adhesive process. The doctrine of the older surgeons, that adhesion depended upon a less degree or smaller amount of the same process which produces pus, and that as inflammation was almost certain to follow these injuries, prophylactic bleedings, to as great an extent as could be borne with safety to life, should be employed, as tending to limit the inflammation to the less degree, or the adhesive stage, seems not at all tenable in the present day. Adhesion and pus formation seem to depend upon two essentially different processes, although the term inflammation has been applied to both; and although we are at present not fully acquainted with the nature of the difference, the opinion appears to be daily gaining ground, that the too early abstraction of large quantities of blood favours the latter, while there can be little question that it impedes the former process. We are, however, by no means prepared to state that exceptional cases of plethora, in which such prophylactic venesection may be beneficial, do not occasionally occur; but they appear to be rare, and indeed are not likely to exist among soldiers on active field-service. Practical experience also, to which all theoretical opinions must give way, seems, during the late war, to point in this direction, and to do so independent of, and making allowance for, the cachectic state before alluded to, into which the bulk of the army had at one time fallen."

Mr. G. Lawson (see *Gunshot Wounds of the Thorax*) gives it as his opinion, that bleeding in these injuries is not called for as recommended by Mr. Guthrie, Hennen, and the older army surgeons, and certainly was not all applicable to the cases occurring in the late war in the Crimea.

After the immediate danger of hæmorrhage either from the wound or the lungs has passed, our attention may be required for the removal of fragments of bone projecting into the cavity, which may irritate or wound the lung; for, as has been before remarked, these wounds seldom occur without fracture of one or more ribs, and any foreign substance within reach must be carefully looked for and withdrawn. Enlargement of the wound may be requisite for this purpose.]

When a ball lodges, without falling into the chest, it may lie either in the substance of the parietes of this cavity between the muscles, or in one of the intercostal spaces, and continue there a very long time without causing much inconvenience, or making its way outward. But, when it is lodged in the thoracic cavity itself, it descends by its weight, and sometimes excites considerable irritation, suppuration, sinuses, and hectic symptoms; in this case, if its situation can be ascertained, Baron Larrey recommends an attempt to extract it. In an early stage of the case, he says, that the intercostal space will often be wide enough to let the ball pass through it; but that, at a later period, this space becomes too narrow, and it will be necessary to cut away a portion of the upper edge of the rib with a lenticular knife, which is to be preferred to a trephine, or saw. This advice is supported by some interesting cases. (See *Mém. de Chir. Mil.* t. iv. p. 253.) Frequently the ball fractures the rib, and, with the aid of dilatation, sufficient room for its extraction may be made; but the possibility and propriety of removing it through the original opening will, of course, depend upon the situation of the foreign body, and the urgency of the symptoms. A case is recorded in which a ball weighing three ounces and a half was thus removed. (*Med. and Surg. Journ.* vol. iii. p. 353.)

[Balls have been known to lodge for a time in a rib, costo-sternal cartilage, or body of a vertebra, and fall afterwards into the cavity of the pleura, causing inflammation of that membrane, or pleuropneumonia, from which the patient perishes, or may gravitate into the costo-diaphragmatic angle of the pleural cavity, and become enveloped in a false membrane, producing no further mischief. (*Baudens, Clinique.*)

Hernia of the lung is one of the rare complications of penetrating wounds of the chest. The protruded lung is sometimes strangulated, and from exposure to the air becomes dry and livid, and appears gangrenous. In such a state it has been returned to its natural cavity, and has recovered its functions. If it be torn, contused, or gangrenous, Baudens recommends it to be excised or cauterised. Mr. Guthrie is of opinion, when it is not strangulated, that it should be allowed to remain, or be so far returned as to rest just within the edges of the divided pleura, so as to fill up the gap made by the wound, and the integuments accurately drawn over it and retained. (*Commentaries*, edit. 6, fol. 499.)

Emphysema of the areolar tissue, formerly so much dreaded by army surgeons, is a rare occurrence to any extent, and it may always be prevented by enlarging the external wound, for it happens in oblique wounds, where the opening in the cavity and the external wound are not opposite; by making them so, and and exerting a little pressure, if necessary, its recurrence may be prevented. Baron Larrey gives a plate of the appearance of a patient in the advanced stage of general emphysema. (See EMPHYSEMA.)

Gunshot wounds of the *diaphragm* are nearly always mortal. Mr. Guthrie states that wounds of this muscle never unite, whether they occur in the muscular or tendinous part. Should the patient recover, he is liable to a protrusion of some of the contents of the abdomen into the cavity of the chest. These wounds are followed by intense inflammation, hiccough, spasmodic or jerking breathing, pain on the top of the shoulder, loss of power of the arm, excessive thirst, and vomiting. (*Commentaries of Surgery*, edit. 5, fol. 500, *et seq.*)

Bullets sometimes lodge in the sternum; for their removal it may be necessary to resort to the application of a trephine, as they become so securely wedged in the spongy structure of that bone. If the bone is fractured and the ball can be detected lying beneath in the anterior mediastinum, the broken fragments should be removed, if loose; if not, a sufficient portion should be divided by the small saw or trephine, and then elevated so as to allow of the extraction of the bullet.

Appended are Tables, showing the number and results of all the cases of gunshot wounds of the chest coming under treatment before Sebastopol, from 1st April 1855, to the end of the war, in Commissioned Officers, Non-commissioned Officers, and Privates.]

[*Non-commissioned Officers and Privates.*]

		Total treated.	DIED.			Total died.	Discharged for duty.	Invalided or transferred.
			In the regimental hospitals.	In the secondary hospitals.	Of other disease while under treatment.			
1. Simple flesh contusions and wounds	slight	143	0	0	0	0	135	8
	severe	112	1	1	1	3	77	32
2. With injury of bone or cartilage, without known lesion of contents, and not opening the cavity		24	0	1	0	1	11	12
3. With lesion of contents, but not opening the cavity		16	9	0	0	9	3	4
4. Penetrating the cavity, and missile lodged, or apparently lodged		33	28	3	0	31	0	2
5. Perforating, or apparently perforating the cavity	superficially	9	2	1	0	3	0	6
	deeply	38	68	3	0	71	0	12
Total		420	108	9	1	118	226	76

[*Commissioned Officers.*]

		Total treated.	Total died.	Discharged for duty.	Invalided or transferred.
Simple flesh contusions and wounds	slight . . .	11	0	7	4
	severe . . .	14	0	5	9
With injury of bone or cartilage, but without known lesion of the contents, and not opening the cavity		6	1	0	5
With lesion of the contents, but not opening the cavity .		1	1	0	0
Penetrating the cavity, and missile lodged, or apparently lodged		8	7	0	1
Perforating or apparently perforating the cavity	superficially . .	1	0	0	1
	deep	13	8	0	5
Total		54	17	12	25

[The following Table shows the number of severe chest wounds which occurred on the several occasions named, taken from the various authorities, with the relative mortality of each, and the percentage of deaths to wounded.]

	Number.	Died.	Per Cent.
Crimean war, from 1st April to the close of the war (Director-General's Report), either the cavity perforated, or lesion of contents, in all	141	114	80·00
Simpheropol (Russians)	200	197	98·05
Toulouse (Guthrie), cavity not penetrated, in all . . .	106	50	50·00
Carlist war	29	27	100·00
Paris (1830)	20	10	50·00
Paris (1848)	9	4	49·00
Paris (1850)	11	5	45·00
Battle of Kilet	21	11	50·00
„ Idstead	97	17	17·00
„ Canton	4	4	100·00
Dolma Batchi Hospital, Constantinople (Legouest)	6	3	50·00
Army Medical Returns, prior to Crimean war	39	27	70·00
M. Menière (chest perforated at shot range)	20	20	100·00
Dr. Kidd	36	24	66·00
Guy's Hospital Reports . . . . Lung only really wounded in two cases.	72	9	12·50

GUNSHOT WOUNDS OF THE ABDOMEN.

[These injuries are judiciously classified under three heads; first, those that concern the abdominal walls only, without penetration of the cavity; secondly, wounds of the parietes opening into the cavity, but without implicating any of the viscera; and thirdly, penetration of the cavity, complicated with lesion of one or more of the hollow or solid viscera. It is not essential to every case of wounded or injured viscera that it should necessarily be accompanied by perforation or other lesion of the abdominal walls; many instances are recorded of laceration of the liver, or spleen, or rupture of the intestine, where the parietes of the cavity were but little, if at all, injured. Four fatal cases occurred from rupture of viscera without external wound, before Sebastopol; in two of these there was rupture of the liver, one of the spleen, and one of the intestines.

The muscular portion of the walls of the abdomen, according to Mr. Guthrie, are subject to absorption after a severe bruise from gunshot injury, rendering the portion liable to rupture; the division of its walls by a sharp cutting instrument is attended by the same consequence, and it never fails to occur after a bullet wound which has penetrated the cavity. (*Commentaries of Surgery*, edit. 6, p. 535–6.) No case of ruptured muscle, followed by atrophy and protrusion of the abdominal contents, is recorded in the returns from Sebastopol.

Musket-balls, impinging obliquely against the wall of the abdomen, are described as sometimes making a circuit round the outside of the cavity, either between the skin and muscles, or in the interval between the latter and the peritoneum; this deflected and circuitous route of the missile seems to have been produced more frequently by the old spherical bullet than is the case with the modern conical one. Yet, according to Dr. Macleod (*Notes on the Surgery of the Crimean War*, p. 255), very many cases of this nature occurred in the Crimea. He says, "The strong aponeurosis which protects the front of the abdomen, exercises a great influence in deflecting the ball when it has struck at all obliquely. The track which is thus made requires careful management during cure, to get it to close. If it be long, it is good practice to make a counter-opening at its centre, in order to prevent the lodgment of pieces of cloth or pus in its interior. This can, however, be necessary only when, neither by syringing, nor by the introduction of an elastic bougie, we can get rid of them." When balls lodge in the parietes and are deeply seated, Mr. Guthrie recommends that they should be left alone, unless they prove troublesome; when superficial, they are to be extracted.

Wounds of the abdominal parietes slightly opening the peritoneum, should be united by suture, they are not generally followed in healthy subjects, by more than partial inflammation of that membrane; a sufficient amount is necessary to agglutinate the edges of the wound together; perfect quietude should be enjoined, and strict antiphlogistic treatment adopted. Mr. Guthrie recommends the avoidance of purgative medicines in such cases. No food, he states, should enter the patient's mouth, and only sufficient water to moisten his lips and allay the thirst. Injections of warm water and gentle laxatives may be administered after a day or two, to assist the operation of the bowels. The treatment should be regulated by the degree of inflammation which follows on the reaction; free venesection may be indispensable. Leeches are often very beneficial combined with bloodletting, or alone, where the patient's strength will not bear a larger abstraction. This treatment must be followed by calomel and opium every four or six hours, according to the urgency of the symptoms of each particular case.

The third order of wounds of the abdomen are perhaps the most fatal injuries that occur; of 63 cases reported under this head as occurring before Sebastopol, in men, subsequent to April 1st, 1855, only three recovered sufficiently to be invalided; in officers, 14 out of 15 died. The cause of death appears usually to have been from "shock" with or without internal hæmorrhage, and the great majority of the cases died within 24 hours of the receipt of the injury. The number of cases where serious hæmorrhage had taken place, either from vessels of the abdominal walls, or the contained great vessels or substance of the viscera, was inconsiderable. A smaller proportion of the cases of penetrating gunshot wounds of the cavity died from peritonitis, usually of an asthenic form, and these often lived many days.

The most significant symptoms of lesion of the viscera are great prostration, weak and feeble pulse, tension of the abdomen, hiccough and vomiting; most if not all of these may occur in cases where there is no injury to the viscera, but the continuance of these symptoms indicates the very great probability of their being wounded. Where balls enter the peritoneal cavity without inflicting injury to the intestine, they may afterwards find their way into some portion of the canal by ulcerative absorption, and be eventually voided per anum: many instances of this nature are recorded; Baron Larrey, however, states that in more than a hundred cases of this accident he had not observed a single example where a ball had been expelled by stool. He therefore advises that search should be made for the bullet with the finger and thumb, and removed if within reach.

Wounds of the small intestines are always considered to be more dangerous than the large. Dr. Thomson only saw two cases of wounds of the small gut, in the way of recovery, after Waterloo. Larrey reports several. The small intestines may be perforated in several places by the same bullet. A case of this kind occurred before Sebastopol, in the 19th Regiment, where the convolutions were wounded in sixteen places.]

It is observed by John Hunter, that such wounds of the abdomen as do not injure parts like the stomach, intestines, bladder, ureters, gall-bladder, large blood-vessels, &c., all of which contain particular fluids, will generally end well. But he adds, that there will be a great difference, when the ball has passed with immense velocity, as a slough will be produced; whereas, when the ball has moved with less impetus, there will not be so much sloughing, and the parts will in some degree heal by the first intention. Even when the ball occasions a slough, the wound frequently terminates well, the adhesive inflammation taking place in the peritoneum, all round the wound, so as to exclude the general cavity of the abdomen from taking part in the inflammation. Such is often the favourable event, when the ball, besides entering the abdomen, has wounded parts like the omentum, mesentery, &c., and gone quite through the body. (*Hunter, On Inflammation, Gunshot Wounds, &c.* p. 543.)

In gunshot wounds of the belly, an extravasation is apt to take place on the sloughs becoming loose, about eight, ten, twelve, or fourteen days after the accident; but, says Mr. Hunter, although this new symptom is in general very disagreeable, most of the danger is usually over before it can appear.

The stupor, that remarkable consequence of severe injuries, is particularly observed to follow those affecting the cavity of the abdomen. The patient quickly turns yellow, and lies completely motionless, inattentive to everything around him. (See *Dupuytren, Clin. Chir.* t. ii. p. 543.) This I have often seen exemplified in fatal cases.

At the assault of Cairo, 1799, M. N. was shot in the abdomen with a ball, which divided the muscular parietes of this cavity on the right side, and a portion of the ileum. Larrey being upon the field of battle, gave him the first assistance. The two ends of the intestine protruded in a separated and inflated state. The upper end was everted, in such a way, that its contracted edge, like the prepuce in a case of paraphymosis, strangulated the intestinal tube. The course of the fæces was thus obstructed, and the contents of the bowel accumulated above the constriction.

Although the patient's recovery was nearly hopeless, both from the nature of the wound, and from the debility and cholera morbus which had already seized him in the short period that he remained without succour in one of the intrenchments, Larrey was desirous of trying what could be done for so singular a case. He first made four small cuts through the constricted part of the intestine, with a pair of curved scissors, and put the bowel into its ordinary state. He passed a ligature through the piece of the mesentery corresponding to the two extremities of the bowel. These he reduced as far as the margin of the opening, which he had taken care to dilate ; and the dressings having been applied, he awaited events. The first days were attended with alarming symptoms, which, however, afterwards subsided. Those which depended upon the loss of the alimentary matter, successively abated ; and, after two months, the ends of the ileum were opposite each other, and disposed to become connected together. Larrey seconded the efforts of nature, and dressed the patient with a tampon, or sort of tent, that was occasionally employed for two months. The patient was then discharged from the hospital quite cured.

In several instances, says Larrey, the sigmoid flexure of the colon was injured, and yet the wounds were cured without any fæcal fistulæ. At the siege of Acre, three examples occurred ; and, at that of Cairo, two. Larrey dilated the entrance and exit of the ball. Clysters of the decoction of linseed, and emollient beverages, were frequently exhibited ; and the patients were kept on low diet, and in the most quiet state.

[Wounds of the intestines sometimes remain fistulous for years, and then close.

Wounds of the stomach are followed by hiccough, bloody vomiting and discharge of its contents, through the wound ; they are very fatal. Baron Larrey calculates that four or five only out of twenty, survive. Mr. Alcock states that only one recovered in the Spanish Legion. In some of the recoveries fistulous openings have continued for years, or throughout life, as in the celebrated case of St. Martin.

Wounds of the spleen are rare; Larrey only saw three cases in his extended experience. The danger arising from them is primarily from hæmorrhage ; and if the patient escapes this he may still succumb to fatal inflammation of the general peritoneal cavity.]

[TABLES showing the nature and results of Cases treated in the British Army, from 1st of April 1855 to the end of the Crimean War.]

Non-commissioned Officers and Privates.

		Total treated.	DIED.			Total died.	Discharged to duty.	Invalided.
			In the regimental or primary hospitals.	In the secondary hospitals.	Of other diseases while under treatment for wounds.			
1. Simple flesh contusions and wounds	slight	35	0	0	0	0	35	0
	severe	66	17	0	0	17	30	19
2. Penetrating or apparently penetrating the cavity, and lodging with lesion	nature not accurately known	12	12	0	0	12	0	0
	of peritoneum only . .	3	3	0	0	3	0	0
	of viscera . .	23	21	0	0	21	1	1
3 Perforating or opening the cavity without lodging; with lesion . .	of peritoneum only . .	2	0	0	0	0	0	2
	of viscera . .	63	59	1	0	60	0	3
4. Rupture of viscera, without external wounds		4	4	0	0	4	0	0
Total		208	116	1	0	117	66	25

Commissioned Officers.

		Total treated.	Total died.	Discharged to duty.	Invalided.
1. Simple flesh contusions and wounds	slight	8	0	8	0
	severe	6	0	1	5
2 & 3. Penetrating or apparently penetrating or perforating the cavity, with lesion . .	nature not accurately known.	2	1	0	1
	of viscera . .	15	14	0	1
Total		31	15	9	7

Wounds and injuries of the liver from blows or musket balls are very serious; when inflicted by grape, shell, or round shot, they generally soon prove fatal from hæmorrhage; when the result of a bullet, they are very generally unsuccessful, from the severe inflammation of the lining membrane of the cavity ensuing upon the injury. The symptoms are those of peritonitis superadded to those peculiar to the organ, viz. discoloration of the skin and urine, amounting to jaundice in some instances, pain in the shoulder and cramps; the discharge from the wound is either blood or bile, sometimes it is glutinous and tinged with bile, at other times it is serous or purulent. Wounds of the gall-bladder are nearly always mortal, from the effusion of bile into the peritoneal cavity giving rise to fatal inflammation. Recorded cases of recovery after this injury are rare.

Gunshot wounds of the kidney are scarcely less dangerous than those of the spleen. They are characterised by great pain in the lumbar region, bloody urine, retraction of the testicle, nausea and vomiting. Foreign bodies lodging in it may afterwards be expelled by the urethra. A very interesting case of this kind is narrated by Mr. Guthrie, attended, however, with great suffering. (*Commentaries*, edit. 6, p. 592—3.) The patient eventually recovered.]

In the article WOUNDS, I have detailed at large the general principles, which should be observed in the treatment of wounds of the belly; consequently it would be superfluous here to go over the whole of this extensive subject. As an excellent practical writer observes, "In their treatment, the violence of symptoms is to be combated more by general means, than by any of the mechanical aids of surgery. The search for extraneous bodies, unless superficially situated, is altogether out of the question, except they can be felt with the probe, as in Ravaton's case (*Chir. d'Armée*, p. 211). Enlargement or contraction of the original wound, as the case may require, for returning the protruded intestine, securing the intestine itself, and promoting the adhesion of the parts, are all that the surgeon has to do in the way of operation; and, even in this, the less he interferes the better. Nature makes wonderful exertions to relieve every injury inflicted upon her, and they are often surprisingly successful, if not injudiciously interfered with. In a penetrating wound of the abdomen, whether by a gunshot, or by a cutting instrument, if no protrusion of intestine take place (and this, it must be observed, in musket or pistol wounds rarely occurs), the lancet, with its powerful concomitants, abstinence and rest, particularly in the supine posture, are our chief dependence. Great pain and tension, which usually accompany these wounds, must be relieved by leeches to the abdomen (if they can be procured), by topical applications of fomentations, and the warm bath; and, if any internal medicine is given, as a purgative, it must, for obvious reasons, be of the mildest nature. The removal of the ingesta, as a source of irritation, is best effected, by frequently repeated oleaginous clysters" (see *Hennen's Principles of Military Surgery*, p. 431, ed. 3); and with respect to dressings, as the same author has observed, concerning cases in which a ball has passed directly through the abdomen, the mildest application should be employed, and no plugging with tents, nor introduction of medicated dressings, thought of (p. 406). In this publication may be found cases, in which musket balls were passed by stool (p. 404); in which an artificial anus was formed, (p. 407, &c.); or the kidneys, liver (p. 430—432), diaphragm (p. 437), and other viscera injured.

[GUNSHOT INJURIES OF THE PELVIC CAVITY.]

[Wounds of this part of the body so often happen concurrently with injury of the peritoneal cavity, that they are classified and treated of under the head of abdominal injuries, as the danger of such wounds often depends upon this complication. Nevertheless, they sometimes occur alone, and render it necessary that they should be separately considered and described. Those occasioned by musket-bullets, where the soft structures only are concerned without including the osseous walls of this cavity, are not dangerous; but such injuries frequently lead to troublesome consequences, from the lodgment of balls giving rise to fistulous passages; the course of the bullet therefore should be carefully sought for, and if possible, it should be extracted. Injuries of this region, when produced by the larger missiles, such as grape-shot or large fragments of shell, are very severe, and often terminate unfavourably. A case of this kind occurred to me in the Crimean campaign, where the gluteus maximus was completely divided through its centre, and the great sciatic nerve severed, by a large portion of shell,—a most ghastly wound it was, attended with great suffering, and terminating fatally. When a bullet lodges near a bone, it sometimes occasions disease of its structure and derangement of the general health; at other times it becomes so deeply imbedded that it is never discovered, and remains during life. The close contact of a ball to a large nerve is followed by numbness, or even partial paralysis of the lower limb, accompanied with pain on change of weather, and obstinate costiveness. (*Hennen, Military Surgery*, ed. 3.) In some cases they give origin to periodical attacks of excruciating agony.

When the bones of the pelvis are broken, the injury is very serious, consequent on their deep position, neighbourhood to important structures, and thick covering. Sometimes balls pass through the pelvis and spare both bones and the contained viscera. Dr. Macleod speaks of a case where a bullet entered one sacro-ischiatic notch, and passed out of the other, without doing more mischief than contusing the rectum.

The cases of gunshot fractures of the bones of the pelvis which occurred before Sebastopol were usually found to be protracted and tedious, and where a fatal termination took place, it was almost invariably caused by sinking of the vital powers from long protracted and profuse discharge. Of twenty-seven cases which came under treatment, fourteen were fatal, and in two similar wounds which occurred in officers, both died. The amount and extent of the fracture, and the degree of displacement of the fractured portions, as well as the injury to the soft parts, were found to be very important elements in determining the probable result of such fractures. The strongest parts of the pelvis appeared to offer no adequate resistance to arrest the progress of the ball, and very frequently not even to turn it in any appreciable degree from its course, so different in this respect from the old spherical bullet. In the majority of instances, but little appeared capable of being done in assisting nature beyond removing dead bone as it became loose, and careful attention to preserve a few outlets for the escape of suppuration. Dead bone often continued to present itself from time to time for many months after the receipt of the injury.]

When a ball passes through the pelvis, and breaks the bones, this latter circumstance alone constitutes a formidable accident; for, as Dupuytren observes, the bones are deep, covered by a thick mass of soft parts, and surrounded by considerable vessels and nerves. If the organs contained in the pelvis are wounded, the fluids or matters which are within them, are effused, inflammation ensues, and the result is mostly fatal. If large vessels are opened, the hæmorrhage cannot be stopped. If nerves are injured, paralysis of the rectum, bladder, or lower extremities, is the consequence. If the ball lodges in the thick substance of the bones, it is apt to bring on necrosis, periostitis, extensive and deep abscesses, sinuses, and fistulous openings. A wound of the bladder is followed by effusion of urine; one of the rectum, by that of fæcal matter; the dangers of which occurrences are great. (See *Dupuytren*, in *Clin. Chir.* t. ii. p. 544.)

[Wounds of the bladder are dangerous in proportion to the quantity of urine it contains at the time of the receipt of the wound, or as the upper and anterior or posterior and lower portion is engaged in the injury. Cases in which balls perforate that part of the bladder covered by peritoneum, almost always terminate fatally from the escape of urine into the peritoneal cavity, giving rise to general and violent inflammation of that membrane. Larrey states that all his patients died in the first forty-eight hours after the injury, and Mr. Guthrie describes them as rarely recovering, generally dying of inflammation and gangrene in from three to six days. (*Commentaries*, 6th ed. f. 603.) In the Crimean war, as far as I can discover by the returns, no case of this nature recovered. When the fundus is wounded at that portion where it is uncovered by peritoneum, the case admits of a cure, unless complicated with too much internal hæmorrhage.]

The surest criterion of these cases is the escape of the urine from the external wound; and its discharge may either be momentary, occasional, or continual; differences to be accounted for by the situation of the wound, and the changes which happen in the bladder. When the bladder is full, and its upper part is pierced, the urine will issue only just at the moment of the accident, and, as soon as it is discharged, the edges of the wound will come together, and permanently close, especially if the urine can pass freely through the natural channel. But when this favourable condition is absent, the bladder becomes enormously distended again, the wound is opened anew, and the urine discharged once more from the external opening. The same things might happen if one were to withdraw too soon the elastic gum catheter, which has been introduced; and by introducing the instrument again, the urine might be diverted from the wound, and its natural course re-established. Lastly, Larrey observes, that, when the wound is situated at one of the lowest points of the bladder, the discharge of urine may be incessant, and be of more or less duration.

When the track of these punctured wounds is extensive, and not direct, abscesses form at different points where the urine passes. These abscesses, Larrey directs to be immediately opened, and their recurrence prevented by the introduction of an elastic gum catheter through the urethra; one of the chief means of relief in all wounds of the bladder. Together with this treatment, he recommends the warm bath, the application of camphorated oily liniments to the belly, antispasmodic cooling medicines, frequent clysters, and sometimes cupping in the vicinity of the wound, or bleeding. (See *Mém. de Chir. Mil.* t. iv. p. 286, 287.) On the two last means of relief, it would have been better if Larrey had laid more stress; for, next to the catheter, they are unquestionably the most essential.

- Baron Larrey informs us, that the gunshot wounds of the bladder, which occurred in Egypt, had for the most part a favourable termination. The most remarkable case was that of F. Chaumette, a light horseman, who was wounded at the battle of Tabor. The ball passed across the hypogastrium, about one finger's breadth above the pubes, to the point of the left buttock which corresponds to the ischiatic notch. The direction of the wound, and the issue of fæces and urine from the two orifices, left no doubt that the bladder and rectum were injured. M. Milioz, who directed the surgical affairs of the division of the army under Kleber, diligently pursued the same kind of treatment which he had seen Larrey adopt at the siege of Acre. During the suppurative stage, the patient was affected with fever; and, after the sloughs were detached, the discharge was very copious. A catheter that was passed into the bladder, prevented an extravasation of the urine, and at the same time promoted the union of the wound of that viscus. This was healed the first, and the patient, upon his return to Cairo, was quite cured.

Larrey has recorded several other interesting cases of wounds, either of the bladder alone, or of it and the rectum together, to which I must content myself with referring. (See *Mém. de Chir. Militaire*, t. ii. p. 160, 165; t. iii. p. 340, &c.; t. iv. p. 296, &c.)

A ball may go through both sides of the bladder, and then either perforate the neighbouring parts, and escape externally, or bury itself deeply in the flesh. When it has gone quite through the bladder, and afterwards passed out of the body again, urine, blended with blood, immediately issues from one or both apertures, according to their situation. The flow of urine through the urethra is either lessened, or completely suppressed; but, through this passage, the patient generally voids more or less blood. Acute and incessant pain is felt in the course of the wound, together with a frequent painful desire to make water, nausea, sometimes actual vomiting, and extreme anxiety and restlessness. Either in its passage inwards, or its course outwards, the ball may have injured or perforated the rectum; in which case, the urine passes into this bowel, and, mixing with the fæces, is discharged from the anus.

When a part of the bladder, towards the cavity of the abdomen, is injured, as, for instance, its posterior surface, which is covered by the peritoneum, the urine is generally extravasated within the belly, and inflammation of this serous membrane is the immediate consequence. This inflammation spreads with rapidity, and attacks all the viscera, producing vast distension of the abdomen, fever, coma, and other bad symptoms, soon terminating in gangrene and death. (*Larrey, Mém. de Chir. Mil.* t. iv. p. 292, 293.)

During the first four-and-twenty hours, very little urine escapes from gunshot wounds of the bladder, in consequence of the swelling which almost instantly affects the lips of the wound. When the bladder is full, this fluid is discharged only at the moment of the accident, and mostly only from the wound by which the ball has made its exit. An extravasation is prevented by the thick slough which fills all the track of the injury, and it is not till the deadened parts become loose that any effusion can happen. Hence it is of the highest importance to introduce an elastic gum catheter into the bladder, where it should be kept, and the instrument should be large enough to fill exactly the urethra; for, according to Baron Larrey's observations, if, at the period when the sloughs are detached, the urine has not a ready passage outward, it passes through the wound, and is extravasated the more readily, inasmuch as the separation of the sloughs has occasioned many openings, by which the fluid may insinuate itself into the cellular membrane. Hence gangrenous mischief and death.

On two points my own experience would not lead me to join in the sentiments of Larrey: first, in opposition to his statement, I am sure that there is risk of extravasation of urine earlier than the period which he specifies, having known this accident commence within a few hours after the receipt of the wound; and therefore I should not depend upon the sloughs being always at first a complete barrier to extravasation of urine (indeed, their formation throughout the whole track of a gunshot wound is by no means a regular occurrence), but invariably pass a catheter as soon as possible, for the more certain prevention of this dangerous consequence. Secondly, the period of the separation of sloughs may indeed often be contemporary with the first appearance of symptoms of extravasation, particularly in cases where the employment of the catheter is for some time deferred, as in Baron Larrey's practice, because then a partial extravasation of the urine, soon after the injury, and previous to the introduction of the catheter, will cause rapid sloughing, and actually prevent the adhesive inflammation from closing up the cavities of the cellular membrane in time to prevent a fatal extension of that irritating fluid amongst the surrounding parts. Were it not for the partial early effusion of urine, no doubt, the adhesive inflammation would, in these cases, soon have the same effect, in obviating the danger of urinary extravasation, which it has after lithotomy, or paracentesis of the bladder. (See BLADDER.)

It is the practice of Baron Larrey to dilate the wounds, in order to facilitate the escape of the urine, which might otherwise lodge in the track of the ball; and perhaps, here the method may frequently be right, though I should conceive its propriety must usually depend upon whether the urine has a tendency to continue to flow out through the wounds or not, and upon the presence of obstruction or not. And, in confirmation of this opinion, I may cite Dr. Hennen's declaration, that, in these cases, he has very rarely found it necessary to enlarge the wound, when the catheter and proper dressings have been employed. (*On Military Surgery*, p. 421, ed. 3.) As soon as possible, a large elastic gum catheter should be introduced, and left in the urethra, taking care to withdraw it, and pass in a clean one every two or three days, so that no incrustations may occur. Sometimes, however, the passage of a catheter is very difficult, as is the case when there are splinters of bone in the urethra, or the parts about the neck of the bladder are inflamed. (*Mém. de Chir. Militaire*, t. iv. p. 294.) Emollient clysters, and acidulated demulcent drinks, are to be prescribed, and the patient is to be kept upon a very low regimen, and in the most quiet state. The dressings are to be light and simple, and cleanliness observed. (Op. cit. t. ii. p. 165—170.) Instead of camphorated embrocations to the abdomen, another means commended by Larrey, it appears to me that this author's directions would have been more complete and judicious had he advised in these cases bleeding, both topical and general.

From the injury of arterial ramifications or varicose vessels, blood is sometimes extravasated within the wounded bladder, and causes deep-seated irritation. According to Baron Larrey, the case is indicated by the symptoms of retention of urine, and those of inflammation, with a small pulse, pallor of the countenance, and dryness of the wounds. (T. iv. p. 295.) A more decided criterion, I should think, would be the partial escape of urine mixed with blood, a symptom which could deceive only where the urethra itself had been injured. Larrey states, that blood, extravasated in the bladder, rarely coagulates, because blended with urine, and hence he advises its discharge to be facilitated by means of a catheter, and tepid, emollient, anodyne injections. (T. iv. p. 295.)

[In reference to this point, Mr. Guthrie states that the blood coagulates with equal proportions of urine, and recommends the introduction of a silver catheter, to break up the clots, and this to be followed by the injection of warm water, to assist in its solution. (*Commentaries*, edit. 6. f. 604-5.)]

Sometimes, balls carry before them into the bladder, fragments of bone, portions of clothing, small coins, pieces of buttons, &c.; or bits of bullets break off, and lodge in that viscus. When these extraneous bodies are not above a certain size, they are frequently voided through the urethra (see cases in Hennen's work, p. 419, 422, 424, &c. ed. 3.), and their evacuation may be materially facilitated by the introduction of an elastic gum catheter, the size of which is to be increased gradually, until the largest can be passed, when the foreign substances will readily enter the tube, or pass out through the dilated urethra. In this way, Baron Larrey has saved patients from a vast deal of suffering. (*Mém de Chir. Mil.* t. iv. p. 302.) In such cases, the urethral forceps, made by Mr. Weiss, might often be used with advantage. (See LITHOTOMY.) When the ball is too large to be taken out in this manner, the lateral operation is to be performed, and it ought to be done before the bladder falls into an ulcerated or gangrenous state, from the pressure and irritation of the foreign body. However, as wounds of this organ frequently give rise to dangerous inflammation, Larrey recommends this operation to be done either before its attack, or after its subsidence. (Vol. cit. p. 309.) In fact, almost all the operations of this kind on record have been done some considerable time after the receipt of the wound, and to this practice my own judgment would lead me to give a general preference. In one case, however, Larrey operated on the fourth day after the receipt of the wound, and with success.

[Balls after remaining in the bladder some time get encrusted with the triple phosphates; the same deposit forms on pieces of bone which are driven into it, and which become the nuclei of calculi. It even forms on the coats of the bladder in the seat of the wound, and these crusts are afterwards detached.]

After the battle of Waterloo, I was not a little surprised to find, in the hospital established in the St. Elizabeth Barracks, at Brussels, a considerable number of cases in which either the intestines, the stomach, the omentum, or the bladder protruded. I think we had, in the division under Mr. Collier and myself, not less than three protrusions of the bladder. An order, which I received to join the army in the field on the 27th of June, deprived me of the opportunity of witnessing the progress and termination of these interesting cases. However, many had ended fatally before my departure from Brussels.

[Paralysis of the bladder is not an uncommon result of blows from shot or large pieces of shell, and rupture of the bladder when in a state of distension may occur, without being accompanied by corresponding injury to the external parts.

The rectum is sometimes wounded alone. Musket-balls occasionally lodge in this canal, and are afterwards passed per anum.]

[Gunshot Wounds of the Perinæum and Genito-urinary Organs.]

[Wounds of the perinæum in which the bladder remains uninjured are not generally very serious, and eventually do well. In wounds of the scrotum where the tunica vaginalis is laid open, the testis, during the healing process, has a tendency to protrude. Many cases of this nature occurred before Sebastopol, and gave but little trouble in their management. Extensive protrusions of the substance of the testicle, or of fungous growth from it, do not appear to have occurred, and judiciously applied pressure seems always to have sufficed for the cure where any amount of protrusion had taken place. (*Medical and Surgical History of the British Army in Turkey and the Crimea*, p. 335.) Balls lodging in the testis must be removed; severe inflammation of this organ follows, and abscesses may form within the tunica vaginalis, and continue open for several weeks, but in the end terminate favourably. In these cases, where the testis is much bruised and shattered, it may be necessary to remove it to accelerate the cure; and Mr. Guthrie states that he has been obliged to extirpate it at a later period, in consequence of the wounded portion becoming enlarged and diseased, but, he observes, this occurrence is rare. In one case to which he refers the lodgment of a shot gave rise to enlargement which could not be distinguished from medullary sarcoma, and rendered the removal of the testis necessary; the patient afterwards died of disease of the lumbar glands. (*Commentaries on the Surgery of the War in Spain, &c.* p. 594.) Even slight wounds of the testis may lead to its ultimate absorption.

Wounds of the spermatic cord are rare, and seldom lead to fatal, although often to inconvenient, consequences.

The great toughness of the fibrous coverings of the erectile tissue of the penis appears to render perforation of its substance difficult. In a case which occurred at Sebastopol, a musket-ball entered between the glans penis and foreskin, ran under the skin the whole length of the organ without wounding the erectile tissue, and made its exit at the root of the penis, afterwards perforating the scrotum and entering the thigh, and was finally cut out of the buttock. Another very similar case is related, where the ball made its escape at the root of the organ on the opposite side of the penis to which it entered, and subsequently inflicted a wound in the thigh. (*Med. and Surg. History of the Army in the Crimea.*) Mr. Guthrie states he had never any occasion to tie an artery, even when the penis was nearly amputated by the missile. "If bleeding should take place in the progress of the cure, a large catheter should be introduced into the urethra, as a point on which pressure may be made laterally; for I am not aware of any other use it can be, unless the urethra be also torn, when a moderate-sized catheter should be kept in it permanently, if it can be borne, to aid in the healing of the surrounding parts, with as little contraction as possible of the canal. When the corpus spongiosum has been carried away, or sloughs with the urethra, there is usually some injury done at the same time to the corpora cavernosa, and the part becomes contracted, and curved when distended. Several of these cases might be benefited by the formation of a new urethra by borrowing from the neighbouring parts after the practice recommended by Dieffenbach." (*Commentaries*, p. 594-5.) A ball passing transversely through the corpora cavernosa causes little inconvenience, and the wound heals favourably. There is usually a deficiency of substance of the part after such wounds, and sometimes an inconvenient curve or twist during erection, such as often takes place when the corpora cavernosa and the corpus spongiosum are injured or ruptured from other causes. (Op. cit. p. 595.) Bullet or shell wounds where extensive laceration of the perinæum is produced, opening the urethra near the bladder, and causing extravasation of urine, will generally terminate unfavourably. Many of these present little or no chance of recovery from the commencement, and admit of but little aid from the surgical art. In all cases where the urethra is opened near the bladder, an attempt must be made to discover the opening, in order that an elastic gum catheter may be passed without delay into the bladder, so as to prevent or arrest extravasation of urine into the areolar tissue of the pelvis or perinæum. For this purpose the wound must be enlarged if necessary, in order to discover the opening into the urethra.

The perinæum may be extensively lacerated, and the bones of the pubis and ischium fractured, without any injury to the urethra, or scarcely any abrasion of the skin, as happened to a cavalry soldier at Goojerat by a round shot. The soft parts of the perinæum sloughed, but recovery took place.

In some cases of wound of the perinæum occurring at Sebastopol, partial or complete division of the sphincter ani was found to be necessary before the cure could be effected.

The following returns of gunshot wounds of the perinæum and genito-urinary organs without fracture of the pelvis or wound of the abdomen, from Sebastopol, occurring in men and officers, shows a considerable mortality; but the fatal cases were the result of large contusions and lacerations of the perinæum, involving the urinary apparatus, and chiefly inflicted by shell.]

Non-commissioned Officers and Privates.

	Total treated.	DIED.		Total died.	Discharged to duty.	Invalided.
		In the regimental or primary hospitals.	In the secondary hospitals.			
Wounds of the perinæum and genito-urinary organs.	55	16	1	17	23	15

Commissioned Officers.

	Total treated.	Total died.	Discharged to duty.	Invalided.
Wounds of the perinæum and genito-urinary apparatus	1	0	1	3

GUNSHOT INJURIES OF THE HEART AND LARGE BLOOD-VESSELS.

[Wounds of the heart are almost always instantly fatal. Some rare instances, however, are recorded where recovery has followed even after severe lesions of this organ. The muscular structure has been perforated, and musket-balls have lodged in its substance, and cicatrices have been discovered after death in persons known to have been wounded in its vicinity, which indisputably show that very considerable lesions of this structure are not necessarily fatal. The diagnosis of these injuries is difficult, and most generally little more than conjectural, but through the instrumentality of the stethoscope some light may be thrown on the nature of the injury.

The symptoms of gunshot wounds of the heart are described to be fainting, palpitation, irregular movement, or total cessation of its action, coldness of the extremities, ghastliness of countenance, succeeded by great anxiety or sense of anguish, intermission or cessation of the pulse. Should the patient survive, and reaction come on, the pulse increases in frequency and force of beat; the anxiety is increased by pain of the part, which is sometimes intolerable. (*Guthrie*, *Commentaries*, ed. 6, p. 510.)

M. Fournier mentions (*Cas Rares*, *Dictionnaire des Sciences Médicales*) the case of a soldier who had a ball lodged in the right ventricle near its apex, and who survived six years, dying at the end of that period of another disease. For the first three years after the receipt of the wound he was harassed with palpitation. Chastenet, a French army surgeon, relates the case of a soldier, the right ventricle of whose heart had been penetrated by a bayonet, and who died at the expiration of fifteen days, from mortification of the lower extremities, apparently the result of cold and languid circulation. At the post-mortem examination the lung, pericardium, and heart were discovered to be wounded, but there was no sign of effusion into the surrounding parts. In the 14th volume of the *Edinburgh Medical and Surgical Journal*, another case is related where the right ventricle was perforated to the extent of an inch in length near the origin of the pulmonary artery; the ball was found in the pericardium; the tricuspid valve had a circular lacerated opening in it. The recipient of this injury was a soldier who had been wounded in Spain, and died at Plymouth the fourteenth day after the injury. These are some of the extraordinary examples of wound of this organ which have been recorded; they are extreme instances of what nature can bear, and we must not suppose that such favourable results are often likely to occur.

Dilatation of the heart is said sometimes to be produced by blows on the back or sternum, and death may occur from the shock of a blow over the region of this organ.

Treatment. — If the injury is the result of a musket-ball, the wound must not be closed, although pressure may be made upon it for a time with a view to the suppression of the external flow of blood; although this succeeds, it is more than probable the hæmorrhage will continue internally, and lead to the death of the patient after much suffering, principally from the oppression caused by the escape of blood into the cavity of the chest. If the wound be a stab, the external opening may be accurately closed and the escape of blood prevented; but as the pressure of the blood in the pericardium is unequal to restrain the action of the heart, blood forced out through the opening fills the cavity of the pleura, and produces suffocation, unless from some accidental circumstance the aperture in the heart becomes obstructed, and the flow of blood thereby arrested. There can be no doubt of the propriety of closing the wound in the first instance, if the hæmorrhage be excessive and likely to endanger life; and the wound must be reopened after a time if the danger of suffocation be imminent. (*Guthrie's Commentaries*, 6th ed. fol. 511-12.) This was the practice pursued by Dupuytren with the Duc de Berri, the right ventricle of whose heart was wounded, and who died from loss of blood: it was found requisite to reopen the wound every two hours to prevent suffocation.

All extraneous matters should be removed from the wound where possible, and inflammatory symptoms subdued by general and local bloodletting, calomel and opium, and antimony. Auscultation and percussion are to be employed, and if the cavity of the pleura or pericardium should be found filled with blood or other fluid, it must be evacuated in order to give the patient the chance of life. Gunshot wounds of the large arteries are very generally followed by speedy if not instant death; rare exceptions, however, occur. The most remarkable instance perhaps of recovery after such injury is that recited by Guattani in his work *On Aneurism*, where a patient survived a wound of the aorta for eight years. Wounds of these large vessels pour out the blood so rapidly, especially the large arteries in the cavities of the body, that there is scarcely a chance of life, the victims of such injuries dying on the field before assistance can be rendered. How these vessels escape being wounded sometimes is a source of surprise amongst military surgeons. This immunity from injury is partly due to the elasticity of their coats, but principally to the ready manner in which they can be pushed aside by the passing ball, owing to the loose areolar tissue which connects them together and to the surrounding structures. I had a case of this kind under my care during the Crimean war, where a bullet passed between the subclavian artery and vein without injury to either, at the point where these vessels pass over the upper edge of the first rib.

In cases where a round shot or sabre injures or divides a large vessel, such as the carotid or femoral artery, immediate death is almost always the consequence; some instances to the contrary, however, are related. Larrey mentions a case in his *Mémoires* where the external carotid was divided at its point of separation from the internal; a soldier immediately applied pressure with his fingers, and Larrey's bandages eventually saved him. Mr. Hennen speaks of an officer who was wounded in the carotid by an arrow, and who owed his life to similar assistance.]

Wounds of the main arteries of the limbs or neck usually require both ends of the divided vessel to be secured with a ligature, if pressure fails to arrest the hæmorrhage. A ligature on the femoral artery, however, may sufficiently check the current of blood through the popliteal artery to put a stop to hæmorrhage from a wound in it; and though such practice in some other cases of wounded arteries is inefficient, on account of the facility with which the blood passes through the anastomoses into the part of those vessels below the ligature (see ARTERIES), its general success, in gunshot wounds of the ham, is very encouraging, not only on account of the difficulties of taking up the popliteal artery itself (difficulties ably depicted by Scarpa), but because laying open the inflamed and diseased parts would frequently have a fatal termination. Dupuytren and Delpech, on the latter principle, have in several instances taken up the femoral artery for the stoppage of bleeding from the tibial arteries in compound fractures, and with complete success. In University College Hospital, I took up the popliteal artery for the suppression of repeated and profuse hæmorrhage from the posterior tibial artery, which had been divided in a lad, who, as he was cleaning a window, slipped, and his leg passed through the glass, and the posterior soft parts were divided down to the bone. As the bleeding ceased, the wound was dressed, but, in consequence of returns of hæmorrhage, the house-surgeon made several unsuccessful attempts to secure the ends of the artery, and the wound had at length assumed a formidable appearance, with considerable swelling and tendency to gangrene. I therefore preferred tying the popliteal artery. The result was entirely successful, no recurrence of bleeding having been experienced. At the same time, I would have surgeons always recollect the important difference between an aneurismal and a wounded artery; for as, in the first case, there is no outlet for the blood, the transmission of this fluid into the part of the vessel below the ligature may keep up a pulsation in the tumor, and retard the cure of the disease, but is attended with no risk of hæmorrhage; while the same free passage of the blood into the wounded portion of a large artery would give rise to dangerous bleeding; and hence the general necessity of applying two ligatures, one immediately above, the other below, the aperture in such a vessel. A single ligature on the brachial artery fails, as I had an opportunity of seeing in Holland, in a case of gunshot wound, where either that vessel, or the commencement of the radial or ulnar, gave way, on the loosening of the sloughs; and, as there was considerable swelling, œdema, and inflammation of the limb, threatening gangrene, the surgeon under whose care the patient was, deemed it right to perform amputation.

I should be sorry if these observations were to hold out any general encouragement of the wrong and dangerous practice of applying only one ligature above a wound in a large artery, or in any recent case of *false diffused* aneurism. The remarks delivered above are chiefly intended to refer to gunshot wounds of the ham, with injury of the popliteal artery, and hæmorrhage first breaking out several days after the receipt of the wound, when all the parts behind the knee are enormously swollen, and in a state of inflammation and suppuration. Here the hope of avoiding any additional violence, or injury to the diseased parts behind the knee, may be a good reason for taking the chance of stopping the bleeding by a ligature applied to the femoral artery; a reason, however, which would not exist in the case of a recent wound of the popliteal artery with a knife. At the same time, I believe this means of checking the current of blood will not always suffice, and that occasionally either the dangerous expedient of cutting open the swelling in this diseased state of the ham, and of applying a ligature above and below the aperture in the popliteal artery, must unavoidably be encountered, or amputation performed. Why the first plan has answered in some cases, and not in others, may depend upon the size and condition of the wound, or opening in the artery, and, in examples of sloughing, upon the degree in which the tube of the vessel may have been closed by the adhesive inflammation. Some wrong conclusions may also have been made respecting the trunk of the vessel being wounded or opened, while in fact only a branch of it was concerned.

[In quoting the following remarks from the *Surgical History of the Crimean War* (p. 345), I would mention that they embody the acknowledged practice for all military surgeons to follow, and that the cases referred to by Mr. Cooper are exceptional ones. "When an artery is primarily wounded and bleeds, it is presumed no surgeon will now dispute the propriety of tying both ends of the vessel at the wounded point. The late Mr. Guthrie has, however, laid it down that this is not to be done unless it bleed, inasmuch as the hæmorrhage once arrested may not be renewed."

Gunshot wounds of arteries sometimes lay the foundation for false or varicose aneurism. Hennen records a case where this condition followed a wound of the femoral, and in the *Bulletin de la Faculté de Médecine* of Paris, another case is given in which it was the result of a wound of the carotid artery. A case occurred in the 4th Regiment before Sebastopol of wound of the profunda femoris, two inches from its origin, which was followed by the formation of an aneurism at the wounded point.

Wounds of veins of the extremities or neck, however large, may always be checked by properly applied pressure; in general they are easily managed, and the hæmorrhage controlled by pressure and position. The amount of bleeding from very large veins is sometimes very inconsiderable. In a case under my care before Sebastopol, in which the subclavian vein, near its origin, was perforated by a bullet, the hæmorrhage was very trifling, and the slightest pressure arrested it. Inflammation of the vessel followed, however, and the man eventually died.

A varicose state of the veins is apt to occur after gunshot wounds. Dr. Hennen gives several cases, and states that it not unfrequently happens.

TABLE showing the number and results of cases of Direct Injury to the Larger Arteries, not being at the same time cases of compound fracture, which came under treatment from 1st April 1855 to the end of the Crimean War, in Men and Officers.]

Total treated.	DIED.		Discharged and re-admitted for amputation.	Invalided.
	In regimental hospitals.	In secondary hospitals.		
13	9	0	2	2

GUNSHOT INJURIES OF JOINTS.

[Amongst the great variety of severe injuries that are met with after an action, perhaps none possess more interest than wounds of the articulations, owing to the numerous successful operations which have been performed for their removal by the Germans in the Schleswig-Holstein campaigns, the French in Algiers, and ourselves recently in the Crimea.

These injuries are, however, seldom confined to the joint; they most usually implicate more or less of the cylinder of the bone as well; but even such lesions, which do not involve too great an extent of the shaft, may be suitable cases for excision, and some most successful operations of this nature have been performed. These wounds are in the present day somewhat shorn of their terrors, for they were looked upon by the old army surgeons as mortal; nevertheless they do form a class of cases entailing much anxiety on the surgeon who is called upon to treat them, as to the best proceeding to be adopted in the management of each particular case. Great triumphs have already been achieved, and by this great advance in operative surgery the science of our art has been elevated, and the possibility of preserving a limb, or portion of a limb, for the unhappy sufferer, must ever enlist our best exertions for its further improvement and extension if possible. Still happier results may yet be accomplished by a more careful selection of the cases, greater skill in their performance, and more judicious after-treatment.

The gravity of these injuries is not always manifest in the first instance; a slight wound may be, and often is, followed by quite as severe symptoms as in those cases where there is a more extensive original lesion of the joint. This forms one of the difficulties in determining what is the best line of treatment to be followed: one is loth to excise a joint for very partial injury of the bones and soft structures, yet when inflammation is set up, and suppuration of the entire articulation is established, the case then often becomes quite as severe in its consequences as where the wound and destruction of the deeper parts were of much greater magnitude in the first instance. As a general rule, the danger of these wounds of joints will depend chiefly on the size and complexity of the articulation affected, the extent of the injury, and the period which has elapsed since the receipt of the wound. Wounds of the ginglymoid articulations are considered to be more severe than those affecting the ball and socket joints, chiefly from their greater extent and more elaborate construction. Larrey has remarked that tetanus often followed their injury.

Hip-joint. — Severe compound fracture of the head, neck, and trochanters, or of the head and neck of the thigh-bone, or of the neck and upper part of the shaft without fracture of the head, which latter is a much more common injury, the head of this bone not being often implicated in the fracture, are all suitable cases for excision. Mr. Guthrie expresses his opinion strongly in favour of this operation in preference to leaving the case to nature, or performing the more severe operation of amputation at the hip-joint. (*Commentaries*, ed. 5. p. 81.) Esmarch considers that excision of the head of the femur ought to be performed in preference to exarticulation, although the single case operated on in the campaigns in the Duchies terminated unfavourably, whereas, out of seven exarticulations, one, a healthy young soldier seventeen years of age, survived the operation. (p. 94.) The experience of the Crimea is in favour of its performance; of six cases operated on, one recovered, and it was supposed would have a tolerably useful limb; another, a case of my own, lived five weeks after the operation, and was doing well until suppuration of the knee-joint supervened. In all the before-mentioned cases a portion of the shaft of the femur was included in the excision, in my own case about one-fifth. Seutin removed as much as six inches of the shaft in one case. In comparing the results of this operation with exarticulations of the limb performed in the English army during the Crimean war, we find the whole of the latter terminated fatally, the longest surviving the operation only thirty-six hours. The French are stated to have had thirteen primary and secondary amputations at the hip-joint after the battles of the Alma and Inkermann, all of which ended unfavourably. Stromeyer recommends resection of the head of the femur even when the fracture barely extends into the capsule, as suppuration is sure to be set up in the articulation, and produce death by exhaustion.

The objection that has been made to excision of the head of the femur—that the limb is rendered useless after the operation, even if recovery takes place—can hardly be entertained with reference to this particular injury. Indeed, it may even be questioned whether absolute inutility of the limb is always the inevitable result of such operations. It is to be hoped that after a sufficient interval of time has elapsed to allow of consolidation of the parts, and the limb has been duly exercised, certain amount of motion, strength, and usefulness of the new joint may be regained. The true aspect in which this operation must be viewed, as has been remarked by Dr. Macleod, is, that, as far as results at present inform us, it is the only one which affords a chance of saving life.

Excision of the knee-joint has seldom been performed by military surgeons, though it has been so repeatedly and successfully executed in civil life for disease. A single operation of this nature, a secondary case, was the only one attempted during the Crimean war, and this unfortunately ended unfavourably. The Germans, during the second campaign of the Schleswig-Holstein war, performed this operation once, and likewise with a fatal result. So that up to the present time military experience of this operation has been very small and very unsatisfactory. The following are cases which, under favourable conditions, require the performance of resection: where a bullet has entered the joint and slightly injured the bone, or where, besides an injury of the capsule merely, a slight grazing or contusion of the bone has taken place. Bullets lodging in the heads of the bones, after entering the capsule, with or without fracture of the articular ends of the bones, but not extending into the shaft, seem also suitable cases for resection. Stromeyer does not recommend resection of this joint for gunshot injury, as, according to him, it affords little hope, even under favourable circumstances, and because in the majority of cases it cannot be certainly known how much of the bone should be sawn off. (*Translation by Statham*, p. 31.) The principal objections which military surgeons have to its performance seem to be the long period necessary to effect a cure, the absolute necessity there is for the perfect repose of the limb, and the very careful treatment requisite during the healing process, all of which are seldom attainable in army practice.

Resection in the continuity of the femur was practised in three cases during the Holstein campaigns, and all were fatal. The great depth at which this bone lies, and the large muscles which surround it, render it very unsuitable for any operation of this nature. Dr. Macleod states that resections of the shaft of the femur were invariably fatal in the Crimea. Esmarch does not recommend excision for any of the smaller shafts of the hand and foot, as hæmorrhage may follow only to be controlled by amputation of the hand or foot. Resection of the ankle-joint has not to my knowledge been performed in military practice. Penetrating wounds of this joint, according to Dr. Macleod, "generally did well in the Crimea, although they required long treatment. Great attention was paid to keeping the articulation perfectly immovable, and to the enlargement of one or other of the wounds, so as to allow of the free escape of all discharges." Comminuted fracture of the astragalus, and, according to Mr. Guthrie, the lodgment of a ball in that bone at a great depth, which cannot be extracted, are both cases which call for the removal of that bone. Ablation of the os calcis may be requisite for the corresponding injuries of that bone. I have seen the half of this latter bone excised for comminuted fracture; the wound healed speedily, and left a good use of the foot. Should the injury include the astragalus and os calcis, both bones must be removed. Mr. T. Wakley has published a very interesting case of this kind from disease, where the patient walked well after the operation. The remaining bones of the tarsus may be removed in like manner for similar injuries. (Vide *Guthrie*, op. cit. p. 101.) Mr. Statham has performed the operation of resection of the ankle-joint successfully for disease. He recommends the flaps to be so made as to fall naturally in place after the operation without the use of sutures, and is of opinion that the limb should never be moved from the splint during the progress of cure. He also enjoins good diet after the operation, and frequently prescribes stimulants as well. If diffuse inflammation comes on, he recommends the patient to be put on the best stimulating and nourishing diet, though the inflammation be at its height, at the same time that abstraction of blood, poultices, &c. are employed locally. Iron, acids, and quinine should be given to enable the patient to assimilate the food he swallows. (*Statham*, p. 120.)

Excision of the Head of the Humerus.—Fractures of the head of the humerus, or cases where a bullet perforates or lodges in it, the main blood-vessel and nerves being uninjured, are very favourable cases for resection. M. Baudens states that excision should be the rule here, and amputation the exception. Mr. Guthrie expresses a similar opinion. The experience of the surgeons of the Schleswig-Holstein war was very favourable to this operation. Out of 19 cases 12 recovered, and a more or less useful arm was preserved. In some of the cases the wound healed in from two to three months. Complete ankylosis occurred in none. Some of the patients could perform heavy work afterwards. In the seven fatal cases the resection was made at the period of highest inflammation, or when the patients had become affected with pyæmia. In eight cases which were left to nature without operation, three did not prove fatal, but at the end of six months amputation of the affected limb was still considered likely to be called for. In some of these resections as much as four or five inches of the shaft of the humerus was included, and in the majority of the successful cases a greater or less amount of the shaft was affected. (*Esmarch, translated by Statham*, p. 65.) Of the 14 cases published by Baudens, 13 recovered, possessing an imperfect ginglymoid joint, but with the loss of the rotatory movements of the shoulder. This able surgeon objects to the division of the long tendon of the biceps muscle in the operation, and the surgeons of the Schleswig-Holstein campaigns always preserved this tendon entire, although they did not consider its preservation absolutely essential to the future mobility of the limb, as shown by three cases where the tendon was torn away by the ball. On the cure being completed, the patient soon obtained free and voluntary use of the arm. (*Esmarch*, p. 67.)

The results of resections of the head of the humerus before Sebastopol were very satisfactory. Of 13 cases 12 recovered, and were sent to England; the remaining one died. Highly favourable results these, when we take into consideration that formerly all these cases would most probably have undergone exarticulation at the shoulder-joint.

Where the scapula is extensively injured, and the injury is accompanied with fracture of the head of the humerus, resection, according to Stromeyer, is not successful. A single case of this kind where excision was resorted to, before Sebastopol, had a fatal termination.

Resection of the Continuity of the Shaft of the Humerus.—Stromeyer is of opinion that extensive resections of the shaft of the humerus should never be practised in fresh wounds; the attention, he says, should be confined to the extraction of fully loose sequestra, and to the removal by the saw of the sharp points of bone. I cannot find recorded a single case where any large portion of the shaft of the humerus was removed during the Crimean war. Dr. Macleod, however, mentions that several cases resulted very favourably where parts of the shaft of the humerus and bones of the fore-arm were excised. I removed as much as three and a half inches of that bone, including in the resection the upper half of the deltoid impression, in a case of very bad compound fracture caused by a fragment of shell. The bone was comminuted and split to rather more than that extent. The wound healed in the most perfect and rapid manner, and the case soon lost its compound character. This soldier was invalided to England, and afterwards discharged the service, and I saw him again at the end of a year with a but little shortened limb. There was almost perfect consolidation of the divided ends of the bone, and all the underhand movements of the arm had been restored, and he was obtaining a livelihood by breaking stones on the road.

Resection of the Elbow-joint.—Baudens was of opinion that resection should only be performed where one alone of the three joint ends is injured. It was recommended as a rule, in all cases where a bone in this joint was injured, by the surgeons in the Schleswig-Holstein campaigns. When the ulna alone was shattered, the corresponding portion of the radius was removed, but seldom more than the head of that bone except in cases where the ulna had been comminuted, when the neck was likewise excised. If the radius was comminuted below the neck, the fragments were extracted, and the uneven projections removed by the saw; the ulna was not sawn off at the same level, but a piece from the olecranon only was removed, as otherwise this protruded in a troublesome manner during and after the healing. As on the ulna depends especially the strength of the elbow-joint, it was not found necessary to saw this bone off so low as the radius. A very small portion of the trochlea humeri was excised; in many cases the humerus was untouched, the cartilage merely being shaved off by the knife. This latter proceeding, however, seemed to have no influence in the production of a more rapid recovery. (*Stromeyer*, p. 24.) In cases where the injury involved only the humerus, one or other condyle being shattered, the fragments were removed and the humerus sawn off at the place where the fissures nearly terminated. By this means nearly an inch in its length was preserved. A piece was still removed from the olecranon, though uninjured. A portion of the wound was then united by interrupted suture, the lower part being left open for the escape of the discharge.

Partial resection of the elbow-joint, according to Esmarch, was not followed by such good results as complete removal of the ends of all the bones entering into the formation of the articulation. We ought not, he says, "to be content with a partial resection of the wounded parts, for in my opinion it is indeed the extensive severing of the ligamentous apparatus of the joint which deprives the wound of its danger, and the less there is removed from the ends of the bones, the greater is the probability of ankylosis. Partial resection was twice tried, and although both cases terminated favourably, yet their progress showed that such an operation is in no respect preferable to the entire division of the articular capsule, perfect ankylosis occurring in both cases, and the process of healing being far more tedious than in resection of the entire joint." The experience of the Crimea was in conformity with this opinion. Dr. Macleod says: "Partial resection—of which there were a good many cases—did not, I think, turn out, on the whole, at all so well as complete ones. They were more tedious, more liable to fail, and less satisfactory when they succeeded, than when the whole articulation was removed." Amputation of the arm had to be performed in two cases after partial resection of the joint, during the Crimean war: in one case, however, where the heads of the radius and ulna were fractured by a rifle-ball which passed across the joint, the broken fragments were removed, and the humerus left entire; the patient, at the end of three months, was discharged with a good joint, which admitted of considerable latitude of motion, and could sustain no small weight.

The resections of the elbow-joint were remarkably successful when considered alone, but still more so when compared with the results of amputation of the arm during the Schleswig-Holstein war. Of 40 resections 6 only died, while out of 54 amputations of the arm 19 terminated fatally. During the latter half of the Crimean war there were 20 resections of this joint, partial and complete, 3 of which died, whereas out of 102 amputations of the arm 27 died. It seems then clearly established by these results, that the preference should always be given to excision in this articulation, in every case where such a proceeding is possible. As to the extent of the shaft that can be removed along with the particular ends of the bone, Esmarch states that as much as four or five inches were taken away both from the humerus and ulna and radius, where they had been struck off by a bullet: in one case a piece of four inches in length was removed. (Op. cit. p. 81-2.)

In the treatment of these injuries after the operation, the most important point to attend to is securing to the patient the most absolute quiet and complete position. The arm is to be laid in the prone position upon a wooden splint, extending from the upper third of the arm to the fingers' ends, at an obtuse angle at the elbow of 140 degrees, and secured to it by a bandage. Esmarch recommends in the first instance cold, and afterwards warm, water dressing, and, when the suppuration diminishes, charpie and oil. After the wound is filled with granulation, and cicatrisation has commenced, the arm is to be carefully raised from the splint, and a flannel roller applied. Passive motion is to be commenced early, very limited at first, and to be increased gradually every day, in order to insure the usefulness of the arm. The general treatment as practised by the Schleswig-Holstein surgeons was strictly antiphlogistic. (*Esmarch*, p. 57.)

In the cases which were operated on during the campaign in the Duchies, the hand could be raised to the mouth before the wound was closed. Pyæmia was the cause of death in most of the seven failures. (*Esmarch*, p. 68.) Of the six operated on in the first twenty-four hours, two were fatal; on the third or fourth day, three were performed, with two fatal cases. Secondary operations after the full occurrence of suppuration were performed ten times, with three fatal results; so that the secondary resections were more favourable than the primary ones. The resections of the left elbow were most fatal: six out of twelve died, and only one out of seven resected on the right side had an unfavourable issue.

Excision of the Carpus, Metacarpus, and Phalanges.—A musket-ball perforating the carpus may so fracture several of the bones, that either amputation of the hand or the removal of the broken bones by excision, may become necessary. Mr. Stanley, in one case of disease of these bones, took away all of them except the trapezium, and even divided the extensor tendons, which reunited, and left a remarkably good motion of the hand and fingers; but in gunshot wounds such perfect and satisfactory results can hardly be expected, as more or less of the tendinous structures slough away, owing to the destruction of their vitality at the time of the injury. Bullets perforating the metacarpus will generally fracture two of these bones; in such cases the shattered ends of the fracture may be excised with the forceps or sawn off, or the entire metacarpal bone, should the injury be sufficiently extensive to require it, may be removed. As before stated, Esmarch does not advise resection for any of the smaller shafts of the hand, owing to the fear of hæmorrhage after the operation. Langenbeck removes the ends of the metacarpal bone and head of the first phalanx, or the distal end of the second and whole of the third phalanx, leaving the nail: the patient recovers with a shortened but useful finger.

It should be our especial aim in all injuries of the hand to preserve as much as possible; a finger, or portion of a finger, will be infinitely more serviceable than any mechanical appliance we can afterwards adapt to the stump. In many of the injuries of the hand the integuments are so much lacerated and contused as to render them very unsuitable cases for any attempt at preservation; under such circumstances we must of necessity have recourse to amputation.]

[TABLE showing the number and results of cases of Resection of Bones in the English Army during the Crimean War, from 1st April 1855 to the end of the War.]

Non-commissioned Officers and Privates.

	Total treated.	Died.	Recovered.	Discharged and re-admitted for amputation.
Head of Humerus	13	1	12	0
Head of Humerus and part of Scapula	1	1	0	0
Shaft of Humerus, 3½ inches	1	0	1	0
Elbow-joint	17	3	12	2
Upper articular end, Radius and Ulna	1	0	1	0
Head of Radius	1	0	1	0
Internal condyle of Humerus	1	0	1	0
Part of Carpus and Metacarpus	3	1	2	0
Head of Femur	6	5	1	0
Knee-joint	1	1	0	0
Lower end of Fibula	1	0	1	0
Os Calcis and part of Astragalus	1	0	1	0
Os Calcis	1	0	1	0
Total	48	12	34	2

[THE USE OF CHLOROFORM IN OPERATIONS FOR GUNSHOT WOUNDS.]

[This anæsthetic agent was very generally used for annihilating pain during the performance of severe operations, both by the French and English surgeons, in the recent war in the Crimea. The experience of the former has been by far the most extensive, and according to their published account its employment has been followed by more fortunate results than has been the case in the English army. M. Baudens states that it was administered more than twenty-five thousand times without one fatal case occurring; "son triomphe a été complet," he remarks in reference to its great utility. In our own army it was employed in nearly every operation of magnitude in all except the 2nd Division, and in that more than one half of the operations were performed under its influence. A prejudice seems to have existed in the minds of some one or two of the surgeons against its use, from having witnessed a fatal case in a soldier who had undergone the operation of amputation of the finger, and this seems to have been the only indubitable case attended with a fatal result which can be strictly charged to its account. Others have been referred to, but as they were all instances of very formidable wounds, it is difficult to determine whether the fatal issue was owing to the poisonous influence of this agent, or due to the severe depression and loss of blood following the injury. In serious wounds it appears to have been the impression of most surgeons of experience that chloroform has a sustaining property rather than otherwise, and enables the sufferer to submit to the operation with better prospects of success than if he had not been brought under its influence; but, as I have already mentioned, some one or two surgeons who had obtained considerable experience in operative surgery in the field, were impressed with the belief that it had deleterious effects when employed during the depression ensuing upon severe injury, although their objection, I believe, did not extend to its use in other cases. (See *Proceedings of the Army Medical and Surgical Society*, *Lancet*, July 19, 1856, p. 78—80.) In the cases detailed in support of this view, there appears to be a want of careful discrimination between the effects of chloroform and the depression consequent on very dangerous operations, superadded to extensive injury and copious hæmorrhage. There can be no doubt that many of the tedious and painful operations, such as excision of joints, were much more readily, carefully, and safely performed in the passive condition of the patient induced by the agency of this drug, than if the operator had had to contend with the writhing and convulsive movements of the sufferer; and the absence of pain during the operation, and generally for some time after the return of consciousness, must place the patient in a better position for recovery than if he had undergone the exhaustion consequent upon the agony and excitement of the operation. Such certainly appeared to me to be its effects in all the operations I myself performed or witnessed by others, and these views are confirmed by the French, and by the large majority of the English army surgeons. We must not, however, be insensible to, or undervalue, the dangers arising from its use ; great caution should be adopted in its administration, the recumbent posture should be especially enjoined, and a watchful attention kept up, both with regard to the pulse and respiration, as well as to the sufficient supply of atmospheric air to the patient during the inhalation. In these cases, where much blood has been lost, this caution becomes even more necessary, owing to its rapid absorption in such persons.

It seems hardly necessary to combat the objections put forward by some, that it favoured secondary hæmorrhage, and that its employment led to the production of pyæmia, as alleged by others : no sufficient proofs have been established to warrant such inferences.

“ In the prolonged searches which are sometimes necessary for the extraction of foreign bodies, chloroform is useful, not only in preventing pain, but also in restraining muscular contractions, by which obstacles are thrown in the way of the extraction, which did not oppose themselves to the introduction of the body. Then much is gained in field practice by the mere avoidance of the patient's screams when undergoing operation, as it frequently happens that but a thin partition, a blanket, or a few planks, intervene between him who is being operated on, and those who wait to undergo a like trial. Thus, when, as after a general engagement, a vast number of men come in quick succession to be subjected to operation, it is a point of great importance to save them from the depression and dread which the screams and groans of their comrades necessarily produce on them.” (*Macleod*, *Notes on the Surgery of the War in the Crimea*, p. 134-5.)] *Geo. E. Blenkins.*

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GUAIACUM. Many writers of the sixteenth century contended, that guaiacum was a true specific for the venereal disease; and the celebrated Boerhaave, in the eighteenth, maintained the same opinion. Mr. Pearson mentions, that when he was first intrusted with the care of the Lock Hospital, in 1781, Mr. Bromfield and Mr. Williams were in the habit of reposing great confidence in the efficacy of a decoction of guaiacum wood. This was administered to such patients as had already employed the usual quantity of mercury; but who complained of nocturnal pains, or had gummata, nodes, ozæna, and such other effects of the venereal virus, connected with secondary symptoms, as did not yield to a course of mercurial frictions. The diet consisted of raisins and hard biscuit; from two to four pints of the decoction were taken every day; the hot bath was used twice a week; and a dose of antimonial wine and laudanum, or Dover's powder, was commonly taken every evening. Constant confinement to bed was not deemed necessary; neither was exposure to the vapour of burning spirit, with a view of exciting perspiration, often practised; as only a moist state of the skin was desired. This treatment was, sometimes, of singular advantage to those whose health had sustained injury from the disease, long confinement, and mercury. The strength increased; bad ulcers healed; exfoliations were completed; and these anomalous symptoms, which would have been exasperated by mercury, soon yielded to guaiacum.

Besides such cases, in which the good effects of guaiacum caused it to be erroneously regarded as a specific for the lues venerea, the medicine was also formerly given by some on the first attack of the venereal disease. The disorder being thus benefited, a radical cure was considered to be accomplished; and, though frequent relapses followed, yet, as these partly yielded to the same remedy, its reputation was still kept up. Many diseases also, which got well, were probably not really venereal cases. Mr. Pearson seems to allow, that, in syphilitic affections, it may, indeed, operate like a true antidote, suspending for a time the progress of certain venereal symptoms, and removing other appearances altogether; but he observes, that experience has evinced, that the unsubdued virus yet remains active in the constitution.

Mr. Pearson found guaiacum of little use in pains of the bones, except when it proved sudorific; but that it was then inferior to antimony, or ammonia. When the constitution has been impaired by mercury, and long confinement, a thickened state of the ligaments, or periosteum, or foul ulcers, still remaining, Mr. Pearson says, these effects will often subside during the exhibition of the decoction. He says, it will often suspend, for a short time, the progress of certain secondary symptoms of the lues venerea; for instance, ulcers of the tonsils, venereal eruptions, and even nodes. Mr. Pearson, however, never knew one instance in which guaiacum eradicated the virus; and he contends, that its being conjoined with mercury neither increases the virtue of this mineral, lessens its bad effects, nor diminishes the necessity of giving a certain quantity of it. He has seen guaiacum produce good effects in cutaneous diseases, ozæna, and scrofulous affections of the membranes and ligaments. (See *Pearson, On the Effects of various Articles in the Cure of Lues Venerea,* edit. 2. 1807.)

[It will be observed, that the virtues attributed to guaiacum in the preceding article are manifested chiefly in the treatment of the tertiary order of symptoms, or syphilitic cachexia, in which the iodide of potassium has of late years proved so eminently successful and almost superseded other remedies. As regards the failure of guaiacum to eradicate all cachectic symptoms, this want of power is shared with iodide of potassium, mercury, sarsaparilla, and all other remedial means. (See SYPHILIS.)]

GUMMA, a soft tumor, so named from the resemblance of its contents to gum. (See SYPHILIS.)

GUMS, INFLAMMATION AND ABSCESS OF. *Gumboil. Parulis.* Inflammation of the gums mostly arises from the irritation of carious teeth, but sometimes from necrosis of a part of the alveolar process, or from the splintering of it, occasioned by the extraction of a bad tooth. Sometimes it originates from exposure to cold, and in other instances from mechanical irritation. When the inflammation, arising from the irritation of a decayed tooth, cold, and some other causes, proceeds to suppuration, the case is then an abscess, here termed a *gumboil.* The treatment consists in making an early puncture for the discharge of the matter, and, after the subsidence of the inflammation, in extracting any bad tooth concerned in keeping up irritation. The mouth is to be frequently cleansed with an astringent gargle. If a fistula form in the gums, it is to be freely divided, and touched with the nitrate of silver, care being taken, however, before resorting to this measure, to remove any carious tooth, splinter, or dead portion of bone, which latter proceeding will, generally, supersede all necessity for laying open the fistula.

GUMS, TUMORS OF. A very common disease is a thickening of the gums at some particular point, which puts on the form of an excrescence, and generally assumes a hard callous nature. Some of these swellings are connected with the periosteum, or bone, and are disposed to acquire a malignant character; frequently, after they have attained a certain size, the neighbouring part of the bone becomes altered and softened. Other tumors of the gums are merely excrescences from the fibro-vascular texture of these parts, not penetrating deeply, not connected with the bone, periosteum, nor sockets of the teeth, and not malignant. The excrescence of the gums then, termed *epulis*, is of very different character in different cases; but, as many tumors of the gums, apparently trivial at first, become fatal diseases in the end, if neglected in their beginning, the rule in surgery is to attempt their extirpation, before they have made considerable progress.

On this subject Sir Charles Bell has made some interesting remarks. "We see (says he) a small tumor of the gums, stationary for a long time, and claiming no attention, at last forcing its way into the bones of the face, filling up the cells and the cavities of the nose, pressing out the eyes, and rising at last upon the base of the brain itself," so as to destroy the patient. The worst diseases of the gums, according to Sir C. Bell, do not come from the irritation of a bad tooth. "We see a carious tooth, attended with ulcer and gumboil, and abscess in the jaw; with fungous tumor of the gums; even with necrosis of the jaw. We find the inflammation from the same source amounting in severity of pain to that of tic-douloureux. But these are of no account, compared in danger with this tumor of which I am treating. This more formidable disease begins when the adjoining teeth are apparently sound, and when we cannot trace it to any common source of irritation. This tumor first shows itself in a small hard prominence of the gum, shooting out betwixt two of the teeth; and the teeth being good is an unfavourable circumstance; for when they have become loose and are displaced, without being themselves diseased, it implies that the cause is deep, and not to be removed by pulling out the teeth. If the teeth be carious and originally in fault, we have a reasonable expectation of arresting the progress of disease by removing the teeth; but when, independent of the teeth, the tumor has its origin in the membrane of the fang, or in the socket, we cannot hope to extirpate the disease, without removing the whole system of parts," the tooth, the gum, and the adjacent portion of the jaw. (See *Sir Charles Bell's Surgical Obs.* p. 413, 8vo. Lond. 1816.) A perpendicular division of the alveolar process is to be made at a prudent distance from each side of the tumor, and to the requisite depth, with a fine saw, any teeth in the way of its action being previously extracted. Then, with a strong pair of forceps, the portion of bone, between the two fissures, is to be broken off. The bleeding, which is copious, may sometimes be stopped by compresses dipped in the tincture of muriated iron, but frequently requires firm and long-continued pressure with the hands of a succession of assistants, or even the actual cautery.

The soft and more superficial kinds of epulis may be extirpated with a scalpel, care being taken to let the excision be sufficiently free and deep, and then to scrape the alveolar process, or rub the bottom of the wound with nitrate of silver, which will generally stop the hæmorrhage, and lessen the chance of a return of the excrescence. When the disease recurs often, as it did six times in a case mentioned by John Hunter, the removal of the parts must either have been imperfect, or the tumor cancerous, as happened in two examples which fell under his observation. (See *J. Hunter*, *On Natural Hist. &c. of the Human Teeth*, p. 188.)

GUTTA SERENA. A term said to have been first applied by Actuarius to amaurosis, or the species of blindness arising from a morbid state of the retina, or optic nerve. When the word is now employed, it usually denotes the complete form of amaurosis, or that in which the patient is entirely deprived of the power of discerning objects, or even the difference between light and darkness. (See AMAUROSIS.)

[**GUTTÆ.**—This term is applied to lotions used in diseases of the eye, which are intended to be *dropped* on to the surface of the conjunctiva; while collyrium signifies a lotion which is to be applied to the outer surface of the eyelids, or with which the lids are to be bathed, a small portion only reaching the conjunctiva. (See COLLYRIUM.)

The following formulæ are in use at the Royal London Ophthalmic Hospital in Moorfields :—

GUTTÆ ACIDI HYDROCYANICI. — ℞ *Acidi hydrocyanici diluti, f.* ʒj.; *Aquæ, f.* ʒvij. Misce.

GUTTÆ ARGENTI NITRATIS.—℞. *Argenti nitratis*, gr. j.; *Aquæ destillatæ, f.* ℥j. Liqua.

GUTTÆ ATROPIÆ SULPHATIS.—℞. *Atropiæ sulphatis*, gr. ij.; *Aquæ destillatæ, f.* ℥j. Liqua.

GUTTÆ BELLADONNÆ.—℞. *Liquoris belladonnæ*, ♏xx.; *Aquæ destillatæ, f.* ʒj. Misce.

GUTTÆ CUPRI SULPHATIS.—℞. *Cupri sulphatis*, gr. ij.; *Aquæ destillatæ, f.* ℥j. Liqua.

GUTTÆ HYDRARGYRI BICHLORIDI.—℞. *Hydrargyri bichloridi*, gr. ⅛; *Aquæ destillatæ, f.* ℥j. Liqua.

GUTTÆ POTASSII IODIDI.—℞. *Potassii iodidi*, gr. iij; *Aquæ destillatæ, f.* ℥j. Liqua.

GUTTÆ ZINCI SULPHATIS.—℞. *Zinci sulphatis*, gr. ij.; *Aquæ destillatæ, f.* Liqua et cola.]

H

HÆMATOCELE (from αἷμα, blood, and κήλη, tumor). A swelling of the testicle, proceeding from, or caused by, blood.

The term has sometimes been applied to every kind of extravasation of blood about the scrotum and spermatic cord; but, at the present day, it is usually restricted by British surgeons to a collection of blood in the cavity of the tunica vaginalis. Extravasation of blood into the cellular tissue of the scrotum and spermatic cord, or within the structure of the testicle itself, Pott, however, arranges with hæmatocele. The swelling of a hæmatocele is generally pyriform, like hydrocele, but is distinguishable from it by its greater weight and firmness, its want of transparency, its obscure fluctuation, and its cause, which is usually a blow upon the scrotum, or an accidental puncture of some vessels of the testicle, or tunica vaginalis, in tapping a hydrocele. When the latter membrane has been long, or much distended by the serous fluid of hydrocele, it becomes thickened, and its vessels, especially those of its inner surface, enlarged, and even varicose. If one of these lies in the way of the instrument with which the hydrocele is tapped, it is of course wounded, and then the fluid, which is discharged, is deeply tinged with blood. Should the bleeding continue, after the evacuation of the hydrocele, the blood will accumulate in the cavity of the tunica vaginalis, and, in the course of two or three hours, the scrotum will again be considerably swollen. In one or two examples, I have known hæmatocele follow the tapping of a hydrocele with a lancet, or other sharp-edged instrument. Sir Astley Cooper has noticed this risk, as attending the plan of tapping a hydrocele with a lancet. (*On the Structure and Dis. of the Testis*, p. 212.) A gentleman in the Fleet prison took it into his head to tap his hydrocele with a kind of long spring-lancet of his own invention: the operation was followed by the rapid formation of a very large hæmatocele.

Sometimes one of the enlarged veins of the tunica vaginalis bursts of itself, after the fluid of a hydrocele has been discharged, and hæmatocele then comes on, as it were, spontaneously. According to Sir Benjamin Brodie, hæmatocele may arise from a diseased condition of the arteries. "This is analogous to that which occurs in the brain, under the form of sanguineous apoplexy. There is a natural change, which takes place in the arteries of old persons; they become ossified in patches, and ulcerate; and I have known this to lay the foundation of hæmatocele." (See *Lond. Med. Gaz.* vol. 1831-32, p. 927.)

As Sir Astley Cooper observes, hæmatocele is often connected with hydrocele, and is a consequence of it. The latter disease frequently becomes complicated with hæmatocele from an accidental blow on the tumor, occasioning a rent in the tunica vaginalis. In one case, operated upon by Sir Astley Cooper, this membrane had been ruptured to the extent of between one and two inches. The same distinguished surgeon records the case of a gentleman, in whom hæmatocele arose, not from a blow, but from excessive bodily exertion. (*On the Structure, &c. of the Testis*, p. 213—215.)

Of all the causes of hæmatocele, a blow on the scrotum is the most frequent, and especially a blow from the pommel of the saddle in riding. I have known the disease produced, however, by external violence of different kinds; as by a fall against a piece of timber, by which the scrotum was violently struck. After such accidents, the scrotum will suddenly swell to double or treble its natural size. Every swelling, so produced in the scrotum by effused blood, is not invariably a collection of this fluid in the tunica vaginalis; for sometimes the extravasation is in the loose cellular tissue external to this membrane. Hæmatocele is to be distinguished from the latter case, partly by the oblong or pyriform shape of the tumor, its obscure fluctuation, its freedom from the common appearances of ecchymosis, and its presenting itself more on one side of the scrotum than the other; while an extravasation of blood in the cellular tissue generally is more diffused, produces a dark blue discoloration of the part, and conceals more or less both testes.

When hæmatocele occurs in combination with hydrocele, the blood is mixed with the serous fluid contained in the tunica vaginalis, and partially dissolved in it: if the quantity of blood be small, the solution is complete; but, in the opposite case, coagula are formed, which remain undissolved. (*Sir B. Brodie*, *ib.*)

In the dissection of some hæmatoceles, the tunica vaginalis is found excessively thickened; and the blood in it, whether coagulated or fluid, is of the colour of coffee. Sir Astley Cooper refers to a preparation at St. Thomas's Hospital, exemplifying the serious mistake of removing the testicle, while the true disease was merely hæmatocele. The tunica vaginalis was excessively thickened, and filled with coagulated blood of a brownish red colour. (Op. cit. p. 215.)

A negro died in St. George's Hospital, who had an enlargement of one testicle; but as it had occasioned little or no inconvenience, the surgeon had not been consulted. Sir Benjamin Brodie examined the part after the patient's death, and found a very large quantity of grumous blood in the tunica vaginalis, and at the back part a soft pulpy mass was seen, not at all resembling the testicle in structure, and only recognisable as such by its connection with the epididymis and vas deferens. Sir Benjamin Brodie conceives, that the changed state of the testicle had been occasioned by the pressure of a large quantity of blood. (See *Lond. Med. Gaz.* 1831-1832, p. 927.)

Hæmatocele is sometimes unaccompanied by pain: this is the case when the quantity of blood is small, and no inflammation present. Under other circumstances, the disease may be attended with excessive pain, and bring on abscesses, gangrene, and dangerous degrees of constitutional disturbance. This was exemplified in the person whom I have mentioned as having produced hæmatocele by plunging a large lancet into his own hydrocele, for the purpose of curing it himself. In this instance, which I visited with Mr. Bransby Cooper, if a free and prompt incision had not been made to discharge the matter and putrid blood, the patient would soon have lost his life by the violence of the constitutional disturbance. Sir Benjamin Brodie mentions a painter, who was in the habit of drinking to excess, and who, while climbing a ladder, was seized with pain in the testicle, and an enormous hæmatocele formed. In this patient, the symptoms at first were more nearly allied to mania than delirium.

If hæmatocele be occasioned by a blow, and not accompanied by hydrocele, and the quantity of blood in the tunica vaginalis be moderate, the treatment should consist in keeping the patient in the recumbent position, administering purgative medicines, and covering the tumor with a cold lotion, which will have the effect of checking any further internal bleeding. These means will prevent inflammation, and, after a time, the blood will probably be absorbed. Were the quantity of blood considerable, its pressure might cause an absorption of the testicle (*Sir B. Brodie*), or, at all events, it would be likely to excite inflammation, and have little or no chance of being dispersed: in such a case, therefore, the best practitioners agree, respecting the propriety of laying open the tunica vaginalis, and taking out the blood.

If hæmatocele be combined with hydrocele, and free from much inflammation, Sir Astley Cooper recommends making an incision into the tunica vaginalis, discharging its contents, and, without introducing any lint into the cavity, leaving the cure to be completed by the process of inflammation. (*On the Structure, &c. of the Testis,* p. 216.)

If, on drawing off a hydrocele, the contents are tinged with blood, Sir Benjamin Brodie allows the fluid to collect again, and repeats the tappings at intervals, until no blood is mixed with it. The injection may then be used with success. Should the quantity of blood be large, he regards the expectation of its being removed by absorption as hopeless, and, therefore, punctures the tunica vaginalis with a lancet, introduces a director into the opening, and then enlarges it with a scalpel.

Whoever has read the observations of Pott on this subject will know that the operation of laying open the tunica vaginalis, for the cure of hæmatocele, is sometimes followed by a severe attack of symptomatic fever, delirium, and even death. In unfavourable constitutions, the symptoms will generally prove serious, whatever be the mode adopted of dressing the wound, or the internal treatment. But now that the plan of introducing lint and other extraneous substances into the exposed cavity is abandoned, bad cases are far less frequent than formerly. The violence of the symptoms will generally depend upon the degree of inflammation in the parts, and the kind of constitution in which it occurs. If hæmatocele excite inflammation, the clots of blood putrefy, and a gangrenous suppuration follows, attended with an accumulation of sulphuretted hydrogen in the part, and most urgent danger. Here a free opening must be made without delay, the scrotum poulticed or covered with cold lotions, and the patient kept under the influence of the muriate or acetate of morphia.

Mr. Pott, in his account of hæmatocele, comprehends one species, which he describes as an extravasation of blood within the tunica albuginea.

I confess that no good reason appears for arranging cases of this kind with hæmatocele; for what are they but diseased testicles, which have been punctured, either on account of their seeming to contain a fluid, or really having within them cysts filled with a chocolate-coloured or other fluid, as I have seen in hundreds of instances of sarcocele? and whatever blood is discharged is not extravasated in the substance of the testis previously to the puncture, but issues as a necessary consequence of that proceeding.

Another species of hæmatocele, noticed by Pott, arises from the bursting of a branch of the spermatic vein, between the groin and scrotum, within the sheath of the cord. This, which is generally produced by great or sudden exertions of strength, feats of agility, &c. may happen to persons in the best health.

I cannot conceive that in any case of a mere rupture of one of the spermatic veins, it can ever be justifiable to tie the whole spermatic cord, and then perform castration, though Pott advises this plan, if the bleeding branch cannot be tied singly. Discutient applications, and an occasional purge, will almost always disperse the swelling; and if not, opening it, and taking out the blood, applying cold, or, if necessary, filling the cavity with lint, and using compression, would be, according to my humble judgment, the most judicious treatment.

With regard to the extravasation of blood in the loose cellular tissue of the scrotum, from blows on the part, and sometimes from lithotomy, castration, &c., I have seen it followed by suppuration and sloughing; but in general the effused blood is gradually absorbed, with the aid of discutient applications, leeches, fomentations, poultices, and saline purges. A surgeon should generally be reluctant to lay open the tumor, as, in many instances, sloughing and severe symptoms have been the result.

[In hæmatocele of any standing, whether traumatic or spontaneous, it should be borne in mind that pathological changes will take place both in the tunica vaginalis and in the blood itself. The serous membrane may inflame, and transude lymph instead of serum; thus a false membrane may be formed, to which the fibrin of the extravasated blood may readily adhere, or the serous membrane may simply have its secreting surface so far changed as to permit of the fibrin attaching itself to it in the form of a false membrane. Be this as it may, the tunica vaginalis will occasionally become more or less thickened, and in some extreme cases to the extent of half an inch or more, so that, after being opened and its contents removed, it is unable to collapse. The extravasated blood in contact with the living tissues does not altogether lose its vital properties, but undergoes peculiar changes in colour, in consistency, and in organisation, producing a variety of appearances in the contents of the more or less thickened tunica vaginalis. The serous parts disappear by absorption, as well as a certain portion of the colouring matter of the blood; the plastic materials become more or less organised, forming layers of false membrane adhering to the tunica vaginalis, or arranged so as to form partitions and cells, giving rise to a honeycombed appearance in the interior of the cyst. These cells and compartments of the hæmatocele will be filled with fluids of various colour and consistency, derived from the blood and from the imperfectly organised membranous laminæ. The plan of treatment suitable to a hæmatocele of long standing differs widely from that which may suffice in recent cases. When the tunica vaginalis becomes thickened to the extent of five or six lines, neither tapping, injecting, nor incision alone will be of any avail. The diseased tissues are incapable of repair. The layers of false membrane, after incision, must be peeled off from the interior of the tunica vaginalis, and the original membrane only left, or, if this cannot be effected, the entire adventitious structures, together with the tunica vaginalis, must be removed by the scalpel or scissors. Fortunately the visceral portion of the membrane is rarely implicated in the thickening, so that the testis and epididymis may generally be left untouched. Should, however, the adventitious deposit be equally developed on the testis and epididymis, or should these structures have suffered disorganisation and atrophy, castration should be performed as the only procedure likely to be effectual. I lately operated on a case in St. Mary's Hospital, by removal of the thickened tunica vaginalis, together with its contents, leaving the testis and epididymis, which appeared sound in the midst of a diseased mass. The man speedily recovered.

As this case explains well the pathological changes which a hæmatocele undergoes, and the treatment required in an advanced state of the disease, I will give it in detail.

Charles B——, aged forty-five, was operated upon for hydrocele during the course of the year 1855 in University College Hospital, with apparent success. In about two years from the date of the operation, however, the complaint began to return. Some months after this, in November 1857, during a violent fit of coughing, he felt something give way, and an extensive and alarming swelling suddenly made its appearance, affecting the scrotum, penis, and cellular tissue over the pubes. This swelling, from its suddenness and from the discoloration of the skin, was evidently occasioned by effusion of blood. The swelling was punctured by a trocar, and a considerable quantity of bloody fluid escaped, inflammation followed, and the tumor returned.

In December of the same year he was admitted under my care in St. Mary's Hospital with a large *pyriform* swelling in the scrotum on the left side, looking like a hydrocele. The upper narrow part of the tumor corresponding to the cord was separated by a slight constriction from the lower and more globular portion. On manipulation, it was found that the tunica vaginalis was thicker than in an ordinary hydrocele, and that the fluctuation was rather less distinct. Five ounces of a dark bloody fluid were drawn off. A sharp attack of inflammation followed the use of the trocar, accompanied by a return of the swelling. On the 6th of January 1858, all inflammation having subsided, the following operation was performed. An incision three or four inches in length was made in front of the tumor, through the superficial coverings of the testicle, into the tunica vaginalis. This membrane was found to be much thickened, varying in this respect from three to six lines in different parts. It was of a yellowish white colour, tough, and sufficiently firm to retain its form. Two or three ounces of a discoloured fluid escaped from its interior. The remainder of its contents appeared to consist of coagulable lymph undergoing organic changes, and arranged so as to form numerous soft partitions, resembling considerably the honeycomb appearance seen in severe and fatal cases of pericarditis. The interspaces between these partitions were filled with serum, more or less tinged by the colouring matter of the blood. Here and there a more decided oval or globular little collection of this fluid might be noticed, looking like a cyst in the process of formation. The whole of these half-organised contents of the thickened tunica vaginalis were readily turned out with the finger; there was no adhesion sufficiently firm to require the use of the knife. The thickened and emptied tunica vaginalis was then dissected away from the scrotum, and detached from the testis and cord at its line of reflection from these structures. The portion of this membrane left adhering to the tunica albuginea and to the cord, did not fortunately partake of the thickening which in so marked a degree affected the part removed. The testis itself was not harder than usual, nor did it exceed its natural size. The patient lost a good deal of blood during the operation, and again the next day from secondary hæmorrhage, by which he was much blanched and debilitated. A healthy suppuration, however, was soon established; the granulations springing from the testis gradually united with those from the scrotum, and the patient made a steady, but slow recovery. He was discharged cured on the 16th of March 1858.

The treatment to be adopted in the several states in which cases of hæmatocele may present themselves may be thus summed up. In recent cases the attempts at obtaining resolution by rest, by discutient lotions, and by support to the tumor, combined with antiphlogistic treatment, will often succeed. If this plan fail, and the blood remain fluid without mixture with coagula, and no inflammatory symptoms be present, the case may be treated successfully by evacuation of the fluid, and by injection, as in hydrocele. Should coagula be present, so as to prevent evacuation by tapping, or should inflammation set in, threatening suppuration, the appropriate remedy will be free incision into the tunica vaginalis. When false membranes have formed, thickening the serous membrane to a slight extent only, provided the contents of the sac can be evacuated, injection after tapping will sometimes effect a cure. But when the serous membrane is so far thickened that it cannot collapse after being emptied, or when its contents are too solid to admit of escape by the trocar, then incision and removal of all the adventitious structures, leaving if possible the original membrane, will be necessary; and lastly, when this cannot be effected with safety to the testis and epididymis on account of their being too seriously implicated in the disease, castration must be had recourse to.]

Celsus and *Paulus Ægineta* are the best of the old writers on hæmatocele. For modern information, consult *Pott's* Chir. Works, vol. ii. *B. Bell,* On Hydrocele. *Flajani,* Collezione d'Osservazioni, &c. t. ii. *Richter,* Anfangsgr. der Wundarzn. b. vi. *Osiander,* in Arnemann's Magazin für die Wundarzn. b. i. p. 355: the patient died after an opening had been made in the swelling. *Follet,* in Journ. de Méd. continué, vol. xiii. p. 422: *Harris,* in Mem. of Lon. Med. Society, vol. v. *Sir B. Brodie,* in Lond. Med. Gaz. for 1831-32, p. 926. *Sir A. Cooper,* in Obs. on the Structure and Dis. of the Testicles, p. 209, 4to. Lond. 1830. [*Nélaton,* Elèmens de Pathol. Chirurg. t. v. p. 624. *Curling* On Diseases of the Testis. *South's* Translation of Chelius.]

HÆMATURIA. (See URINE.)

[**HÆMITIS.** A term applied by *Piorry* to signify *Inflamed Blood. The Croupy Crasis* (*Rokitansky*); *Buffy Blood, Ebullition, Commotion, Inflammation,* of the blood (*Galen, Boerhaave, Sydenham,* and the physicians and surgeons generally before the time of Cullen); *Hyperinosis* (*F. Simon*).

Fever, small-pox, plague, and many other diseases were attributed by many of the most eminent of the humoral pathologists to an inflammation of the blood. This opinion was founded, in a great measure, on the occurrence of the buffy coat, and the resemblance which blood drawn in these diseases often bears to the blood in active inflammation, as pleurisy, and in rheumatism. (*Sydenham,* Op. c. ii. s. ii. iii.) Sydenham considered that wine inflamed the blood. (Op. c. iv.) These observers were guided by the increased temperature, bright colour, and other physical appearances. Surgeons of the present day have the advantage of more accurate anatomical details, and also of chemical researches, the result of which has been to confirm the idea of an inflammation of the blood. Even with those who adopt "exudation," as part of the definition of "inflammation," the blood need not be excluded, since the cellular structure of the corpuscles implies nutrition and secretion, and the probability of pathological exudations. An inflamed state of the blood being generally attended with an increase of fibrin, and some objections existing to the term hæmitis, we have preferred treating of the surgical importance of this morbid condition under another head. (See HYPERINOSIS.)]

Henry Ancell.

HÆMORRHAGE (from αἷμα, blood, and ῥήγνυμι, to break out). *Bleeding. Effusion, or loss of blood.*

This is doubtless one of the most important subjects in surgery. The fear of hæmorrhage retarded the improvement of our profession for ages; the ancients, ignorant how to stop bleeding, were afraid to cut out the most trivial tumor, or they did so with terror. They generally performed slowly and imperfectly, by means of burning irons or ligatures, the same operations which the moderns execute quickly and safely with a knife. If the old surgeons ventured to amputate a limb, they only did so after it had mortified, by dividing the dead parts; and so great was their apprehension of hæmorrhage, that they only dared to cut parts which could no longer bleed. (*John Bell's Principles of Surgery,* vol. i. p. 142.) But not only as a consequence of surgical operations, is hæmorrhage to be feared; it is also one of the most alarming accidents which the surgeon is called upon to relieve. "*Un sentiment naturel attache à l'idée de perdre son sang, une terreur machinale, dont l'enfant qui commence à parler, et l'homme le plus décidé, sont égulement susceptibles. On ne peut point dire que cette peur soit chimérique. Si l'on comptoit ceux qui perdent la vie dans une bataille, on verroit, que les trois quarts ont péri par quelque hémorrhagie; et dans les grandes opérations de chirurgie cet accident est presque toujours le plus formidable.*" (*Morand, Mém. de l'Acad. de Chir.* vol. v. 8vo.)

As the blood circulates in the arteries with much greater impetus and rapidity than in the veins, it necessarily follows that their wounds are generally attended with more profuse hæmorrhage than those of the latter vessels, and that such hæmorrhage is more difficult to suppress. However, as the blood also flows through veins of great magnitude with much velocity, bleeding from them, if they lie deeply, is frequently highly dangerous, and sometimes unavoidably fatal. When a large artery is wounded, the blood is of a bright scarlet colour, and gushes from the vessel *per saltum;* but, if the artery be of inferior size, the blood, which first spouts from it, does not issue *per saltum;* and it is not until the first gush has subsided, that the stream takes place in jets. (See *J. W. Earle,* in *Lond. Med. Gaz.* vol. xvi. p. 9.) The blood issues from a vein in an even unbroken stream, and is of a dark purple red colour. It is of great practical use to remember these distinguishing differences between arterial and venous hæmorrhage, because, though in both cases the oozing of blood may be equal in quantity, yet, in the latter instance, the surgeon is often justified in bringing the sides of a wound together, without taking further means to suppress the bleeding, while it might not be proper to adopt the same conduct, were there an equal discharge of arterial blood.

Dr. Jones has favoured the world with a matchless work on the present subject; and as one grand object of this Dictionary is to present a careful account of the principal improvements in surgical science, I shall first endeavour to make the reader acquainted with the more accurate doctrines first promulgated by this gentleman relative to the subject of hæmorrhage. Afterwards, the surgical means to be practised in different cases will be considered.

The walls of the arteries are divisible into three coats. The *internal one* is extremely thin, and transparent and smooth. [It is lined by a delicate tesselated epithelium, which gives it somewhat the appearance and character of a serous membrane.] It is elastic and firm in the longitudinal direction, but easily torn by the slightest force applied in the circular direction. Its diseases prove that it is vascular, and probably possesses sensibility. The experiments of M. Manec shew, that it secretes an unctuous matter, which facilitates the course of the blood; another fact in confirmation of its vascularity. (See *Manec, Traité de la Ligature des Artères*, Paris, 1832, in fol.)

[The *middle coat* is the thickest, and is divided into two layers. The outer of the two is composed of the yellow elastic tissue, and is found more abundant in the large arteries, the middle coat of the aorta being formed entirely of this layer. The inner or muscular layer is constituted of organic muscular fibre, arranged circularly, and is found in the greatest quantity in the smallest arteries. In those of intermediate size only are the two layers manifest, holding the position we have assigned to them.] As the middle coat has no longitudinal fibres, *the circular fibres are held together by a slender connection, which yields readily to any force, applied in the circumference of the artery.* It easily gives way, whether the force is exerted in the direction of the diameter, or in that of the course of the vessel. (See *J. L. Sanson, Des Hémorrhagies Traumatiques*, p. 33.)

The *external coat* is remarkable for its whiteness, density, and great elasticity. It adheres to the middle coat by means of very fine reddish filaments, analogous to those which unite the middle to the internal coat, and it manifestly receives the *vasa vasorum.* (See *J. L. Sanson*, op. cit.) *When an artery is surrounded with a tight ligature, its middle and internal coats are as completely divided by it as they could be by a knife, while the external coat remains entire.* (*Jones.*)

If an artery be extended longitudinally, the internal tunic is first ruptured, and then the middle one; but the external coat will admit of being elongated to a great extent before it will be torn. If an artery is twisted, rents are formed in the internal coat, and next in the middle one; but it is difficult to produce a complete rupture of the external tunic. If an artery is struck and forcibly contused, or if it is surrounded with a tight ligature, its internal and middle coats are readily divided, but the external one still makes resistance. (See *L. J. Sanson, Des Hémorrhagies Traumatiques*, p. 33.)

In addition to these three coats, it would appear from the researches of M. Malgaigne, that in the aorta, and the large trunks derived from it, there is interposed between the internal and fibrous coats, one, which he has named *sclerous*, which renders the aorta stronger and more rigid than the pulmonary artery; and is the seat of various earthy, steatomatous, and cartilaginous formations, met with in the former vessel. It is certainly remarkable, that no good specimen of an ossification of the pulmonary artery has ever been noticed. (See *J. Lisfranc, De l'Oblitération des Artères*, p. 10.)

Besides these proper coats, all the arteries, in their natural situations, are connected, by means of fine cellular tissue, with surrounding membranous sheaths. *If an artery be divided, the divided parts, owing to their elasticity, recede from each other, and the length of the cellular tissue, connecting the artery with the sheath, admits of its retracting a certain way within the sheath.*

Another important fact is, *that when an artery is divided, its truncated extremities contract in a greater or less degree, and the contraction is generally, if not always, permanent.*

Arteries are furnished with arteries, veins, absorbents, and nerves; *a structure, which makes them susceptible of every change to which living parts are subjected in common; enables them to inflame, when injured, and to pour out coagulating lymph, by which the injury is repaired, or the tube permanently closed.* (See *Jones, On Hæmorrhage.*)

Petit, in 1731, first endeavoured to explain the means which nature employs for the suppression of hæmorrhage. He thought that bleeding from a divided artery is stopped by the formation of a coagulum of blood, which is situated partly *within*, and partly *without* the vessel. The clot, he says, afterwards adheres to the inside of the artery, to its orifice, and to the surrounding parts; and he adds, that when hæmorrhage is stopped by a ligature, a coagulum is formed above the ligature, which only differs in shape from the one which takes place when no ligature is employed. His theory leads him to recommend compression for the support of the coagulum.

In 1736, Morand published additional interesting remarks. He allowed, that a coagulum had some effect in stopping hæmorrhage; but contended, that a corrugation, or plaiting, of the circular fibres of the artery which diminish its canal, and a shortening and consequent thickening of its *longitudinal ones,* which nearly rendered it impervious, had some share in the process. He thought that the cavity of an artery might be obliterated, by the puckering, or corrugation, when *circular pressure, like that of a ligature, was made.*

Morand erred chiefly in his mode of explanation, and in his belief in the existence of longitudinal fibres, which no modern anatomists admit; for the *contraction* and *retraction* of divided arteries are indisputable facts, and, as Dr. Jones remarks, this does not affect the truth of his general conclusion, *that the change, produced on a divided artery, contributes with the coagulum to stop the flow of blood.*

Mr. S. Sharp (2nd edit. of *Operations of Surgery*, 1739) supported the same doctrine. "The blood-vessels, immediately upon their division, bleed freely, and continue bleeding, till they are either stopped by art, or at length contracting, and withdrawing themselves into the wound, their extremities are shut up by coagulated blood."

Pouteau (*Mélanges de Chirurgie*, 1760) denied, that a coagulum is always found after an artery is divided; and when it is, he thought it only a feeble subsidiary means towards the suppression of hæmorrhage. He contended, that the retraction of the artery had not been demonstrated, and could not be more effectual than a coagulum. His theory was, that the swelling of the cellular membrane, at the circumference of the cut extremity of the artery, forms the principal impediment to the flow of blood; and that a ligature is useful in promoting a more immediate and extensive induration of the cellular substance.

Gooch, White, Aikin, and Kirkland, all oppose Petit's doctrine of coagulum. The first blends some of Pouteau's theory with his own, by observing, that "when a small artery is totally divided, its retraction may bring it under the surrounding parts, and with the natural contraction of the diameter of its mouth, assisted by the compressive power of those parts, increased by their growing tumid, the efflux of blood may be stopped."

White was convinced, from what Gooch had suggested, and Kirkland confirmed, that the arteries, by their natural contraction, coalesce as far as their first ramification.

Dr. Jones admits, that an artery contracts after it has been divided, and his experiments authorise him to say, that the contraction of an artery is an important means, but certainly not the only, nor even the chief means, by which hæmorrhage is stopped. When the artery is above a certain size, the impetuous flow of blood through the wound of the artery would resist the contraction of the vessel in such a degree, that the consequences would be fatal in almost every instance, were it not for the formation of coagulum.

Mr. J. Bell supposed, that when hæmorrhage stops of its own accord, it is neither from the retraction of an artery, nor the constriction of its fibres, nor the formation of clots, but by the cells of the cellular tissue which surrounds the artery being injected with blood. I must refer the reader to Dr. Jones's work for a complete exposure of the inconsistencies and absurdities in Mr. Bell's account of his own theory. (See p. 25, &c.) Dr. Jones concludes his criticisms on Mr. Bell with observing, that if this gentleman really mean to confine his doctrine of the natural means of suppressing hæmorrhage to the injection of the cellular tissue round the artery with blood, he dwells improperly on one of the attendant circumstances, to the exclusion of the retraction and contraction of an artery, and the formation of a distinct clot, all primary parts of the process.

The blood, besides filling the cellular tissue round the artery, also fills that which is at the mouth of the artery in a particular manner; for the divided vessel, by its retraction within its cellular sheath, leaves a space of a determinate form, which, when all the circumstances necessary for the suppression of hæmorrhage operate, is gradually filled up by a distinct clot. (*Jones.*)

Arteries of the fourth or fifth order, like those of the forearm and leg, have not any well-defined sheath; and hence the constantly greater difficulty of insulating small vessels than large. (See *P. Manec, De la Ligature des Artères*, p. 3.)

MEANS OF NATURE IN STOPPING BLEEDING FROM DIVIDED ARTERIES.

Dr. Jones has given a faithful and accurate detail of a series of experiments on animals, which demonstrate, "that the blood, the action, and even the structure of the arteries, their sheath, and the cellular substance connecting them with it," are concerned in stopping bleeding from a divided artery of moderate size, in the following manner:—"An impetuous flow of blood, a sudden and forcible retraction of the artery within its sheath, and a slight contraction of its extremity, are the immediate, and almost simultaneous, effects of its division. The natural impulse, however, with which the blood is driven on, in some measure counteracts the retraction, and resists the contraction of the artery. The blood is effused into the cellular tissue between the artery and its sheath, and, passing through that canal of the sheath which had been formed by the retraction of the artery, flows freely externally, or is extravasated into the surrounding cellular tissue, in proportion to the open or confined state of the wound. The retracting artery leaves the internal surface of the sheath uneven, by lacerating or stretching the cellular fibres that connected them. These fibres entangle the blood as it flows, and thus the foundation is laid for the formation of a coagulum at the mouth of the artery, and which appears to be completed by the blood, as it passes through this canal of the sheath, gradually adhering and coagulating around its internal surface, till it completely fills it up from the circumference to the centre." (*Jones*, p. 53.)

The effusion of blood into the surrounding cellular tissue, and between the artery and its sheath, but, in particular, the diminished force of the circulation from loss of blood, and the speedy coagulation of this fluid under these circumstances, most essentially contribute, says Dr. Jones, to the desirable effect.

It appears then that a coagulum, which Dr. Jones calls the *external* one, situated at the mouth of the artery, and within its sheath, forms the first complete obstacle to the continuance of bleeding; and though it seems externally like a continuation of the artery, yet, on slitting open this vessel, its termination can be plainly observed, with the coagulum shutting up its mouth, and contained in its sheath.

No collateral branch being very near the impervious mouth of the artery, the blood just within it is at rest, and usually forms a slender conical coagulum, which neither fills up the canal of the artery nor adheres to its sides, except by a small portion of the circumference of its base, near the extremity of the vessel. This coagulum is distinct from the former, and is called by Dr. Jones the *internal* one.

The description given by Mr. Guthrie of this subject differs in some respects from that of Dr. Jones. The contraction of the divided end of the artery is alleged by Mr. Guthrie "to be confined, in the first instance, to its very extremity, so that the barrier, opposing the flow of blood, is formed by this part alone. This contraction, however, goes on increasing for the space of an inch, and the inside of this contracted inch of the vessel is filled up with an internal coagulum, which takes the shape of, and *adheres to, the inside of the artery*, rarely extending as far as a collateral branch, or, under almost any circumstances, beyond a couple of inches. (*On Dis. and Injuries of Arteries*, p. 247.)

The cut end of the artery next inflames, and the vasa vasorum pour out lymph or fibrine, which fills up the extremity of the artery, is situated between the internal and external coagula, and is somewhat intermingled with them, or adheres to them, and is firmly united all round to the internal coat of the vessel. Dr. Jones further states that the permanent suppression of hæmorrhage chiefly depends on this coagulum of fibrine; but that the end of the artery is also secured by a gradual contraction which it undergoes, and by an effusion of fibrine between its tunics, and into the surrounding cellular tissue; whereby these parts become thickened, and so incorporated with each other, that one cannot be discerned from the other. Should the wound in the integuments not heal by the first intention, the coagulating lymph, soon effused, attaches the artery firmly to the subjacent and lateral parts, gives it a new covering, and entirely excludes it from the outward wound.

The same circumstances are also remarkable in the portion of the vessel most remote from the heart. Its orifice, however, is usually more contracted, and its external coagulum smaller, than the one which attaches itself to the other cut end of the artery. (*Jones*, *On Hæmorrhage*, p. 56.)

According to Mr. Guthrie's observations, the lower end of a divided artery is more prone to secondary hæmorrhage than the upper; and this he believes to be so much the fact, that, when hæmorrhage returns, after having been arrested for a period of four hours, it is in all probability from the lower end. This, he further observes, may always be known by the "*darker colour of the blood, and by its flowing out in a continuous stream*, in the same manner as water rises from a spring, and without an arterial impulse. The surgeon has no right to believe that the blood comes from the upper extremity of the artery, unless it is of a florid scarlet arterial colour, when it will usually rush out with force, if not with undisguised arterial impetus." The greater disposition to secondary hæmorrhage in the lower than in the upper end of the artery, is thought by Mr. Guthrie to depend upon the retraction and contraction of the former, being neither so perfect nor so permanent as in the latter; a statement at variance with that of Jones. He suspects, also, that the internal coagulum is in many instances altogether wanting, or very defective in its formation. (See *G. J. Guthrie, On the Dis. and Injuries of Arteries*, p. 248.) We have seen that Dr. Jones found the external coagulum smaller here than that which is formed over the mouth of the end of the artery nearest the heart. The darker colour of the blood from the distal end of the artery is ascribed by M. Sanson to its previous passage through the capillary vessels; and the fact, he says, was observed by John Hunter. (*Des Hémorrhagies Traumatiques*, p. 45.)

The impervious extremity of the artery no longer allowing blood to circulate through it, the portion which lies between it and the first lateral branch gradually contracts, till its cavity is completely obliterated, and its tunics assume a ligamentous appearance. In a few days the external coagulum, which in the first instance stopped the hæmorrhage, is absorbed, and the coagulating lymph effused around it, and by which the parts were thickened, is gradually removed, so that they resume again their cellular texture.

At a still later period, the ligamentous portion is reduced to a filamentous state, so that the artery is, as it were, completely annihilated, from its cut end to the first lateral branch; but, long before this final change is accomplished, the inosculating branches have become considerably enlarged, so as to establish a free communication between the disunited parts of the main artery.

As Mr. Guthrie observes, out of four or five inches of the artery, two or three will be impervious, and the remaining part very much contracted, although, perhaps, still permeable by a probe. The accompanying nerve, where there is one, has undergone a change, the very reverse of that of the artery, its cut extremity having become enlarged or bulbous, the nerve gradually diminishing upwards until it resumes its proper size. (*On Dis. and Inj. of Arteries*, p. 248.)

When an artery has been divided *at some distance from a lateral branch*, three coagula are formed: one of blood, externally, which shuts up its mouth; one of lymph, just within the extremity of its canal; and one of blood, within its cavity, and contiguous to that of lymph. But, *when the artery has been divided near a lateral branch, no internal coagulum of blood is formed.* (*Jones*, p. 63.)

The external coagulum is always formed when the divided artery is left to nature: not so, however, if art interfere, for, under the application of the ligature, it can never form. If agaric, lycoperdon, or sponge be used, its formation is doubtful, depending entirely upon the degree of pressure that is used; but the internal coagulum of blood will be equally formed, whether the treatment be left to art or nature, if no collateral branch be near the truncated extremity of the artery; and, lastly, effused fibrine, which, when in sufficient quantity, forms a distinct coagulum, just at the mouth of the artery, will be always found, if the hæmorrhage be permanently suppressed. (*Jones*, p. 74.)

MEANS WHICH NATURE EMPLOYS FOR SUPPRESSING THE HÆMORRHAGE FROM PUNCTURED OR PARTIALLY DIVIDED ARTERIES.

The suppression of hæmorrhage by the natural means is sometimes more easily accomplished, when an artery is completely divided, than when merely punctured or partially divided. Completely dividing a wounded artery was one means practised by the ancients for the stoppage of hæmorrhage: the moderns frequently do the same thing, when bleeding from the temporal artery proves troublesome.

Dr. Jones has related many experiments, highly worthy of perusal, and which were undertaken to investigate the present part of the subject of hæmorrhage. He candidly acknowledges, however, that, in regard to the temporary means by which the bleeding from a punctured artery is stopped, he has but little to add to what Petit has explained in his third publication on hæmorrhage. (*Mém. de l'Acad. des Sciences*, 1735.) The blood is effused into the cellular substance, between the artery and its sheath, for some distance both above and below the wounded part; and when the parts are examined, a short time after the hæmorrhage has completely stopped, we find a stratum of coagulated blood between the artery and its sheath, extending from a few inches below the wounded part to two or three inches above it, and somewhat thicker, or more prominent, over the wounded part than elsewhere.

Hence, rather than say that the hæmorrhage is stopped by a coagulum, it is more correct to say, that it is stopped by a thick lamina of coagulated blood, which, though somewhat thicker at the wounded part, is perfectly continuous with the coagulated blood lying between the artery and its sheath. (*Jones*, p. 113.)

When an artery is punctured, the immediate hæmorrhage, by filling up the space between the artery and its sheath with blood, and consequently distending the sheath, alters the relative situation of the puncture in the sheath to that in the artery, so that they are not exactly opposite to each other; and, by this means, a layer of blood is confined by the sheath over the puncture in the artery, and, by coagulating there, prevents any further effusion of blood.

But this coagulated blood, like the external coagulum of a divided artery, affords only a temporary barrier to the hæmorrhage; its permanent suppression is effected by a process of reparation, or of obliteration.

Dr. Jones's experiments prove that an artery, if wounded only to a moderate extent, is capable of reuniting and healing so completely, that, after a certain time, the cicatrisation cannot be discovered either on its internal or external surface; and that even oblique and transverse wounds (which gape most), when they do not open the artery to a greater extent than one fourth of its circumference, are also filled up and healed by an effusion of coagulating lymph from their inflamed lips, so as to occasion but little or no obstruction to the canal of the artery. The utmost magnitude of a wound, which will still allow the continuity of the canal to be preserved, is difficult to be learned; for, when the wound is large, but yet capable of being united, such a quantity of coagulating lymph is poured out, that the canal of the vessel at the wounded part is more or less filled up by it. And when the wound is still larger, the vessel soon becomes either torn or ulcerated completely across, by which its complete division is accomplished.

Béclard made a series of experiments upon dogs, whose arteries are said not to differ much from those of man, though *the impulse of the heart is not so strong, and the blood is more coagulable*—two circumstances which should be duly considered in applying any of the inferences drawn from such experiments to the human subject. "In his first experiment he pricked the femoral artery with a needle; the blood flowed, but soon stopped. On removing the coagulum it again flowed, but in a smaller stream: it gradually ceased to bleed, and finally stopped, though the coagulum was again scraped off. On examination of the artery, no trace of the cicatrix was found. Several similar experiments had the same result. In experiment four, he denuded the femoral artery, and made a longitudinal cut in it, from two to three lines. The lips of the wound were seen in contact during the diastole of the ventricle, and to be separated by a jet of blood during the systole. The blood was stopped by a coagulum; this was removed twice, and each time the blood flowed in a diminished stream, but the animal died. In experiment six he made the same incision, but did not detach the sheath from the artery, and the wound was left to nature. The hæmorrhage was not great; there was an infiltration of blood into the sheath, the size of an almond, which at the end of some days began to diminish, and disappeared in two or three weeks. On the limb being examined, fifteen days afterwards, a little white ridge was found adhering firmly to the artery and to the sheath, and completely closing the wound. In the interior there was a depressed longitudinal cicatrix of the breadth of the fifth of a line. *The canal was regular and pervious* through its whole extent.

"In experiments 7, 8, 9, he made transverse incisions of ¼, ½, and ¾ of the circumference of the femoral artery, *separated from its sheath*: all the animals died. In experiment 10, he made a transverse incision through ¼ of the circumference, *without disturbing the sheath*. The bleeding was stopped by a coagulum, but, on the animal moving, it again flowed, and the dog died. But, in the next experiment of the same kind, the blood was stopped by a coagulum, and the artery was closed by nearly the same process as in the 6th experiment. So complete was the cure, at the end of six weeks, that the external part of the artery did not show any mark of a wound, and the cicatrix was scarcely observable on the interior surface. In his 12th experiment, he cut one half of the circumference; the animal died; the same result followed in several similar experiments. In experiment 13, he cut ¾ of the circumference: after the animal was much reduced, the bleeding ceased, and the artery was closed in the same manner that it is when the section is complete.

"From these experiments, he concludes that wounds of the arteries of dogs are cured by nature, when they are only occasioned by a puncture or a longitudinal incision, whether the artery be denuded or not; but, when arising from transverse incisions, they are always mortal if the artery be laid bare. If the artery retain its sheath, and the wound be ¼ or ¾ of the circumference, it may be cured by the efforts of nature; but it is always fatal if one half of it be cut through." (See *Mém. de la Soc. Méd. d'Emulation*, t. viii. p. 569.) The inferences respecting the curability of a wound, extending through ¾ of the circumference, and the incurability of one that affects only one half of the circumference of the vessel, I should presume, must require further examination, notwithstanding an accidental faintness, produced by the sudden loss of blood in the first instance, may have been the means of saving one or two of the animals on which Béclard made his experiments.

This author thinks it probable that a puncture, or longitudinal incision, in the artery of a man, may be cured by nature; but that a transverse wound never cicatrises properly, as the clot becomes displaced, or, if a cicatrix be formed, it will be distended and torn.

One fact, made out by the same professor, is, that when an artery is deprived of its sheath for an extent greater than its distance of retraction, the hæmorrhage is mortal. I have not looked over the original paper; but it appears to me that it would be desirable to know precisely the size of the arteries which the author is referring to, when he is making some of the above inferences. The size and condition of each animal the subject of experiment, should also be particularly specified; as experiments made on the femoral artery of a lady's lap-dog would surely not have the same results as those performed on the same artery of a large terrier or Newfoundland dog.

According to Dr. Jones, the lymph which fills up the wound of an artery, is poured out very freely both from the vessel and surrounding parts, and it accumulates around the artery, particularly over the wound, where it forms a more distinct tumor. The exposed surrounding parts at the same time inflame, and pour out coagulating lymph, with which the whole surface of the wound becomes covered, and which completely excludes the artery from the external wound. This lymph granulates, and the wound is filled up and healed in the usual manner. (See *Jones, On Hæmorrhage*, p. 113, &c.)

SURGICAL MEANS OF SUPPRESSING HÆMORRHAGE.

It must be plain to every one who understands the course of the circulation, that pressure made on that portion of a wounded artery which adjoins the wound towards the heart, must check the effusion of blood. The current of blood in the veins, running in the opposite direction, requires the pressure to be applied to that side of the wound which is most remote from the heart. However, on account of the freedom and facility with which the blood is transmitted through the anastomosing branches, from the portion of the artery above the point of pressure into the branches of the lower continuation of the artery, such pressure will often only check, and not effectually stop the bleeding, unless the part of the vessel directly below the wound be also compressed or secured. As pressure is the most rational means of impeding hæmorrhage, so it is the most effectual; and almost all the plans employed for this purpose are only modifications of it. The tourniquet, the ligature, the application of a roller and compresses, even agaric itself, only become useful in the suppression of hæmorrhage, on the principle of pressure: the cautery, caustics, and styptics, however, have a different mode of operation.

In order to prevent a wounded person from dying of hæmorrhage, Celsus advised the wound to be filled with dry lint, over which was laid a sponge dipped in cold water, and pressed on the part with the hand. If, notwithstanding these means, the hæmorrhage should continue, he recommends repeatedly applying fresh lint, wet with vinegar; but he is against the use of corroding escharotic applications, on account of the inflammation which they produce, or only sanctions the employment of the mildest ones. When the hæmorrhage resists these methods, *he advises two ligatures to be applied to the wounded part of the vessel, and then dividing the portion situated between them*:—"*Quod si illa quoque profluvio vincuntur, venæ, quæ sanguinem fundunt, apprehendendæ, circaque id, quod ictum est, duobus locis deligandæ, intercidendæque sunt, ut et in se ipsæ coeunt, et nihilominus ora præclusa habeant.*" (Lib. v. cap. 26.) When the ligature was impracticable, the wound bled dangerously, and no large nerves, nor muscles, were situated in the bleeding part, Celsus proposed the actual cautery.

Galen also mentions tying the vessels for the purpose of stopping hæmorrhage; and there are some traces of the same information in other authors who lived before him, as Archigenes and Rufus. Probably, however, the ligature was little used at these early periods, as may be inferred from the multitude of astringents, caustics, and other applications, which were advised for stopping bleeding, and in which less confidence would have been put, had the use of the ligature been familiarly known. No one can doubt that, if the old surgeons had had many opportunities of seeing the advantages of the ligature, they would soon have used it after amputations; but so far were they from adopting such practice, that Albucasis, a long while afterwards, refused to amputate at the wrist, lest he should see his patient bleed to death.

Paré is considered as the first who regularly employed the ligature after amputation. His method having been attacked, he modestly defends it in the part of his works entitled *Apologie*, where he takes great care to impute the origin of it to the ancients; and cites many of them, who had made mention of it. However, he thinks its utility in amputations of such consequence, that he ascribes his first adoption of this practice to inspiration of the Deity.

The method, in which the ancients placed most confidence, for stopping hæmorrhage after the amputation of a limb, was the cauterisation of the cut vessel and surrounding flesh. The parts thus affected by the heat, formed an eschar of greater or less thickness, which blocked up the opening of the vessel, and hindered the blood from escaping. The separation of the eschar, however, which frequently took place too soon, occasioned a return of hæmorrhage, and rendered it the more dangerous, as its suppression was now more difficult than before the cautery had been applied. Sometimes the instrument, being too much heated, immediately brought away with it the eschar. At the present time, the cautery is never employed as a means of suppressing hæmorrhage, or, at most, only in a few very unusual cases, in which neither compression nor the ligature can be made use of. In Great Britain, the cautery is never employed, except in circumstances of this description; but in France, the best hospital surgeons now and then employ it to stop bleedings from the anus, antrum, and mouth.

The old surgeons very commonly applied to bleeding parts pledgets, dipped in boiling turpentine,—a practice that has long been most justly abandoned.

ASTRINGENTS, STYPTICS, &c.

Le Dran says, that a button of vitriol, or alum, applied and properly confined on the extremity of the vessel, is sufficient to stop the hæmorrhage in amputations. Heister recommends the application of vitriol, in preference to the ligature, in the amputation of the fore-arm. Great praises have also been conferred on agaric, and sponge, for their styptic properties. Solutions of iron, and all the mineral acids in various forms, have been recommended to the public, as remedies of the same kind, and possessing great efficacy. The ancients, centuries ago, left no application of this nature untried, and the pretended discoveries of new and more effectual styptics in later times, may almost all be met with in their writings. This fact merits particular notice, because the little success attending their practice, especially when bleeding from a considerable artery was to be suppressed, clearly proves what little reliance ought to be placed on means of this description. (*Encyclopédie Méthodique, Partie Chir.*) The most which styptics can do, is to stop hæmorrhages from small arteries; but they ought never to be trusted when large vessels are concerned.

[Perhaps the most efficient styptic is a saturated solution of the perchloride of iron, applied to and gently pressed upon the bleeding surface by means of a small piece of sponge or lint. This solution acts by promoting coagulation of the blood, as well as by inducing contraction of the blood-vessels. With this view it has been used as an injection in nævi and in varicose veins. (See NÆVUS, VARICOSE VEINS, &c.)]

There is no doubt that cold air has a styptic property; by which expression, I mean that it promotes the contraction of the vessels. We frequently tie on the surface of a wound every artery that betrays the least disposition to bleed, so long as the wound continues exposed to the air. We bring the opposite sides of this wound into contact, and put the patient to bed. Not an hour elapses before the renewal of hæmorrhage compels us to remove the dressings. The wound is again exposed to the air, and again the bleeding ceases. This often happens in the scrotum, after the removal of a testicle, and on the chest, after the removal of a breast. The proper conduct, in such cases, is not to open the wound unnecessarily, but to apply pressure, or else wet linen, to the part, so as to produce such an evaporation from its surface as shall create a sufficient degree of cold to stop the bleeding. As all styptics are more or less irritating, no judicious practitioners apply them to recent wounds. However, for the suppression of hæmorrhage from diseased surfaces, where the vessels seem to have lost their natural disposition to contract, these applications are sometimes indicated.

Compression.

We have already remarked, that all the best means of checking hæmorrhage operate on the principle of pressure; the actual and potential cautery, and some styptics excepted: the two first of which act by forming a slough, which stops up the mouths of the vessels; while the latter operate either by promoting their contraction or by coagulating the blood. Let us next consider the various modifications of pressure.

In a dissertation on the manner of stopping hæmorrhage, printed in the *Mém. de l'Acad. des Sciences, année* 1731, Petit endeavoured to prove, that different articles, praised as infallible specifics, would seldom, or never, have succeeded without compression. Even when caustics were employed, it was usual to bind compresses tightly on the part, so as to resist the impulse of the blood in the artery, and the premature separation of the eschar. Had this precaution not been taken, Petit believes that hæmorrhage would almost invariably have followed; and, indeed, notwithstanding the pains taken to avert it by suitable compression, it did too frequently take place on the detachment of the eschar. Petit has noticed, that the end of a finger, gently compressing the mouth of a vessel, is a sufficient means of stopping hæmorrhage from it, and that nothing else would be necessary, if the finger and stump could always be kept in this posture. Hence, he endeavoured to obviate these difficulties by inventing a machine which securely and incessantly executed the office of the finger. The instrument was a double tourniquet, which, when applied, compressed at once both the extremity of the divided artery and its trunk above the wound. The compression on the end of the vessel was permanent; that on the trunk was made only at the time of dressing the wound, or when it was necessary to relax the other. An engraving and particular description of the instrument are to be found in Petit's memoir.

Surgeons formerly filled the cavities of wounds with lint, or charpie, and then made pressure on the bleeding vessels, by applying compresses and a tight roller over the part. The practitioners of the present day are too well acquainted with the advantages of not allowing any extraneous substance to intervene between the opposite surfaces of a recent wound to persist in the above plan. They know, that the sides of the wound may be brought into contact, and that compression may yet be adopted, so as both to restrain particular hæmorrhages, and rather promote, than retard, the union of the wound.

When the blood does not issue from any particular vessel, but from numerous small ones, compression is preferable to the ligature. In the employment of the latter, it would be necessary to tie the whole surface of the wound. The sides of the wound are to be brought accurately together, and compresses are then to be placed over the part, and a roller to be applied with sufficient tightness to make effectual pressure, but not so forcibly as to produce any chance of the circulation in the limb being completely stopped.

If, in bleeding from large arteries, compression can ever be prudently tried, it is when these vessels lie immediately over a bone. Bleedings from the radial and temporal arteries are generally cited as cases of this kind, though, from the many instances of failure which I have seen happen where the first of these vessels is concerned, I should be reluctant either to advise or make such an attempt. Compression is sometimes tried, when the brachial artery has been wounded in phlebotomy. Here it is occasionally tried, in preference to the ligature, because the latter cannot be employed without an operation to expose the artery.

"When the brachial artery has been wounded, in bleeding at the bend of the arm (says Mr. Crosse), I find so many instances narrated of successful management by pressure, that it seems imperative on us to regard this as the general rule of treatment. Sometimes the artery has been extensively obliterated by the pressure employed; at others, the same change has taken place in the vein; and one example is afforded of the aperture between the artery and the vein closing, each vessel remaining pervious after the cure. Pressure is, however, applicable only where a competent surgeon has the opportunity of employing it soon after the injury" (*J. G. Crosse*, in *Prov. Med. and Surgical Trans.* vol. v.); and, I would add, while the quantity of blood, effused in the cellular tissue, is not such as to interfere with its operation, or to render the trial of it likely to bring on mortification.

When there is a small wound in a large artery, the following plan may be tried: a tourniquet is to be applied, so as to command the flow of blood into the vessel; the edges of the external wound are next to be brought into contact: then, a compress, shaped like a blunt cone, and which is best formed of a series of compresses, gradually increasing in size, is to be placed with its apex exactly on the situation of the wound in the artery. This *graduated compress*, as it is termed, is then to be bound on the part with a roller.

In this manner, I once healed a wound of the superficial palmar arch, in a young lady in Great Pulteney Street. The outward wound was very small; and though the hæmorrhage was profuse, I conceived, that it might be permanently stopped, if compression could be so made as to keep the external wound incessantly and firmly covered for the space of a day or two. At first I tried a compress of lint, bound on the part with a roller; but this proving ineffectual, I took some pieces of money, from the size of a farthing to that of a half-crown, and, wrapping them up in linen, put the smallest one accurately over the wound, so as completely to cover it. Then the others were arranged, and all of them were firmly confined with a roller, and the arm kept as quiet as possible in a sling. They were taken off after three days, and no hæmorrhage ensued.

When the palmar fascia is not freely cut, it is conceivable, that it might prevent compression from operating on the vessel; but the foregoing case shows, that a wound of the superficial palmar arch is capable of healing, if the blood be completely prevented from getting out of the external wound by the proper application of compression. Were the outer wound free and open, it would be the safest practice to take up the ends of the vessel. Mr. Crosse, of Norwich, in more than one or two instances, has succeeded in tying the palmar arch when wounded, and would always *first* attempt it, going to another resource only when that had failed, or swelling and inflammation prevented it. He thinks it would be going a great length, to put a ligature on the brachial artery for a wounded palmar arch. (Op. et vol. cit.) Sometimes tying the ulnar artery has failed; but, under these circumstances, instead of tying the brachial artery, if the state of the wound would not bear pressure, I should prefer the trial of moderate compression of the radial artery, by means of a graduated compress, or the steel semicircle and screw, occasionally resorted to by Dupuytren, when he wished to check the flow of blood through any particular artery, without stopping the circulation in the limb. I feel confident that this plan would answer, when the ligature of the ulnar artery had not sufficiently commanded the bleeding.

Besides compressing the wounded part of the artery, some surgeons also apply a longitudinal compress over the track of the vessel above the wound, with the view of weakening the flow of blood into it. Whatever good effect it may have in this way, is more than counterbalanced by the difficulty which it must create to the circulation in the arm. If the graduated compress be properly arranged, an effusion of blood cannot possibly happen, and pressure along the course of the artery must, at all events, be unnecessary. After relaxing the tourniquet, if no blood escape from the artery, the surgeon (supposing it to be the brachial artery wounded) should feel the pulse at the wrist, in order to ascertain that the compression employed is not so powerful as entirely to impede the circulation in the fore-arm and hand. The arm is to be kept at rest in a sling, and in forty-eight hours, if no bleeding take place, there will be great reason to expect that the case will do well. In another work, I have given an engraving and description of an instrument, invented by Plenck, for making pressure on the wounded brachial artery, at the bend of the arm, without pressing upon the whole circumference of the limb, and consequently without stopping the circulation. No one, however, would prefer compression when large arteries are injured, except in the kind of cases to which we have just now adverted, or in those in which the wounded vessel can be firmly compressed against a subjacent bone. Sometimes the compresses slip off, or the bandages become slack, and a fatal hæmorrhage may arise; and a still greater risk is that of mortification from the constricted state of the limb. When the method is tried, the tourniquet should always be left loosely round the limb, ready to be tightened in an instant. Sometimes the external wound heals, while the opening in the artery remains unclosed, and a false aneurism is the consequence.

Tourniquet.

At the present day, the means for the temporary stoppage of the flow of blood through the arteries in operations, are reducible to two, viz. pressure, and, in a few instances, the preliminary application of a ligature on the trunk of the vessels expected to bleed in a dangerous degree. Pressure is made either with mechanical instruments or the hand. In amputations, M. Dupuytren rarely employed any other means but the hand of an intelligent assistant; and it was only in special cases that he had recourse to the ligature or mechanical pressure. The same rule is adopted by Mr. Liston in University College Hospital; and I sometimes dispense with the tourniquet myself. Two conditions are necessary to render pressure effectual, whether made with an instrument or the hand; the superficial situation of the artery, and its position upon a bone, or some other part sufficiently unyielding to admit of the vessel being pressed against it. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 377.)

M. Dupuytren confirms what every experienced operator is well aware of, namely, the fact of the flow of blood through the larger arteries admitting of being commanded by means of moderate pressure. But this must be made with precision, and perpendicularly to the surface, which serves as a point of resistance. The inclination of the surfaces of the bones on which the vessels lie, should therefore be recollected. For example, that of the upper surface of the horizontal branch of the os pubis faces upwards and forwards, and that of the first rib upwards and slightly outwards. Consequently, in the groin, the pressure should be directed from above downwards, and from before backwards; and in the hollow, above the clavicle, from above downwards, and from without inwards. If the operation about to be performed is likely to be long, or the artery is large or rather deep, M. Dupuytren recommends the assistant to place the fingers of his unemployed hand over those which compress the vessel, in order to second their action, and hinder them from being fatigued. But, before beginning the operation, the surgeon is always to assure himself of the exactness of the pressure. In some regions of the body, and in thin persons, the diastole and systole of the vessel are perfectly visible, and then the stoppage of them denotes that the pressure is well made. The total interruption of the pulsations, as ascertained by the touch, will leave no doubt on this point. There are some amputations, in which every modification of pressure may be dispensed with, even though arteries of great size are concerned: such are cases, in which the principal artery will be cut only in the final division of the parts, and in which an assistant, who can be relied upon, will let his fingers follow closely the knife, and seize hold of the flap containing the artery, and compress this vessel just before the section of the flap is completed. This method is practicable in amputations at the shoulder, and even in those of the hip. M. Dupuytren knew of only one case in which the preliminary ligature of the artery was absolutely necessary in amputation, viz. that in which the disorganisation of parts, and of the artery in particular, is such, that a definitive ligature on the surface of the stump would in all probability fail. In this circumstance he sanctions tying the arterial trunk above the point at which the amputation is to be performed. (See *Clin. Chir.* t. iv. p. 382, 385.) I would ask, however, should this measure be preliminary, or ought it not rather to be deferred till the failure of the ligature on the face of the stump has been proved? The performance of two severe operations, instead of one, must never be undertaken without a positive necessity. Most of the preliminary operations on the trunks of arteries, hitherto performed for the prevention of hæmorrhage during amputations, and in the removal of the upper or lower jaw, are now considered to have been unnecessary. In England, we should never amputate in parts known beforehand to be so disorganised, that ligatures would have no chance of securing the vessels on the face of the stump.

When hæmorrhage takes place from a large artery in one of the limbs, where the vessel can be conveniently compressed above the wound, a tourniquet, judiciously applied, never fails to put an immediate stop to the bleeding. Until the invention of this instrument, which did not take place till the latter part of the 17th century, and until it was known that a very moderate degree of well-directed pressure on an artery would stop profuse bleeding, surgery was really a very defective art. No important operation could be undertaken on the extremities, without placing the patient in the most imminent peril; and many wounds were mortal, which, with the aid of these simple expedients, would not have been attended with the least danger.

The first invention of the tourniquet has been claimed by different surgeons, and even different nations. But, whoever was the inventor, it was first presented to the public in a form so exceedingly simple, that it seems extraordinary its invention did not happen sooner. A small pad being placed on the principal artery of a limb, a band was applied over it, so as to encircle the limb twice. Then a stick was introduced between the two circles of the band, which was twisted; thus the pad was made to stop the flow of blood into the lower part of the vessel.

Although in the *Armamentarium Chirurgicum* of Scultetus, there is a plate of a machine invented by this author for compressing the radial artery by means of a screw, J. L. Petit is universally allowed to be the first who brought the tourniquet to perfection, by combining the circular band with a screw, so that the greatest pressure may operate on the principal artery.

The advantages of the modern tourniquet are, that its pressure can be regulated with the utmost exactness; that it operates chiefly on the point where the pad is placed, and where the main artery lies; that it does not require the aid of an assistant to keep it tense; that it completely commands the flow of blood into a limb; that it can be relaxed or tightened in a moment; and that, when there is reason to fear a sudden renewal of hæmorrhage, it can be left slackly round the limb, and, in case of need, be tightened in an instant. Its utility, however, is confined to the limbs; and, as the pressure, necessary to stop the flow of blood through the principal artery, completely prevents the return of blood through the veins, its application cannot be made very long without inducing mortification. It is of use also in putting a sudden stop to profuse hæmorrhages for a time, that is, until the surgeon has put in practice some other means, the effect of which is more permanent.

In the article Amputation, many observations will be found on the advantages and disadvantages of tourniquets in that operation. M. Dupuytren sometimes employed, instead of a common tourniquet, what he terms a *compressor*, which makes pressure only on two opposite points of the limb; but, as he acknowledges, it would not be sufficient, if it were necessary, as in a case of extreme debility, to arrest the blood in all the arteries of the limb. (See *Clin. Chir.* t. iv. p. 386.) The compressor is an old instrument, consisting of a segment of a circle of steel, and the pressure of which is regulated by a screw. It has often been tried in England for the cure of popliteal aneurism. It is an instrument which I think ought always to be kept ready in hospitals, where many cases present themselves, especially of secondary hæmorrhage from stumps, the palmar arches, &c., where its application might be of important use. Professor Regnoli, of Pisa, in a case of aneurism, where secondary hæmorrhage took place from the femoral artery, high up the limb, and where, in consequence of disease, another ligature would probably have failed, applied Dupuytren's compressor, and thus made moderate pressure on the bleeding point with complete success. (See Amputation and Tourniquet.)

Ligature.

The ancients were quite unacquainted with the use of the tourniquet; and though some of their writers have made mention of the ligature, they do not seem to have known how to make proper use of it, nor to have possessed any other certain means of suppressing hæmorrhage from wounds. In modern times, it is easily comprehensible, that when any great operation was undertaken, while surgery was so imperfect, there was more likelihood of the patient's life being shortened than lengthened by what was attempted. Under these circumstances, it is not surprising that the old practitioners should have taken immense pains to invent a great many topical astringents. But now that the ligature is known to be a means which is safer and less painful than former methods, no longer search need be made for specifics against hæmorrhage.

It may, indeed, be set down as a rule in surgery, that whenever large arteries are wounded no styptic application should ever be employed; but immediate recourse had to the ligature, as being, when properly applied, the most simple and safe of all methods.

In order to qualify the reader to judge of the best mode of applying ligatures to arteries, I shall first explain to him their effects on these vessels, as related by Dr. Jones.

This gentleman learned from Dr. J. Thomson, of Edinburgh, that in every instance in which a ligature is applied around an artery, without including the surrounding parts, the internal coat of the vessel is torn through by it; and that this fact had been originally noticed by Desault. Dr. Thomson even demonstrated to Dr. Jones, on a portion of artery taken from the human subject, that the internal and middle coats are divided by the ligature. (*Jones*, p. 126.)

This led Dr. Jones to make some experiments on the arteries of dogs and horses, tending to the conclusion, that *when several ligatures are applied round an artery*, with sufficient tightness to cut through its internal and middle coats, although the cords be immediately afterwards removed, the vessel will always become impervious at the part which was tied, as far as the first collateral branches, above and below the obstructed part. Dr. Jones thinks it reasonable to expect that the obstruction produced in the arteries of dogs and horses, in the manner he has related, "might be effected by the same treatment in the arteries of the human subject ; and, if it should prove successful, it might be employed in some of the most important cases in surgery. The success of the late important improvements, which have been introduced in the operation for aneurism, may perhaps appear to most surgeons to have rendered that operation sufficiently simple and safe ; but, if it be possible to produce obstruction in the canal of an artery of the human subject in the above-mentioned manner, may it not be advantageously employed in the cure of aneurism, inasmuch as nothing need be done to prevent the immediate union of the external wound ?" Dr. Jones next questions, whether this mode of obstructing the passage of blood through the arteries may not also be advantageously practised in cases of bronchocele ? (P. 136.)

Subsequent experimenters have not been equally successful with Dr. Jones in obtaining the obliteration of the cavity of the vessel after this operation. Did this difference depend upon their having tied the vessel only in one place ? Mr. Hodgson tried the experiment in two instances upon the carotid arteries of dogs, and in neither of them was the cavity of the vessel obliterated. The same experiment has been repeated by several surgeons upon the arteries of dogs and horses; but in no example, as far as Mr. Hodgson knows, has the complete obliteration of the cavity of the vessel been accomplished. However, as an effusion of lymph is an invariable consequence of the operation, the want of union is owing to the opposite sides of the vessel not being retained in a state of contact, so as to allow of their adhesion. (See *Obs. on the Application of the Ligature to Arteries, &c., by B. Travers*, vol. iv. *Med. Chir. Trans.*) The presence of the ligature, in the common mode of its application, effects this object ; and, for the success of Dr. Jones's experiment, it appeared only necessary that the opposite sides of the wounded vessel should be retained in contact, until their adhesion had been sufficiently accomplished to resist the passage of the blood through the tube. This object might probably be effected by compression; but the inconveniences attending such a degree of pressure as would retain the opposite sides of an artery in contact at the bottom of a recent wound, are too great to permit its employment. It occurred to Mr. Travers, that, if a ligature were applied to an artery, and suffered to remain only a few hours, the adhesion of the wounded surfaces would be sufficiently accomplished to insure the obliteration of the canal ; and by the removal of the ligature at this period, the inconveniences attending its stay would be obviated. The danger produced by the continuance of a ligature upon an artery arises from the irritation which, as a foreign body, it produces in its coats. Ulceration has never been observed to commence in less than twenty-four hours after the application of a ligature ; whilst it is an ascertained fact, that lymph is in a favourable state for organisation in less than six hours, in a wound the sides of which are preserved in contact. (*Jones*, chap. 4, exp. 1.) If it be sufficient, therefore, to insure their adhesion, that the wounded coats of an artery be kept in contact by a ligature only three or four hours, ulceration and sloughing may, in a great degree, be obviated by promoting the immediate adhesion of the wound. Justified by this reasoning, Mr. Travers performed several experiments, by which he ascertained that if a ligature be kept six, two, or even one hour, upon the carotid artery of a horse, and then removed, the adhesion is sufficiently advanced to secure the permanent obliteration of the canal. It appeared probable that the same result would be obtained upon the healthy artery of a human subject. (*Hodgson, On the Dis. of Arteries, &c.* p. 228 et seq.) Mr. A. C. Hutchison, in the year 1800, tied the brachial arteries of two dogs, and removed the ligatures immediately after their application. In both instances, the complete obliteration of the canal of the artery was the consequence of the operation. (See *Practical Obs. in Surgery*, p. 103.) He has also tried this method, as modified by Mr. Travers, in an operation which he performed for a popliteal aneurism in a sailor, in Nov. 1813. A double ligature was passed under the femoral artery ; the ligatures were tied with loops, or slip-knots, about a quarter of an inch of the vessel being left undivided between them. All that now remained of the pulsation in the tumor was a slight undulatory motion. Nearly six hours having elapsed from the application of the ligatures, the wound was carefully opened, and the ligatures untied and removed, without the slightest disturbance of the vessel. In less than half a minute afterwards, the artery became distended with blood, and the pulsations in the tumor were as strong as they had been before the operation. Mr. Hutchison then applied two fresh ligatures : hæmorrhage afterwards came on, amputation was performed, and the patient died. (See *Pract. Obs. in Surgery*, p. 102, &c.) Now, as Mr. Hutchison chose to apply other ligatures, on finding that the pulsation returned, the above case only proves that the artery was not obliterated in about six hours ; and we are left in the dark respecting the grand question, namely, whether the vessel would have become obliterated by the effusion of coagulating lymph and the adhesive inflammation, notwithstanding the return of circulation through it. As for the hæmorrhage which occurred, I think it might have been expected, considering the disturbance and irritation which the artery must have sustained in the proceedings absolutely necessary for the application of not less than four ligatures, and the removal of two of them. According to my ideas, only one ligature ought to have been used, and none of the artery detached. We also have no description of the sort of ligatures which were employed,—an essential piece of information in forming a judgment of the merits of the preceding method. The application, removal, and re-application of ligatures are not consistent with the wise principles inculcated by the late Dr. Jones, and have, in more instances than that recorded by my friend Mr. Hutchison, brought on ulceration of the artery and hæmorrhage. The researches of M. Manec lead him to conclude, with all the best practical surgeons of the present time, that the removal of the ligature at an earlier period than that of its spontaneous detachment is not likely to answer. He observes, that "the continuance of the ligature on the artery for some hours after the division of the internal and middle coats, is not sufficient in man to produce its closure. The plan succeeds but seldom in animals; dogs, for instance, whose blood is more plastic. On one hand, the adhesion of the parietes of the artery together is so feeble for the first five or six hours after the operation; and, on the other, the clot is so small, that the impulse of the blood and the disturbance of extracting the thread will destroy one and displace the other." (See *P. J. Manec, De la Ligature, &c.* p. 30.) If ever the practice, however, should merit revival, I invite the attention of the profession to the simple invention proposed by Mr. John Barker, of Ipswich, for loosening and removing the ligature. (See Aneurism.)

It appears, then, that the first effects of a ligature upon an artery are, a complete division of its internal and middle coats, the bringing of its wounded surfaces into contact with each other, and an obstruction to the circulation of the blood through its canal. There must be a small quantity of stagnant blood, just within the extremity of the artery; but this does not, in every instance, immediately form a coagulum capable of filling up the canal of the artery. In most cases only a slender coagulum is formed at first, which gradually becomes larger by successive coagulations of the blood; and hence the coagulum is always at first of a tapering form, with its base at the extremity of the artery. But, as Dr. Jones remarks, the formation of this coagulum is not material; for, soon after the ligature has been applied, the end of the artery inflames, and the wounded internal surface of its canal, being kept in close contact by the ligature, adheres, and converts this portion of the artery into an impervious and, at first, slightly conical sac. It is to the effused lymph that the base of the coagulum adheres, when found to be adherent. Lymph is also effused between the coats of the artery, and among the parts surrounding its extremity. In a little time the ligature makes the part on which it is directly applied ulcerate; and, acting as a tent, a small aperture is formed in the layer of lymph effused over the artery. Through this aperture a small quantity of pus is discharged, as long as the ligature remains; and, finally, the ligature itself also escapes, and the little cavity which it has occasioned granulates and fills up, and the external wound heals, leaving the cellular substance a little beyond the end of the artery much thickened and indurated. (*Jones*, pp. 159, 161.)

In short, when an artery is properly tied, the following are the effects.

1. The first action of the ligature is to pucker up, and press towards one another, the parietes of the artery, and, after they touch, if the ligature is further tightened, the internal and middle coats of the vessel are cleanly and regularly cut through; while the external coat, which, by being forcibly constricted by the ligature, has been the direct means of producing this division, resists the action of the ligature, and becomes interposed between the upper and lower margins of the wound in the other coats of the artery. Thus the ligature now only embraces the external coat, the two divided ones being retracted, one towards the heart, the other towards the capillaries. Hence, the cavity of the artery has a conical shape, above and below the ligature, and the points of these cones, formed by the edges of the division in the internal and middle coats, which are in apposition, hinder the blood from passing further, and striking against the external coat. As M. Manec observes, the whole operation of the ligature must be concentrated on this point; and the margins of the wound, in the middle and internal coats, are only held in contact, inasmuch as the external tunic presses upon them, and inclines them towards the centre of the artery. This pressure, which is sufficient to close the calibre of the vessel, does not interrupt the vital properties of these two coats; but the external coat, on which the ligature exclusively acts, is killed at the constricted point, and a suppurative, or rather an ulcerative, process must occur in this situation, in order to detach the dead circle of this external coat from the living parts, together with the ligature itself. Thus all the artery becomes severed; the internal and middle coats first; the external at a later period. (See *Manec, De la Ligature des Artères*, p. 14.)

2. Another effect is to occasion a determination of blood to the collateral branches.

3. To allow the formation of a coagulum of blood just within the artery, provided a collateral branch be not very near the ligature. It merits particular notice, however, that, though the nearness of a collateral branch always prevents the formation of the coagulum, it cannot always prevent the completion of the adhesive process. In the experiments made on the arteries of horses and dogs by Mr. Travers, the ligature was purposely applied close to large collateral branches, yet the vessels were safely obliterated. (See *Med. Chir. Trans.* vol. vi. pp. 658, 660.)

4. To excite inflammation in the internal and middle coats of the artery, by having cut them through, and, consequently, to give rise to an effusion of lymph, by which the wounded surfaces are united, and the canal is rendered impervious; to produce a simultaneous inflammation on the corresponding external surface of the artery, by which it becomes very much thickened with effused lymph; and, at the same time, from the exposure and inevitable wounding of the surrounding parts, to occasion inflammation in them, and an effusion of lymph, which covers the artery, and forms the surface of the wound.

5. To produce ulceration in the part of the artery around which the ligature is immediately applied, viz. its external coat.

6. To produce indirectly a complete obliteration, not only of the canal of the artery, but even of the artery itself, to the collateral branches on both sides of the part which has been tied.

7. To give rise to an enlargement to the collateral branches. (*Jones*, pp. 163, 164.)

Every part of an artery is organised in a similar manner to the other soft parts, and its coats are susceptible of the same processes of adhesion, ulceration, &c. as the latter parts are. Hence, the precautions taken to secure the adhesion of other parts, should be observed for the same purpose, with regard to an artery. The vessel is put in a state to admit of adhesion by the ligature, which, when properly applied, cuts through its internal and middle coats, keeps their cut surfaces in contact, and affords them an opportunity of uniting by the adhesive inflammation, as other cut surfaces do. The immediate stoppage of the bleeding is merely the incipient and temporary part of what the ligature has to accomplish: it has also to effect the adhesion of the internal and middle coats of the artery, which, being the thing on which the permanent suppression of hæmorrhage depends, is the most important. The size and form of the ligature, whether completely flat or irregular, have not been, as Dr. Jones remarks, sufficiently attended to; nor is the degree of force employed in tying the artery often considered. Some surgeons, wishing to guard against the ligature slipping off, tie it with very considerable force; while others, apprehensive of cutting through the artery, or of occasioning too early a separation of the ligature, draw it only sufficiently tight just to prevent the escape of blood. A broad flat ligature is not likely to make such a wound in the internal and middle coats of the artery as is most favourable to adhesion, because it is scarcely possible to tie it smoothly round the vessel, which is very likely to be thrown into folds, or puckered by it, and consequently to have an irregular bruised wound made in its middle and internal coats. By covering also a considerable space of the external coat, it may destroy the very vessels which pass on it in their way to the cut surfaces of the inner coats, and thus render them incapable of inflaming. Even supposing the wound to unite, still such a ligature may cover that part of the external coat which is directly over the newly united part, and, consequently, as soon as it has produced ulceration through the external coat, it will cause the same effect on the newly united parts, and of course secondary hæmorrhage. (*Jones*, p. 168.)

When a ligature is of an irregular form, it is apt to cut through the internal and middle coats of an artery more completely at some parts than at others; but these coats ought to be perfectly cut through, in order to produce an effusion of fibrine from the inside of the vessel, which seems to adhere most securely at its cut surfaces.

Also, when the ligature is not applied with sufficient tightness, the inner coats of the artery will not be properly cut through. Dr. Jones thinks that the ligature being sometimes put on so as to deviate from a circle, has a tendency to produce secondary hæmorrhage.

Dr. Jones conceives that ligatures are best when they are round and very firm; and he adds, that, though only a slight force is necessary to cut through the internal and middle coats of an artery, it is better to tie the vessel more tightly than is necessary merely to cut through its inner coats, because the cut surfaces will thus be more certainly kept in contact, the separation of the ligature expedited, and the danger of ulceration spreading to the newly cicatrised part diminished. The external coat will never ulcerate through before the inner ones have adhered. The limb, however, should be kept in a perfectly quiet state.

I am sincerely glad to find that so accurate an observer as Dr. Jones has refuted the idea, that ligatures occasionally slip off the vessels, in consequence of the violent impulse of the blood. In fact, the blood does not continue to be impelled against the extremity of the artery with the same impetuosity with which it circulated through the vessel before it was tied. The blood is immediately determined into the collateral branches, nor is there any pulsation for some way above the ligature. Dr. Jones, more rationally, imputes this accident either to the clumsiness of the ligature, which prevents its lying compactly and securely round the artery; or to its not having been applied with sufficient tightness; or to its having that very insecure hold of the vessel which the deviation from the circular application must occasion. (P. 173.)

Another circumstance in ligaturing the cut extremities of arteries, adverted to by Dupuytren, may cause the accident: — "The surgeon (says he) should avoid taking hold of only one side of the artery by placing one blade of the forceps into its canal; for it has sometimes happened that, when only a part of the circumference of the artery has thus been included in the noose, hæmorrhage has come on directly the wound has been dressed." (See *Clin. Chir.* t. iv. p. 399.)

Dr. Jones is of opinion, that in cases of aneurism, in which the artery has only been tied with one ligature, and left undivided, and in which secondary hæmorrhage has arisen, this has most probably been owing, either to a diseased state of the artery; to various contrivances for compressing a large portion of the vessel; to having a loose ligature above the one which is tied; or, lastly, to not tying the artery sufficiently tight to cut through the internal and middle coats, so as to fit them for adhesion. The latter fault can hardly fail to produce a gradual ulceration of those coats, and, of course, to bring on hæmorrhage, which returns with greater violence as the ulceration advances. (P. 176.)

These reflections must also obviously explain why Scarpa's practice of using a largish ligature, with the intervention of a piece of cloth between the cord and the vessel, for the express purpose of hindering the inner coats of the vessel from being divided, must be objectionable, because it may be set down as an axiom, in all operations where large arteries are to be tied, that the quantity of extraneous substances in the wound, and particularly of such as are in contact with the artery, should be diminished as much as possible. And, though I may be disposed to go so far with Scarpa as to believe, that the interposition of a piece of cork or wood is worse than that of a cylinder of linen, I cannot accede to the proposition, that the latter is free from objection, because it rather acts as a cushion than as a body likely to bruise. (See *Mem. on the Ligature of Arteries*, p. 44.)

With the differences in the constitutions of man and animals, I know that the results of experiments on the latter can never be looked upon as a positive proof of what would happen from the same experiments performed on the human subject. The stronger or weaker impulse of the heart, the more or less coagulable nature of the blood, the greater or less degree of general and local irritability, the more or less quick tendency to adhesive inflammation and ulceration, are circumstances which must make in different animals the same experiments lead to different results. The question, whether a small round ligature or a larger flat one, with a piece of linen between it and the vessel, be best, must therefore, after all, be decided, not by Dr. Jones's experiments, nor those of Scarpa or Mislei, but by the practice of surgery on the human body; and that the principles defended in this Dictionary are, on the whole, to be preferred, can hardly be questioned by any man who knows how much less frequent secondary hæmorrhage now is in this metropolis than it was formerly when those principles were neither observed nor comprehended. (See Amputation, Aneurism, Arteries, and Ligature.)

We may next inquire, are small round ligatures most advantageous when arteries are ossified? M. Manec states, that, under these circumstances, such a ligature will break the calcareous and cartilaginous deposits into irregular fragments, so that the external coat, instead of making moderate and uniform pressure on the section of the middle and internal tunics, is distended and violently pushed up by the irregular edges of each fragment. At one of these points, the external coat is likely to give way between the second and fourth day. M. Manec further notices the greater difficulty and slowness with which the exudation of a plastic lymph, the exhalation of an unctuous matter, and the formation of a clot, in an artery thus diseased and tied, occur, than in a healthy artery similarly treated. These considerations lead him to join Boyer (*Mal. Chir.* t. ii. p. 139, 155) in deeming small, round, firm ligatures, or even those which are composed of three or four threads, as improper for ossified arteries; he states, that they ought to be rejected, because they too quickly cut through the external coat. In these particular examples, he expresses a preference to arterial compressors (*presse-artères*), or to Scarpa's method, care being taken not to let the pressure, or constriction, be too considerable. In amputations, cases in which ossified arteries are frequently met with, M. Manec admits the unfitness of any arterial compressors, on account of their irritation and interference with the dressing of the stump. In these instances, therefore, he says, that either Scarpa's method, or, what is better, the introduction of a piece of bougie into the ossified artery, as practised by MM. Dupuytren and Roux, is the only resource. (See *P. J. Manec*, *De la Ligature*, *&c.* p. 25.) One inference made by him is, that when an artery is ossified or cartilaginous, the formation of a clot is the only thing which can be confided in as a means of closing the vessel. (P. 30.)

Dr. Jones seems to consider that the advantage of the retraction of the *divided* artery within the cellular tissue is compensated, in the case of the *undivided* artery, by the speedy and profuse effusion of lymph which takes place over and round the vessel at the tied part, and even covers the ligature itself. Another cause of secondary hæmorrhage is the including of other parts in the ligature together with the artery, by doing which the division of the inner coats of the vessel may be prevented.

In the valuable publication of Dr. Jones, to which I have so freely adverted, some secondary hæmorrhages are also imputed to the hidden separation, or laceration, of the recently united parts of an artery by premature and extraordinary exertions of the patient. Hence the necessity for keeping a limb, in which a large artery has been tied, perfectly at rest.

I shall conclude these remarks on the ligature with a few practical rules.

1. Always tie a large artery as separately as possible, but still let the ligature be applied to a part of the vessel which is close to its natural connections.

Besides the reasons for this practice already specified, I may observe, that the inclusion of other living textures in the ligature produces immense pain, and causes a larger part of a wound to remain disunited; the ligature is also apt to become loose as soon as the substance between it and the artery sloughs or ulcerates. Sometimes the ligature, thus applied, forms a circular furrow in the flesh, and remains a tedious time incapable of separation. In particular, the surgeon should take great care not to include in the ligature considerable nerves or veins: "intolerable pain, and, frequently, very serious effects, would immediately follow the constriction of a nervous trunk. Tying large veins does not produce any instantaneous bad symptoms; but it has often led consecutively to phlebitis, and been followed by symptoms which have too often proved fatal." (*Dupuytren, Clin. Chir.* t. iv. p. 399.)

The blood-vessels being organised like other living parts, the healing of a wounded artery can only take place favourably, when that part of the vessel, which is immediately contiguous to the ligature, continues to receive a due supply of blood through its vasa vasorum, which are ramifications of the collateral arteries. Hence the disadvantage of putting a ligature round the middle of a portion of an artery, which has been separated from its surrounding connections; and hence the utility of making the knot as closely as possible to that part of the vessel which lies undisturbed among the surrounding flesh.

Small arteries neither allow, nor require, these minute attentions to the mode of tying them.

2. When a divided artery is large, open-mouthed, and quite visible, it is best to take hold of it, and raise its extremity a little way above the surface of the wound, with a pair of forceps, or Assalini's double tenaculum. When the vessel is smaller, the common tenaculum is the most convenient instrument.

3. While the surgeon holds the vessel in this way, the assistant is to place the noose of the ligature round it, and tie it according to the above directions. In order that the noose may not rise too high, and even above the mouth of the artery, when it is tightened, the ends of the ligature must be drawn as horizontally as possible, which is best done with the thumbs. A knot is next to be made.

4. As ligatures always operate in wounds as extraneous bodies, and one half of each is sufficient for the removal of the noose when detached, the other should be cut off close to the knot and taken away.

As I have explained in the articles Amputation and Ligature, trials have been made of the practice of cutting off both ends of the ligature close to the knot, with the view of diminishing as far as possible the quantity of extraneous substances in the wound.

Upon the whole, the plan is not, however, considered to be advantageous, because the portion of the ligature, left in the wound, whatever be the materials of which it is composed, is never absorbed, but gives rise to small abscesses, or even causes a fistulous opening in a stump, of which I lately saw an instance in University College Hospital. In this case, as the two ends of the ligature had been accidentally, and not intentionally, snipped off, the cause of the fistula was, for nearly a fortnight, unsuspected.

5. When a large artery is completely divided, two ligatures,—one to the upper, the other to the lower part of the vessel,—are commonly necessary,

in consequence of the anastomosing branches conveying the blood very readily into the part of the artery most remote from the heart, when the ligature has been applied only to the upper extremity of the bleeding artery.

6. When a large artery is punctured, and compression cannot be judiciously tried, the vessel must be first exposed by an incision, only a small opening being made in its sheath, and then a double ligature introduced under it, with the aid of an eye probe. One ligature is to be tied above, the other below, the bleeding orifice, with due attention to the principles explained in this article and in that on ANEURISM.

7. Ligatures usually come away from the largest artery ever tied in about a fortnight, and from those of moderate size in six or seven days. When they continue attached much beyond the usual period, it is proper to draw them very gently every time the wound is dressed, for the purpose of accelerating their detachment. Great care, however, is requisite in doing this; for, as Dr. Jones remarks, as long as the ligature seems firmly attached, pulling it rather strongly must act, more or less, on the recently cicatrised extremity of the artery, which is not only contiguous to it, but is still united to that portion of the artery (the external coat) which detains the ligature. (*Jones*, p. 162.)

TORSION.

As even the most considerable arteries, in cases of lacerated wounds, frequently do not bleed, in consequence of the violent extension of these vessels, and the change produced in the disposition of their tunics, the idea of stopping hæmorrhage, by methodically twisting the end of the wounded arteries, led to trials of what is called *torsion*. The practice was first hinted at by Galen, and proposed in modern days by M. Amussat, in 1829, and about the same period also by MM. Velpeau and Thierry. (See *Sanson*, *Des Hémorrhagies*, p. 157.) After having ascertained, by experiments on animals, that torsion was capable of arresting hæmorrhage from the femoral, brachial, and carotid, and other arteries of magnitude, M. Amussat tried the method on the human subject in amputation, castration, and the removal of the breast. In one case he adopted it after amputation at the shoulder-joint. In none of these instances did any secondary hæmorrhage arise; but union by the first intention was followed only in one of the cases referred to, viz. that of a child. In 1829, M. Lieber, surgeon to the new hospital at Berlin, tried the plan with equal success; and, about the same period, it was had recourse to with success by Dr. Fricke of Hamburg, by MM. Rust and Dieffenbach of Berlin, and by M. Schrader of Dresden. On the other hand, in France, the practice of torsion proved unsuccessful after two amputations performed by Professor Delpech. As the patients did not die of secondary hæmorrhage, perhaps their cases have nothing to do with the advantages or disadvantages of torsion. In the hospital of St. Louis at Paris, however, torsion failed in five out of six cases of amputation. Baron Dupuytren, having been requested by the Institute to make a report of the merits of the plan, tried it in the Hôtel-Dieu, and came to the conclusion, that *torsion may be safely applied to arteries of small calibre, but that it is imprudent to trust to it when they are of large size.* (See *Clin. Chir.* t. iv. p. 410.) In a certain number of instances, torsion of the arteries has been followed by extensive inflammation and abscesses in the sheath of the artery.

With regard to its increasing the chance of union by the first intention, inasmuch as no extraneous substance is left in the wound, experience has not proved that it has any advantage over the ligature (*Dupuytren*, vol. cit. p. 411); and, as M. Manec's researches show, the process of torsion kills a small portion of the artery, and the little slough is, in point of fact, quite as much an extraneous substance as the ligature itself. (See *Traité Théorique et Pratique de la Ligature, &c.*; also *Sanson*, op. cit. p. 161.) Torsion is practised in two modes; in one, which is termed by the French *torsion libre*, the end of the artery is taken hold of with a pair of forceps, gently drawn out, and twisted round from four to six or eight times according to its size. This is the plan adopted by M. Thierry (*De la Torsion des Artères*, Paris, 1829), and by Dr. Fricke; but as it has been found sometimes to produce inflammation, extending along the coats of the vessel, and even to rupture a collateral branch, the plan recommended by M. Velpeau is mostly preferred in France. This gentleman takes hold of the end of the artery with a pair of forceps, having a groove or not, draws it out of the wound, and separates it from the surrounding tissues; then he takes hold of it near its base with a second pair of forceps, with which he fixes it, while with the first pair of forceps he performs the torsion, three or four times for small arteries, and eight for large ones. (*Sur la Cessation Spontanée des Hémorrhagies, &c.* Paris, 1830.) Some improvements were made in the practice of torsion by M. Amussat. He prefers forceps with longish flat blades, and which admit of being kept firmly shut with a screw. He aims particularly at dividing the inner coats, at the base of the end of the artery, with his finger-nail, or the second pair of forceps, and then pushes them away from the surface of the wound, as it were, into the vessel. The torsion then only affects the external coat. The artery is thus closed by a kind of double valve, or rather barrier; viz. that formed of the internal coats, and another by the twisted external one.

In practising torsion, great care should be taken not to introduce one of the blades of the forceps into the mouth of the artery, for then all the three coats might be torn, and the bleeding not be stopped. (See *Dupuytren*, *Clin. Chir.* t. iv. p. 405.)

We find, then, that torsion does not consist in merely twisting the end of the artery, but that the two internal coats are also to be separated from, and pushed back from, the external one by the manœuvres adopted. Then the torsion is of the external tunic.

As the twisted end of the artery sloughs, and necessarily excites some degree of suppuration, this fact seems to explain why torsion is not less objectionable than the ligature, as preventing union by the first intention. On the whole, I believe, that M. Dupuytren's report of it, above referred to, is as correct as it is concise. The ligature only interferes with the union by the first intention in the part of a wound where it lies: the rest may still heal in this desirable manner.

VENOUS HÆMORRHAGE.

Though *arterial* hæmorrhage in operations has received full attention, it must be acknowledged, with M. Dupuytren, that *venous* bleeding has not attracted due consideration. At the instant of the soft parts being divided, where the course of the blood has been suspended by compression, a profuse quantity of this fluid sometimes gushes from the wound. Inexperienced surgeons, alarmed by the circumstance, stop the operation, and, by deranging the compression already made, rather increase than lessen the bleeding. Here, according to Dupuytren, *the colour of the blood should guide the operator. If dark-coloured, it comes from the limb below the incisions*, and, as it will soon cease, is of no importance. But, in operating on parts abounding in veins, and in which the circulation has not been interrupted, the dark-coloured bleeding will sometimes go on, fill the wound, and hinder the operator's proceedings. This is often illustrated in laryngotomy and tracheotomy. In other instances, the blood flows out profusely from the large veins, which are divided, the patient turns pale, and seems as if he would perish on the operating table. Dupuytren observes, that the continuance of such hæmorrhage depends more upon the patient suspending respiration than on the size of the veins, and the blood, not being then able to pass through the lungs, makes its escape from the veins divided in the operation. Here it is inexpedient to apply ligatures, because if one set of veins were tied, another set would begin to bleed. But directly the patient has filled his lungs two or three times completely with air, by making full inspiration, the hæmorrhage ceases. These precepts were never forgotten by Dupuytren, whenever he divided considerable veins, either in the trunk, face, neck, or upper part of the limbs. (See *Leçons Orales de Clinique Chir.* t. iv. p. 392.) It would appear, from the researches of M. Poiseuille, that the interruption of respiration has influence only on the portion of the venous system above the diaphragm. (See *Journ. Univ. Hebdom. de Médecine*, t. i. p. 289, et t. ii. p. 97, 8vo. Paris, 1830.) However this may be, the practical observations of M. Dupuytren are highly important with reference to venous hæmorrhage in the extraction of fibrous tumors from the nose or antrum, tracheotomy, and all other operations in the anterior region of the neck, a region so abundantly provided with veins of all sizes. The long and deep inspirations, however, recommended for the suppression of venous bleedings, are suspected by M. Sanson to have had, in some instances, a share in promoting the entrance of air into the veins, particularly when one of those in the upper part of the body has been wounded, and when, in consequence of its parietes being indurated, it gapes, as was once exemplified to M. Delpech in the axillary vein. (*Clin. Chir. de Montpellier.*) The passage of air into the wounded veins, observed by Beauchêne, Dupuytren, Graefe, Mott, and Clemot, usually destroys the patient almost instantly, unless care be taken to place a finger over the wound in the vein, as was done by M. Clemot. (See *Sanson, Des Hémorrhagies Traumatiques*, p. 91.)

The hæmorrhage from the bites of leeches sometimes proves exceedingly obstinate, and instances of death from this cause have occasionally happened, particularly in children. When common methods fail, the plan has been recently tried of passing a fine sewing needle through the skin on one side of the wound, and then another through the skin on the opposite side, and next twisting some thread round the needles, so as to draw them together and close the bite. The experiment fully answered. (See *Lond. Med. Repository*, Jan. 1819, p. 23—26.) Simply transfixing the leech bite with a single small sewing needle, and passing a ligature around it answers equally well.

[ACUPRESSURE.]

[A novel method of arresting hæmorrhage has been lately introduced by a high authority in obstetric medicine, Dr. J. Y. Simpson, of Edinburgh, to whom the profession and the public are indebted for the selection of chloroform as an anæsthetic in preference to ether, and for many other original and important improvements in medical science. Dr. Simpson gives to this new method the term of "Acupressure," which he recommends to surgeons as a substitute for the ligature, the ordinary means now universally adopted by the profession for securing bleeding vessels. The needles, or rather pins, used for this purpose are straight, and of various lengths and thicknesses, guarded by a knob at one end and pointed at the other, resembling those employed in the operation for hare-lip. The mode of using the pins is described by Dr. Simpson in the *Edinburgh Med. Journal* for Jan. 1860, p. 647, from which I subjoin the following extracts.

"The whole process consists in passing the needle *twice* through the substance of the wound, so as to compress together and close, by the middle portion of the needle, the tube of the bleeding artery a line or two, or more, on the cardiac side of the bleeding point. In acting upon this mode, the surgeon may place the tip of the fore-finger of his left hand upon the bleeding mouth of the artery which he intends to compress and close; holding the needle in his right hand, he passes it through the *cutaneous* surface of the flap, and pushes it inwards until its point projects out to the extent of a few lines on the raw surface of the wound, a little to the right of, and anterior to, his finger-tip; he then, by the actions of his right hand upon the head of the needle, turns and directs the needle so that it makes a bridge, as it were, *across* the site of the tube of the bleeding artery, immediately in front of the point of the finger with which he is shutting up its orifice. He next, either with this same fore-finger of the left hand, or with the side of the end of the needle itself, compresses the locality of the bleeding arterial orifice and tube, and then pushes on the needle with his right hand, so as to make it *re-enter* the surface of the wound, a little to the left side of the artery; and, lastly, by pressing the needle further on in this direction, its point re-emerges through the *cutaneous* surface of the flap, and the site of the tube of the bleeding artery is in this way left pinned down in a compressed state by the arc or bridge of steel that is passed over it. The needle thus passes first from and through the skin of the flap *inwards* to the raw surface of the wound, and, after bridging over the site of the artery, it passes, secondly, from the raw surface of the wound *outwards* again, to and through the skin. Sometimes the needle will be best passed by the aid of the eye alone, and without guiding its course by the finger-tip applied to the bleeding orifice. To compress a bleeding artery against a bone is somewhat more complicated, but not much so. In accomplishing it, we have to introduce, from the cutaneous surface, a long needle through the flap of the wound obliquely to near the site of the artery, and then compressing, with the fingers of the other hand or with the end of the needle, the part containing the artery against the bone, we make the needle, after passing over this compressed part, and after testing whether it has closed the vessel or not, enter into the tissues beyond, and, if necessary, even emerge from the cutaneous surface on the other side, at an angle somewhat oblique to that at which it entered ; thus taking advantage of the resiliency and resistance of the soft textures to make them push the needle with the necessary degree of compression against the artery and bone. Arteries in particular parts require special adjustments and modifications to compress them against the neighbouring bone, which only experience can point out.

"It has been hitherto a difficult problem to obstruct the vessels of the ovarian ligament in ovariotomy, without leaving a foreign body, whether clamp or ligature, upon the stalk of the tumor, to ulcerate and slough through it. If the stalk be transfixed and pinned in its whole breadth to the interior of the relaxed abdominal walls, by one or more acupressure needles passed through these abdominal walls from without, this difficulty may possibly be overcome."

Dr. Simpson thus sums up the various important advantages which he conceives acupressure to present, as compared with the ligature :—"1st. It will be found more easy, simple, and expeditious in its application than the ligature. 2nd. The needles, in acupressure, can scarcely be considered as foreign bodies in the wound, and may always be entirely removed in two or three days, or as soon as the artery is considered closed; whilst the ligatures are true foreign bodies, and cannot be removed till they have ulcerated through the tied vessels. 3rd. The ligature inevitably produces ulceration, suppuration, and gangrene, at each arterial point at which it is applied; whilst the closure of arterial tubes by acupressure is not attended by any such severe consequences. 4th. The chances, therefore, of the union of wounds by the first intention should be greater under the arrestment of surgical hæmorrhage by acupressure than by the ligature. 5th. Pyæmia and surgical fever seem not unfrequently to be excited by the unhealthy suppuration, &c. in wounds, which are liable to be set up by the presence and irritation of the ligature. 6th. These dangerous and fatal complications are less likely to be excited by the employment of acupressure, seeing the presence of a metallic needle has not the tendency to create local suppurations and sloughs in the wound, such as occur at the seats of arterial ligatures. And 7th. Hence, under the use of acupressure we are entitled to expect both,—*first*, that surgical wounds will heal more kindly and close more speedily; and, *secondly*, that surgical operations and injuries will be less frequently attended than at present by surgical fever and pyæmia."

Dr. Greig, surgeon to the hospital at Dundee, tried acupressure in two cases of amputation of the fore-arm, and in a case of extirpation of the breast, and speaks in the most favourable terms of the facility of arresting hæmorrhage by needles. In a letter to Dr. Simpson, he expresses his intention of employing them in preference to ligatures in all cases under his care. "It is a great comfort," he says, "to both patient and surgeon, that by acupressure the artery is closed in about forty-eight hours (a large artery may, of course, require a longer time), and all cause of irritation at once removed. In my first case I allowed the needles to remain in for three days; but in future I will consider two days long enough, and, for all I know, perhaps it is longer than is required.

"I have now the greatest faith in acupressure, I intend employing it in all kinds of cases that may come under my care, and I will have no fear whatever to use it in my first thigh amputation.

"In giving directions for securing the vessel, you advise the surgeon to place the fore-finger over its bleeding mouth, &c. Now you will find it much better, when you have a flap, to keep the finger of the left hand on the skin side, and use the thumb. You feel the vessel beating between the thumb and fore-finger, and you can introduce the needle in the dark." (*Medical Times and Gazette* for Feb. 11, 1860, p. 137.)

Acupressure has likewise been practised to arrest hæmorrhage by Mr. Adams, of London; Mr. Edwards, of Dundee; Mr. Page, of Carlisle; Mr. Bickersteth, of Liverpool; Drs. John and James Struthers, of Leith; and Mr. Dickenson Crompton, of Birmingham; who appear to approve of the proceeding. It has not, however, been generally adopted ; nor is it, in my opinion, likely to supersede the use of the ligature, notwithstanding the powerful advocacy of its claims by its talented proposer.

Above all things the surgeon desires after his operations to feel assured that his patient is left secure from hæmorrhage, as regards the principal arteries of a limb. He knows that in his absence a few seconds of bleeding from a main artery will terminate the existence of his patient. No minor advantage in the healing of the wound can compensate for the risk and for the painful anxiety attending the idea that he may have left his patient liable to such a catastrophe. The most secure method, the one least liable to accidental disturbance, will always be preferred by the generality of surgeons. The ligature properly applied fulfils this all-important requirement. It remains to be proved whether acupressure can be equally depended upon, and whether stumps and wounds, in which acupressure has been resorted to in preference to ligatures, will heal more kindly by the first intention, and will be less likely to be followed by sloughing, by abscess, or pyæmia. It should be remembered that as many as a dozen ligatures may be required in some operations, and that acupressure needles to this amount must seriously interfere with the adjustment of the wound; and it is to be feared, also, that a stump thus circumstanced cannot so readily be supported without disturbing the needles, or interfering with the relative pressure exerted by each on the artery it is intended to constrict. Another advantage possessed by the ligature is, that the artery can be selected from the surrounding textures, and alone constricted ; while in acupressure the vein, the nerve, and other structures, are equally subjected to pressure with the artery itself. It is but fair to state, however, that this pressure has not hitherto been found injurious, and that no patient has as yet suffered from a recurrence of bleeding where acupressure has been resorted to, although four thigh amputations are included amongst the cases thus treated,—one by Dr. James Struthers, of Leith, two by Mr. Dickenson Crompton, of Birmingham, and one just below the trochanters, by Dr. Handyside, of Edinburgh.

(See *Edin. Med. Journ.* for Dec. 1860, pp. 504, 567; also for Feb. 1861, p. 692.)]

For additional information respecting hæmorrhage, see AMPUTATION, ANEURISM, ARTERIES, LIGATURE, and WOUNDS.

Consult also *Petit's* Mémoires, among those of l'Acad. des Sciences for the years 1731, 1732—1735. *Morand*, Sur le Changement qui arrive aux Artères coupées, 1736. *Pouteau*, Mélanges de Chirurgie. *Gooch's* Chirurgical Works, vol. i. *Kirkland's* Essay on the Method of suppressing Hæmorrhages from divided Arteries, 8vo. Lond. 1763. *White's* Cases in Surgery. *J. Bell's* Principles of Surgery, Vol. i. *Larrey*, Mém. de Chir. Militaire, tom. ii. p. 379. *Pelletan*, Clinique Chir. t. ii. p. 140, &c. *Richerand*, Nosographie Chir. t. iv. sect. sur les Maladies des Artères, p. 23, &c. edit. 4. *Jones*, On the Process employed by Nature in suppressing the Hæmorrhage from Divided and Punctured Arteries, 1805. *Hodgson*, On the Diseases of Arteries and Veins. *Benj. Travers*, Observations upon the Ligature of Arteries, and the Causes of Secondary Hæmorrhage, &c. in Med. Chir. Trans. vol. iv. p. 435 et seq. Likewise Further Obs. on the Ligature of Arteries, by the same, in Med. Chir. Trans. vol. vi. p. 632 et seq. *W. Lawrence*, On a New Method of Tying the Arteries in Aneurism, Amputation, &c. in vol. vi. of the Med. Chir. Trans. p. 156, &c.; and Crampton, in vol. vii. of the same work. *Langenbeck*, Bibl. b. i. *Dr. J. Thomson's* Lectures on Inflammation, p. 250, &c.; and Obs. made in the Military Hospitals in Belgium, p. 42—44. *Scarpa*, On Aneurism, and particularly his Memoir on the Ligature of Arteries: this is contained in the second edit. of the Transl. by *Wishart*. *Béclard*, Expériences sur les Blessures des Artères, Mém. de la Soc. Méd. d'Emulation, t. viii. *Robt. Harrison*, Surgical Anatomy of the Arteries, 2 vols. Dublin, 1824-25. *T. Turner*, On the Arterial System, &c. and the Surgical Treatment of Hæmorrhage, 8vo. Lond. 1825. *Velpeau*, Anatom. Chir. 2 tomes, 8vo. Paris, 1825. *John Green Crosse*, A Case of Amputation, with some Experiments and Observations on the securing of Arteries with minute Silk Ligatures, in Lond. Med. Repository, vol. vii. p. 353. *P. J. Manec*, Traité Théorique et Pratique de la Ligature des Artères, fol. Paris, 1832. *M. le Baron Dupuytren*, Leçons Orales de Clinique Chir. t. iv. art. 13, 8vo. Paris, 1834. *G. J. Guthrie*, On the Diseases and Injuries of Arteries, 8vo. Lond. 1830. *J. Lisfranc*, Des diverses Méthodes pour l'Oblitération des Artères, 8vo. Paris, 1834. *L. J. Sanson*, Des Hémorrhagies Traumatiques, 8vo. Paris, 1836. *Robert Carswell*, Illustrations of the Elementary Forms of Disease; Fasciculus 6, 4to. Lond. 1834. [*Miller*, Principles of Surgery, ed. 2, Edinburgh, 1850. System of Surgery, edited by Holmes, vol. 1; London, 1861.]

[HÆMORRHAGIC DIATHESIS. *Hæmorrhagic crasis* (*auc. var.*); *Hæmorrhopilis* (*Rokitansky*). A watery condition of the blood, coupled with a preternaturally delicate and vulnerable structure of the coats of the vessels.

This disease is by no means of uncommon occurrence in this country, and is met with in America, but is believed to be most frequent in Germany.

It is for the most part hereditary, affecting the males in families, although occasionally the females, and is very often transmitted for many generations to the males from the maternal grandfather through the mothers, although in some families the females have been known to die in after life during childbirth or from uterine hæmorrhage. It most commonly manifests itself at a very early period; but there is no certainty as to this, since it sometimes occurs for the first time in adult age. The liability to it declines as age advances, individuals of this diathesis having lived to be old, and died of other diseases. Men marrying healthy wives are said not to transmit the tendency to their progeny. Although hereditary in this remarkable manner, it is occasionally induced, even in this country, in previously healthy subjects, by anti-hygienic influences, as deficiency of food, pure air, light, and exercise.

Dr. John Hay asserts that "the children of bleeders are never subject to this disposition; but their grandsons by their daughters are." The circumstances connected with a case recorded in Mr. Wardrop's work, by Mr. Ward, of Ewell, are as follows: "His mother has a numerous offspring, and a brother who is twenty-two years old is afflicted in a similar way, and is also an almost constant sufferer with rheumatic gout. He had five uncles and two aunts; all his uncles had the same hæmorrhagic tendency. Three died from slight wounds, as division of the frænum linguæ, and the other had the same disease, but died from some other cause. The aunts had not that tendency in their persons; the one had three boys, two of whom were thus afflicted; the other had two boys and two girls; both boys were afflicted in the same way." Mr. Lane, from an investigation of the cases before him, at the time he wrote, came to the conclusion "that males only are subject to this peculiarity of constitution; that the father of a bleeder is always free from the disease; that the son of a bleeder is never affected by it; that the bleeder inherits this tendency invariably from his maternal grandfather." (*On the Hæmorrhagic Diathesis, by Samuel Lane. The Lancet*, 1840, vol. i. p. 185.) The later experience of the Germans seems to have shown that this is not an absolute law, although a very general rule.

The blood in this disease is essentially hydræmic, deficient in fibrine, and in extreme cases non-coagulable. The fibrine occurs in diminished proportion absolutely, and also in relation to the red corpuscles; differing in the latter particular from the blood of chlorosis. When coagulation takes place, the clot, remarkably destitute of firmness, is porous, being easily permeated by fluid, and consequently useless as a hæmostatic. Some observers have found the red corpuscles altered in structure, angular, or otherwise misshapen, jagged, and serrated; but in the early stages the blood is of the ordinary colour. Most of the structures, including the capillary vessels, and especially the arteries, are remarkably fine. The diminution of fibrine is accompanied with diminished viscidity. There is thus, failure, both in the coagulability of the blood and in the contractility of the vessels, the latter becoming almost passive and easily dilatable tubes, with a degree of fluidity of their contents favourable to hyperæmia and hæmorrhage.

The disease most frequently proves fatal by capillary hæmorrhage. The hæmorrhage is sometimes the result of a solution of continuity, and sometimes spontaneous. It is most severe from lacerated wounds. It may be periodical, recurring at regular or irregular periods, and has been known to return annually. Death may result from the slightest wound or surgical operation, and has happened very frequently from the abstraction of a tooth. Cases are also recorded in which the operations of bleeding, cupping, the introduction of a seton needle, the division of the frænum linguæ, also the accidental biting of the tongue, or a slight wound of a finger, have proved fatal. A small pebble fell on the nail of a finger of a boy under two years old, and blood issued from the end of the finger till he bled to death. (*Dr. J. C. Otto, lib. cit. passim.*) Frequently all the males of a family die of it. Sanson, in his Thesis for 1836, mentions the case of a man who died of urethral hæmorrhage, and six of his children from bleeding from casual wounds. In one family, Dr. Otto states, "So assured are its members of the terrible consequences of the slightest wound, that they will not suffer themselves to be bled on any consideration." The blood proceeds from the capillaries or the minutest ramifications of the arteries, no branch of any importance being involved.

This disease frequently exists without manifesting itself by any symptoms; and it is not until some accident occurs, or some operation has been performed, that the condition of the blood and blood-vessels becomes known. At other times a certain delicacy of constitution exists, by which, with the hereditary tendency, it may be predicated. In the more severe and fatal cases, apart from the accidental occurrence of hæmorrhage, there is a tendency to dropsical effusions. Ecchymoses also take place on the slightest pressure, or even spontaneously, and disappear slowly, leaving a yellow tint. Bullæ frequently occur filled with blood. There is a liability also to attacks of pain and swelling of the wrists, ankles, and knee-joints, attended with fever, which have been attributed to rheumatism, but can have no real analogy to that disease, in which the blood is essentially hyperinotic. The subjects of this disease are also more especially liable to epistaxis, hæmatemesis, hæmoptysis from the slightest cough, melæna, hæmaturia, and other hæmorrhages. A febrile paroxysm usually attends when the hæmorrhage sets in; but the symptoms of loss of blood rapidly supervene. The blood, at first of the usual colour and feebly coagulable, becomes gradually paler, and ultimately nearly colourless and incoagulable, the fibrine becoming exhausted, and the red corpuscles, which at first existed in something approaching their normal proportions, being also greatly diminished. There is loss of appetite; sometimes, but not always, thirst; the urine becomes gradually more and more limpid, and smaller in quantity, until it ultimately ceases to be secreted; the lips become dry; the breathing slow, with frequent sighing, and the action of the heart irregular, intermittent, and indistinct, and ultimately it ceases.

The theory has been advanced that this disease is the result of excessive hæmatosis, in relation to the strength and calibre of the vessels; the febrile and reactionary symptoms recurring periodically being the result of a certain degree of relative plethora; since even wounds are not followed by excessive hæmorrhage during the intervals. The hæmorrhage also is of rare occurrence in men affected with hæmorrhoids and in women during the menstrual period of life, and, as will be seen under the head of "treatment," it is often prevented by circumstances which diminish the quantity of the blood in the vessels, as purging and other depleting measures.

Schreyer states of a boy five years and another fifteen months old: "Both present, at variable intervals, on their legs and thighs, a number of blue spots which swell to the size of a pigeon's egg and then assume a yellowish green shade; they do not bleed, unless when opened artificially, but the hæmorrhage continues until the patient falls into a swoon, and his body becomes pale as death. The blood is at first red, and subsequently resembles water in which raw meat has been steeped; and at this period of the hæmorrhage the blue colour of the spots disappears. The further progress of the bleeding is arrested by the pressure of the finger on the orifice, which it is generally necessary to continue for twenty-four hours. The orifice is never closed by a well-formed coagulum. The children slowly recover, and continue to all appearance healthy until the next renewal of the hæmorrhage." (*Andral, Path. Anatomy, by Townsend and West,* vol. i. p. 418.)

The causes of this disease are involved in obscurity. Mr. Millar remarks that it bears an analogy, in some respects, to tuberculosis (scrofula), and in others to scorbutus. Virchow, on the principle that every dyscrasia is dependent upon a permanent supply of noxious ingredients from certain sources (*Cellular Pathology, transl. by Dr. Chance*, p. 132), points to the spleen or liver as being obviously associated with its production in many instances; but he admits that from our want of knowledge of the influence exerted by these organs over the special composition of the blood, it is impossible to determine how they produce such an effect. Leukæmia, in its advance towards its usually fatal termination, developes this hæmorrhagic state of the blood. In this disease, the spleen and lymphatic glands are the organs most frequently affected. (See LEUKÆMIA.)

On the post-mortem examination of a boy aged between three and four years, who died from biting his tongue, Mr. Wilson records that "the coats of the vessels of the arterial system were not more than half their usual thickness," and he attributed the hæmorrhagic tendency to a deficiency of the contractile power in the arteries. (*Lane*, lib. cit. p. 187.)]

In the last edition of this Dictionary Mr. Cooper remarks: Sometimes this extraordinary disposition to hæmorrhage is owing to an accidental cause little suspected. Thus, in an example which happened in the practice of M. Dupuytren, a tumor was found in the right auricle, completely blocking up and greatly dilating the superior vena cava, and extending into the jugular vein up the lower third of the neck: it also filled up the right subclavian vein. The patient, a young woman, lost fatal quantities of blood from the wound of the skin in venesection, and from the socket of a tooth. The actual cautery and all other means were tried in vain. (See *Sanson, Des Hémorrhagies Traumatiques*, p. 21.) A mechanical obstacle to the circulation, situated either in the heart or blood-vessels, is noticed by Dr. Carswell, as one of the causes of hæmorrhage; and, besides solutions of continuity, he likewise enumerates as causes a modification of the functions of the capillaries, as evinced in vicarious hæmorrhage, and that from erectile tissue. Nor does he omit a diseased state of the blood, as exemplified in scurvy, and some forms of purpura, and typhus fever. (See *Carswell's Illustrations of the Elementary Forms of Disease*, fasc. 6.)

[In illustration of the impropriety of the performance of surgical operations on the subjects of this disease, Dr. Millar has the following quotation:—"In a patient of a hæmorrhagic tendency, affected with white swelling of the knee-joint, a puncture of the tumor with a lancet was followed by the most alarming bleeding; yet a surgeon was found bold enough to propose amputation, which accordingly was performed in opposition to the opinion of a more cautious practitioner. The principal bleeding vessels were secured as usual, yet the patient bled to death, the blood continuously oozing from the stump in spite of all applications. (*Lancet*, No. 138, p. 99.)

Treatment.—For the purpose of improving the condition of the blood, and correcting the hæmorrhagic tendency, a tonic and invigorating course is indicated, and in particular, a full nutritious diet and free exposure to the open air and light, with the avoidance of all exhausting or debilitating habits. Iron, cod-liver oil, and bitter tonics have also to be employed, the first two being especially useful by increasing the amount of red corpuscles and diminishing the hydræmic condition of the blood. Whether the inhalation of an increased amount of oxygen, either by means of an apparatus for the purpose or the compressed air-bath, would produce a permanent increase of the fibrine, there are no experiments to determine. Saline purgatives have been found particularly useful. In one case, hæmorrhage appeared to be averted for a long period by a full dose of sulphate of magnesia taken as a purgative once a week. Citric acid has also been proposed as a prophylactic, owing to the resemblance which the disease bears to scurvy. But no general plan of treatment of this kind can avail much when the hæmorrhage sets in. Persons of this constitution should avoid occupations in which they are liable to wound or otherwise injure themselves.

In the treatment of the hæmorrhage much depends on energy, promptitude, and the judicious selection of remedies. Mr. Millar points out the desirableness of bearing in mind, that when the bleeding commences the blood is coagulable, which ceases to be the case as it continues to flow. Where the vessel could be reached all the usual methods of compression and the most powerful styptics, as the acid nitrate of mercury, the potential and the actual cautery, have been resorted to, sometimes successfully; but it has too frequently happened, even when the bleeding has been arrested, that it has broken out again, or that upon a subsequent attack the case has proved fatal. These remedies are treated of in full under another head (see HÆMORRHAGE); we therefore limit ourselves in this place to a statement of views entertained on the arrest of hæmorrhage in the hæmorrhagic diathesis.

Mr. Wardrop justly remarks, that substances which dispose the blood to coagulate have more effect in restraining the bleeding for a time than those which excite the arteries to contract. In the earliest stage the invigorating general treatment, already described, is indicated, to maintain or increase the amount of fibrine in the circulating blood. As the blood flows, at first more of the globules than of the fibrine are wasted and the proportion of the latter becomes relatively increased, a circumstance favourable to coagulation. Stimulants should not be resorted to in this stage, since they are calculated to rouse the circulation, and prevent that approach to syncope which frequently occurs and sometimes leads to coagulation. One patient took a bottle of port-wine daily, but continued to sink till the system of treatment was abandoned. (*Lancet*, No. 974, p. 149.) Mr. Millar suggests an irritant applied to some distant part and rapidly exciting a superficial inflammation, as feasible and safe, for the purpose of increasing the quantity of fibrine in the general mass of blood, and also acting as a derivative. And this gentleman remarks, that it is not rapid coagulation, usually affording a loose and porous clot, which is required, but just that solid and efficient clot which results from the slow coagulation of blood in inflammations. Dry cupping is also suggested as a derivative. "For the purpose of calming the general circulation and depressing the influence of the nervous system, thereby favouring a coagulation of the blood in the vessels," acetate of lead and opium may be given in doses of three to five grains of the former to half a grain of the latter, every four or six hours, according to the urgency of the symptoms. Of the astringent class of medicines, twenty grains of sulphate of alumina, every two or three hours, is amongst the best. A full dose of oil of turpentine has been successful in some hands. Nauseating doses of ipecacuanha or tartarised antimony are also recommended to moderate the general circulation and promote the coagulation of the blood in the capillaries, and to remove the febrile condition which attends the early stage of the hæmorrhage; but these should never be carried to emesis. Purgatives, and particularly the sulphate of soda, administered several days in succession, have been found remarkably useful in arresting the hæmorrhage, by Dr. Otto, Dr. Hay, and others. This has been attributed to their effect in diminishing the serous part of the blood. Elaterium, for the same purpose, is suggested by Mr. Millar, with the remark that its exhibition is practicable, administering support at the same time. Andral considered sulphate of soda the most efficient substance to retard the commencement of coagulation, and render the clot firm; and Mr. Millar adds that it is useful in obviating any bad effects that might result from a previous exhibition of lead, but the two remedies cannot be administered together. Upon the whole, Mr. Millar seems to regard the *Pil. Plumb. Opiat.* as the most powerful remedy, acting favourably on the blood, calming the circulation, subduing the nervous influence, and "correcting the degeneracy of the capillaries themselves." Wachsmuth recommends *secale cornutum* in doses of five grains every half-hour. The Germans, who regard the spontaneous bleedings as critical, lay it down as a principle that they should not be arrested too quickly lest a vicarious hæmorrhage occur in some vital organ.

Amongst the topical applications, Mr. Millar condemns the use of the *cautery*, actual or potential, in very decided terms. He believes that in the hæmorrhagic diathesis they have no virtue as hæmostatics, and that the former, especially, inflicts almost irretrievable injury. "The vessels are unable to pucker and contract; the eschar is comparatively soft, and will not adhere; if it does adhere, it is imperfectly, and for a short period; the parts have no plastic power necessary for permanent occlusion; and the result is, that the cauterisation either does not arrest the bleeding at all, or it does so only in part, besides mystifying and obscuring the source of the hæmorrhage; or if the cessation be satisfactory at first, the flow returns in a few hours with redoubled vigour; the bleeding surface is increased, the part is being inflamed, and more blood is sent thither, and perhaps, worst of all, it is fast becoming wholly intolerant of pressure." Mr. Millar quotes numerous cases which practically illustrate the correctness of these views, showing that in a great majority of the cases in which it has been employed death has resulted. To distinguish between *ordinary* hæmorrhage of local origin, and that proceeding from a *constitutional vice*, is thus of the greatest importance, "seeing that in the one the cautery may be demanded, and its use prove profitable; while in the other it will not only fail, but injure."

Deligation of the principal arterial trunk, which has occasionally been resorted to, is equally condemned by the eminent surgeon from whose paper we have so largely quoted. In Mr. Blagden's case of hæmorrhage after extraction of a tooth, quoted at large in former editions of this Dictionary, after the failure of a variety of remedies, including the cautery, Sir B. Brodie tied the carotid; but the case proved fatal. After tying a principal vessel, the flow of blood is quickly resumed on the distal side (see HÆMORRHAGE), and the capillary hæmorrhage can be but little, if at all, affected. Even should the original hæmorrhage be arrested, the patient's life will be compromised by bleeding from the recent wound. In a case of Mr. Wardrop's, in which the hæmorrhage was induced by the insertion of a seton, this gentleman secured no less than nine vessels; blood continued to ooze from innumerable small orifices over the whole surface of the wound, which every mode of treatment usually resorted to failed to arrest, and the patient died. (*On Bleeding*, p. 14.) M. Roux tied the radial and ulnar on account of bleeding from the palm; his patient died in the course of the evening; the blood oozed not only from the palm of the hand, but also from the two incisions of the fore-arm." For analogous reasons, general inclusion of the bleeding surface by ligature is equally inappropriate.

Styptics, by their local and astringent effects upon the capillaries, are useful in this, as in ordinary hæmorrhage; but the remedy most to be relied on is *pressure*. Creosote, perchloride of iron, or nitrate of silver, by forming a coagulum, may act powerfully for a short time as hæmostatica, and fulfil the important indication of obtaining a dry bed for a compress of lint or cotton; but their continued use being inconsistent with pressure, and far less important when this can be applied, they must be abandoned if they do not quickly take effect. Mr. Millar gives conclusive evidence, from numerous cases, of its beneficial results, and states his belief that, in every successful case, pressure, early and judiciously employed, has been found one of the most important agents of the cure. A lacerated wound has been known to cease to bleed by converting it into an incised wound.

All other remedies failing, the operation of *transfusion* has been resorted to. Mr. Lane had a successful case, the progress of which the writer of this article watched. The patient was a lad eleven years old, who had exhibited the hæmorrhagic tendency on former occasions. He had bled for six days from a wound made in the operation for strabismus, and was reduced to the most extreme state of spanæmia, threatening immediate dissolution, and as a last resource, when all hope had vanished, was saved by transfusion from the vein of a "stout healthy young woman." "The wound at the bend of the arm healed in about ten days, and the boy, after being wheeled out in a hand-carriage in the open air, soon recovered his appetite and strength, and in about three weeks went into the country, whence he returned in a few days perfectly well." (*Lancet*, vol. i. 1840, p. 185.) It is worthy of record that this lad died of consumption a few years afterwards.

Mr. Millar remarks on this operation:—"There is a risk of bleeding continuing to a dangerous extent from the wound made to reach the vein; but experience is not so very unfavourable on this point." "Wounds of the larger blood-vessels, such as that in venesection, are usually found to heal as readily in hæmorrhagic individuals as in any other set of patients. This, however, is not always the case." (*Med. Chir. Rev.* vol. xxix. p. 228.) "Hæmorrhagic patients have perished by the venesection wound. Such risks will justly deter us from having recourse to transfusion until other means have been tried and failed. But when *in extremis*, we ought surely to afford the patient the chance, and that no improbable one, to be derived from this *dernier ressort*, the more especially as we have at least one good fact in its favour afforded by Mr. Lane." (*On the Treatment of the Hæmorrhagic Diathesis, by James Millar, Esq., F.R.S.E. &c. London and Edin. Monthly Journal*, 1842, p. 567. This paper contains references to numerous cases and to the literature of the subject generally.)]

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HÆMORRHOIDS (from *αῖμα*, blood, and *ῥέω*, to flow). See PILES.

HÆMOSTATICS. Substances which arrest hæmorrhage. Of these the coagulum of blood is the most important. The greater the proportion of fibrine in the blood, and the more dense the clot, the greater its power as a hæmostatic. (See HÆMORRHAGE, HÆMORRHAGIC DIATHESIS.)

HARE-LIP. (*Labium Leporinum*, Lat.; *Bec de Lièvre*, Fr.; *Hasenscharte*, *Lippenspalt*, Ger.) A fissure or perpendicular division of one or both lips. The term has arisen from the fancied resemblance of the part to the upper lip of a hare. Occasionally the fissure is more or less oblique: it may be directly below the septum of the nose, or correspond to one of the nostrils. The two portions of the lip are generally movable, and not adherent to the alveolary process; in some cases they are closely attached to it.

Children are frequently born with this kind of malformation, which is called a *natural* hare-lip, while that which is produced by a wound is named *accidental.* Sometimes the portions of the lip, which ought to be united, have a considerable interspace between them, while in other instances they are not much apart. The cleft is occasionally *double*, a little lobe, or small portion of the lip, being situated between the two fissures ; this is termed a *double hare-lip.*

The fissure mostly affects only the lip itself, and usually the upper one. In many cases, however, it extends along the bones and soft parts forming the palate, even as far as the uvula; and sometimes those bones are entirely wanting. In a few instances, the jaw not only is imperfectly ossified in front, so that a cleft presents itself there, but one side of it projects forward, and is at the same time inclined too much outward, drawing with it the corresponding part of the palate, and the septum nasi, so that a very unsightly distortion of the nostril and nose is produced. Such cases are denominated *complicated hare-lips.*

[These deformities are often hereditary. Several children of the same parents have been so born. Mr. C. Forster records a very interesting case in which of nine children of a father who had hare-lip, two had hare-lip, and one defective palate; others had imperforate rectum. After the birth of the ninth child the operation for hare-lip was performed on the father, and there have been two healthy children since. (*Surgical Diseases of Children*, p. 30.) In common with many other deformities, hare-lip is the result of some arrest or irregularity of fœtal development. Simple hare-lip is merely non-union of the median labial fissure. This may be complicated by arrested development of one or more portions of the superior maxillary bone. The incisive portions of the bone, including the two incisor teeth on each side, have separate centres of development. In some animals each constitutes a separate inter-maxillary bone ; and in some cases of hare-lip it remains more or less perfectly detached — any fissure that may exist corresponding to the line of union between the maxillary and inter-maxillary bones, or rather between the incisive and the palatal and facial portions of the maxillary bone. There is, very rarely however, a central fissure with two lateral fissures superadded. Central fissure, resulting from non-union of the incisive and palatal portions of the two bones, accompanied by non-union of the soft parts, may be continued backwards through both hard and soft palate, and often so that there is free communication between the nasal and oral cavities. Fissure of the hard palate on one side only of the vomer is rare. In many of these complicated cases the soft palate is deeply fissured.

All these clefts or fissures are due to arrest of development prior to the end of the third month of fœtal existence. Wagner (*Verhandlungen der Gesellschaft für Gebürtshulfe in Berlin*) has seen two cases where union of the labial cleft took place within the uterine cavity. Dr. P. Frank, who saw one of these cases, has informed me that it was on the left side of the upper lip. Union had taken place with a distinct red cicatrix, and that deep indentation of the free margin which it is our object to avoid in operative proceedings.

Fissure of the lower lip, in the median line, is sometimes seen, and may be complicated by more or less fissure in the lower maxillary bone, but it is very rare.]

A hare-lip, in its least degree, occasions considerable deformity ; and when more marked, it frequently hinders infants from sucking, and makes it indispensable to nourish them by other means. When the lower lip alone is affected, which is rare as a malformation, the child can neither retain its saliva, nor learn to speak, except with the greatest impediment. The constant escape of the saliva, besides being an annoyance, is found to be detrimental to the health; for its loss impairs the digestive functions, the patient becomes emaciated, and even death would sometimes ensue, if the incessant discharge of so necessary a fluid in the animal economy were not prevented. Thus, a lady, who was in this state, consulted Tronchin, who immediately saw the cause of her indisposition, and recommended the fissure in the lip to be united: the operation was done, and the dyspeptic symptoms then ceased. And when the fissure pervades the palate, the patient not only articulates very imperfectly, but cannot masticate nor swallow, except with great difficulty, on account of the food readily getting up into the nose.

[It is believed that Dieffenbach's observation is confirmed by others, to the effect that more infants are born with double than with single hare-lip; and that the fact of more single than double hare-lips being operated on is accounted for by the great mortality in the double cases. In addition to the causes of mortality just enumerated, we must also remember that the inspired air is not warmed, as in the natural state of parts, before its entry into the air-passages.]

An early removal of the deformity must obviously be very desirable; but as it cannot be accomplished without an operation attended with some degree of pain, Dionis, Garengeot, and others advise waiting till the child is four or five years old, on the supposition that, at an earlier age, the child's agitations and cries would render the operation impracticable, or derange all the proceedings taken to insure its success. It is plain, however, that such reasons are not of great weight. A child four or five years old, and very often even one eight or ten years of age, is more difficult to manage than an infant only a few months old. Every child of the above age has a thousand times more dread of the pain than of the deformity, or of the inconveniences of the complaint to which he is habituated; while an infant of tender years fears nothing, and only feels the pain of the moment.

A more rational objection is the liability of infants to convulsions after operations; and this has induced many surgeons to postpone the cure of the hare-lip till the child is about two years old. This custom is also sanctioned by Sir Astley Cooper, who mentions in his lectures several instances which have either been communicated to him by others, or have occurred in his own practice, where operations for the cure of hare-lips in very young infants have had a fatal termination, in consequence of an attack of convulsions or diarrhœa. The period when dentition is completed, or the age of two years, he therefore sets down as the most advantageous for the operation.

Le Dran performed the operation on children of all ages, even on those at the breast. B. Bell operated with success on an infant only three months old. Muys advises it to be undertaken as soon as the child is six months old. Roonhuysen operated on children ten weeks after their birth, and all his contemporaries praised his singular dexterity and success. As an essential step to the success of the operation, he recommended hindering the children from sleeping a certain length of time before it was undertaken, in order that they might fall asleep immediately afterwards; and with the same view opiates have been prescribed.

Baron Dupuytren deems it unsafe to operate on newborn children, because their flesh is so soft that the pins readily cut through it, and because general mortality, independent of every particular cause, being at this age greater than at any other period of life, it would be imprudent to augment the chances of death which hang over the young being, by an additional one resulting from the operation. On the whole, he infers, that the best period for operating is when the infant is three months old. (See *Clin. Chir.* t. iv. p. 90—92.)

[More recent experience has led most surgeons of the present day to operate as soon as possible after birth. Dr. P. Frank informs me that he assisted Dr. Wagner to operate on a child two hours and a half after birth. I have done the operation myself four hours after birth, and the infant fell asleep before the application of the suture was completed. Langenbeck, who advocates early operation strongly, says he has frequently seen children fall asleep thus before the surgeon's task is over.

Quite apart from other considerations, early operation seems desirable on account of the acknowledged influence which closure of the labial fissure exercises in promoting union of the palatine cleft. In the first year of life, the growth of the incisive portion and alveolar process is more rapid than that of the palatine process. Union, therefore, must commence anteriorly, and it is obvious that it must be favoured by the pressure exercised by the united lip, which can then be used for the purpose of suction. Without this pressure, muscular action would evidently tend to increase the breadth of the fissure.]

Putting out of consideration the partial success which has attended the use of blistering plaster, for making the edges of the fissure raw and capable of union, all practitioners entertain the same sentiment with regard to the object of this operation, which consists in reducing the preternatural solution of continuity to the state of a simple wound, by cutting off the edges of the separated parts throughout their length, and then keeping these parts in contact until they have completely grown together. But, although such principles have been generally admitted, there was formerly some difference of opinion with respect to the best method to be followed in practice; some operators having preferred sutures for keeping the edges of the wound in contact, while others disapprove of them, believing that a perfect cure might always be accomplished by means of adhesive plaster and a uniting bandage, so as to save the patient from all the pain and annoyance of sutures.

Modern surgeons do not doubt that a hare-lip may possibly be cured by means of adhesive plaster and uniting bandages, quite as perfectly as with a suture; and they readily allow that the first of these methods, as being more simple and less painful, would be preferable to the latter if it were equally sure of succeeding. But it is far more uncertain in its effect. To accomplish a complete cure, the parts to be united must be maintained in perfect contact until they have contracted the necessary adhesion; and how can we always depend upon a bandage for keeping them from being displaced? What other means, besides a suture, affords in this respect perfect security?

I shall first describe the operation as usually performed at the present day. It may be divided into three stages. 1. Loosening the lip. 2. Paring the edges of the cleft. 3. Uniting the raw edges.

1. *Loosening the Lip.*—The first thing is to examine whether there is any adhesion of the lip to the gum; and, if there be, to divide it with a knife. Some authors (*Sharp*) recommend the frænulum, which attaches the lip to the gum, always to be divided: but when the hare-lip is at some distance from this part, it will not be in the way of the operation, and need not be cut. On the other hand, when the frænulum is situated in the centre of the division, it should be divided beforehand.

[In separating the lip from the alveolar process, to loosen the parts, Soupert (*Nouveau Procédé pour le Bec de Lièvre*, Brussels, 1858) is careful to preserve the labial frænum, as he imagines that in after-life the lip loses much of its characteristic expression if the frænum be removed.]

When one of the incisor teeth, opposite the fissure, projects forward, it must be drawn, lest it irritate the parts after they have been brought into contact.

Sometimes, but particularly when a cleft exists in the bony part of the palate, a portion of the upper jaw forms such a projection, just in the situation of the fissure in the lip, that it would render the union very difficult, if not impracticable. In this circumstance, the common plan has been to cut off the projecting angles of bone with a strong pair of bone-nippers. The part was then healed, and the operation for the hare-lip performed. Cutting off the projection of bone leads to a diminution in the diameter of the bone, which no longer corresponds to the lower jaw-bone, and great disfigurement, and even inconvenience in mastication, are the consequences. Hence, Desault used to employ simple compression, by which means the prominence was usually reduced in a few weeks, and the opportunity afforded of operating for the cure of the hare-lip. (*Œuvres Chir.* t. ii. p. 207.) Of course the actual necessity of using bone-nippers, or even of having recourse to compression, will depend upon circumstances; for if the prominence of bone be sharp and irregular, no surgeon, I conceive, would hesitate about the removal of such inequalities in preference to the trial of pressure; but a moderate prominence of bone, without any sharp, irritating edges, or angles, will not hinder the success of the operation; and even the propriety of removing teeth must entirely depend upon their being likely, by their direction, to irritate the lip, and disturb the union of the fissure.

One serious objection to cutting away the projection of the jaw is the deformity afterwards, likely to continue during life, from the deficiency of the incisor teeth; and another is the subsequent overlapping of the lower jaw, and its projection beyond the upper one; communicating to the mouth an appearance seen in very old subjects. These were the considerations which have induced me to employ pressure, which is much more conveniently applied by means of a kind of spring truss, adapted to the child's head, than with bandages, which would be seriously annoying, and the right action of which could not be regulated without the utmost difficulty. When some of the bone must be cut away, on account of its roughness and angular prominences, I advise the practitioner to remove only the irritating points, and afterwards have recourse to pressure.

In a boy, thirteen years old, where the alveolar process jutted forward, M. Gensoul took hold of it with a strong pair of forceps, and brought it into the perpendicular position by main force. This rough method succeeded perfectly. (See *J. F. Malgaigne,* in *Manuel de Méd. Opér.* p. 444, ed. 2.)

[There cannot now be any difference of opinion with regard to the advisability of pressing the prominent inter-maxillary bone backwards. As a general rule it should be done. Its removal is only indicated when it is very imperfectly developed or deformed. The manner of attaining the object is not of great consequence, provided it be obtained. Sometimes it may be pressed backwards by the fingers. Some operators divide the vomer; others follow Blandin's example, who fractured the osseous connection between the vomer and inter-maxillary bones. Langenbeck divides the triangular cartilage of the nose. If any portion of the projecting inter-maxillary bone be removed by cutting pliers, the actual cautery should be applied to the bleeding surface of bone, as oozing of blood is very apt to continue, and has proved fatal.]

2. *Paring the Edges of the Cleft.*—In the operation for single hare-lip, the grand object is to make as smooth and even a cut as possible, in order that it may more certainly unite by the first intention, and be of such a shape that the cicatrix may form only one narrow line. Hence, in this country the edges of the fissure are cut off with a sharp knife. One plan is to place any flat instrument, such as a piece of horn, wood, or pasteboard, underneath one portion of the lip, and then, holding the part stretched and supported on it, to cut away the whole of the callous edge. Another is to hold the part with a pair of forceps, the under blade of which is much broader than the upper one: the first serves to support the lip, the other contributes also to this effect, and, at the same time, serves as a sort of ruler for guiding the knife in an accurately straight line. When the forceps are preferred, the surgeon must of course leave out of the upper blade just as much of the edge of the fissure as is to be removed, so that it can be cut off with one sweep of the knife. This is to be done on each side of the cleft. But at the present day most surgeons remove the margins of the fissure by transfixing the lip with a long sharp-pointed narrow bistoury just above the upper end of the cleft, and then cutting towards the red portion of the lip, while the part is held and stretched by the surgeon himself, or his assistant. One side of the cleft is thus pared off, and then the other; particular care being taken to remove a small piece of the red part of the lip on each side, lest an ugly notch should be left in that situation. This is the plan ordinarily followed by Mr. Liston.

In France, the edges of the fissure are always taken off with a pair of strong, sharp, long-handled scissors, invented for the purpose by M. Dubois. (See *Alf. A. L. M. Velpeau,* in *Nouv. Elém. de Méd. Opér.* t. ii. p. 4; and *J. F. Malgaigne,* in *Manuel de Méd. Opér.* p. 442, ed. 2.) Scissors had an advocate in Desault (*Œuvr. Chir.* t. ii. p. 179); and B. Bell was also in favour of them.

In cutting off the edges of the fissure, the incision must be carried to the upper part of the lip; and even when the fissure does not reach wholly up the lip, the same thing should be done; for, in this manner, the sides of the wound will admit of being applied together more uniformly, and the cicatrix will have a better appearance. We should also not be too sparing of the edges which are to be cut off. Practitioners, says M. Louis, persuaded that the hare-lip was a division with loss of substance, have invariably advised the removal of the *callous* edges. But, in the natural hare-lip there is no callosity; the margins of the fissure are composed, like those of the lip itself, of a pulpy, fresh-coloured, vermilion flesh, covered with an exceedingly delicate cuticle. The whole of the part having this appearance must be taken away, together with a little of the true skin. At the lower part of the fissure a rounded red substance is commonly situated, which it is absolutely necessary to include in the incision. Were this neglected, the union below would be unequal, and, through an injudicious economy, a degree of deformity would remain. The grand object, however, is to make the two incisions diverge at an acute angle, so that the edges may be put into reciprocal contact their whole length, without the least inequality.

[The next object, after doing everything to secure perfect union by the first intention, is to prevent the formation of an indentation at the free margin of the united lip, just at the lowest point of the united fissure. This indentation is not only a deformity, but it must also impede, to some extent, perfect articulation of the labial sounds. Malgaigne's mode of paring the edges prevents this indentation. He separates a strip from each edge, by carrying two incisions from above downwards, towards, but not through, the free margin of the lip. The two upper thirds of the strip are then cut away, and the lower third pressed downwards and united, forming a projection downwards. Other operators obtain a nearly similar result by making an elliptical incision on each side instead of the oblique cut. The objection is, that infants are apt to suck at the small protuberance remaining at the inferior angle of the united fissure, and loss of blood may thus take place. The method of Langenbeck is perfect in this respect, especially when the fissure is lateral. One side is pared simply, the lower end of the cut curving outwards; the other side is pared almost after Malgaigne's method, and the lower free border, which is not removed, passes over the median line for some distance, and is united with the opposite border. The cicatrix is thus vertical at the upper part and oblique at the lower part, and no contraction of the cicatrix can lead to notching or indentation of the free border of the lip.]

These observations particularly refer to the most simple form of hare-lip, viz. to that which presents only one fissure. When there are two clefts, the cure is accomplished on the same principle; but it is rather more difficult of execution; so that the old surgeons, until the time of Heister, almost all regarded the operation for the double hare-lip as impracticable: only a few described it, with the direction to operate on each fissure, just as if it were single. M. de la Faye operated in this way with success. (*Mém. de l'Acad. de Chir.* t. iv. 4to.) M. Louis was of opinion that all difficulties would be obviated by doing the operation at two different times, and awaiting the perfect cure of one of the fissures before that of the other was undertaken. Experience proves, however, that it is not essential to perform two operations for the cure of the double hare-lip. Desault found that when the edges of the two fissures were pared off, and care taken to let one of the pins pass across the central piece of the lip, the practice answered extremely well. (See *Œuvres Chir.* t. ii. p. 201.)

Dupuytren had a particular method of operating in some cases of complicated hare-lip. He observed that when the labial tubercle was inserted very close to the point of the nose, its union to the lateral parts drew the lip upwards, and exposed the gums and teeth; while the nose itself was pulled down and flattened in a most ugly manner. Hence he conceived that it would be better to employ the labial tubercle in forming the lower part of the partition of the nose, and to unite at once the lateral portions of the lip. He first divided with a bistoury the fold of mucous membrane uniting the labial tubercle to the osseous one, and then, with a pair of cutting forceps, removed all such portions of the latter as projected beyond the anterior level of the jaws. He next pared off the sides of the cutaneous tubercle and its lower edge. These things having been done, the vertical margin of the fissure, on each side, was cut off with a pair of scissors. The two lateral portions of the lip were now brought together and united with two pins; and then the fresh-cut bleeding middle tubercle was laid over the bony partition of the nostrils, of which it was to form the lower portion. A third pin was applied so as to include at once the upper end of each part of the lip, and the loose extremity of the reflected tubercle. Lastly, two interrupted sutures united the angles of this tubercle to the lateral portions of the lip. The sutures were assisted with strips of adhesive plaster, and a bandage, that made pressure on the apex of the nose, so as to keep the flap from being too much stretched. (See *Clin. Chir.* t. iv. p. 92.)

[Four interesting cases in which this practice has been followed are recorded by Mr. Fergusson. (*Practical Surgery*, p. 572, 573.) Voss, of Christiania, has recently revived the operation *à deux temps*, first uniting one side to convert the double into a single hare-lip, and three weeks afterwards depressing the inter-maxillary protuberance and uniting the remaining fissure. The cases must be very rare, however, in which it would not be preferable to complete the operation at one sitting.

3. *Union of the raw edges* may be effected by ordinary insect needles, or hare-lip pins with glass or wax heads, or silver pins with movable steel points, or by some modification of the quill suture, such as Mr. Brooke's beads, or the metal button of Mr. Wood, of Gloucester; or, lastly, by the simple suture, interrupted or uninterrupted, of silk or of wire.]

Although the generality of surgeons use the twisted suture, Sir Astley Cooper gave the preference to the common interrupted suture, on account of the difficulty sometimes experienced in withdrawing the pins, and the liability of the new adhesions to be broken on the occasion; whereas the threads of a common suture may be cut, and taken out with the greatest facility. However, as most children cry on the removal of the suture, whether one kind or the other be employed, the only safe plan is not to withdraw the pins or ligatures till three or four complete days have elapsed from the time of the operation, when the adhesions will be tolerably strong; and the cheeks should always be held forward by an assistant, until the plasters, and, if deemed necessary, compresses and a bandage, have been put on.

[At Guy's Hospital, Mr. Cock and Mr. Forster have followed Sir Astley Cooper's practice, but employ the uninterrupted suture. Most surgeons, however, prefer some form of hare-lip pins, believing that union is more certainly attained by their use, and that the objection to the scar at the points of exit and entrance is trivial.] The simplest pin is that used by Dr. Barton, of Philadelphia, who prefers a piece of iron wire, with a point made by simply cutting it with a pair of scissors. Thus he avoids the risk of the steel point slipping off the pin, and remaining within the lip; an accident which Dr. Reese states has often happened. "So many failures" says he, "have occurred from the pins being torn out by the child, or catching in the nurse's clothes, that, if there were no other objection to the use of pins, they ought to be abandoned. Many surgeons in this country [the United States], and among these Dr. Mott, have adopted the interrupted suture in cases of hare-lip, and with the most satisfactory results." Notice is then taken of Sir Astley Cooper's relinquishment of the twisted suture. (See *Dr. Reese's Amer. ed. of this Dict.*)

It is obvious that a great deal of exactness is requisite in introducing the pins, in order that the edges of the incision may afterwards be precisely applied to each other. For this purpose some surgeons previously place the sides of the wound in the best position, and mark with a pen the points at which the pins should enter and come out again. The pins ought never to extend more deeply than about two thirds through the substance of the lip. [The lowest pin should be introduced first, just at the red margin of the lip, and close to the orifices of the bleeding coronary arteries, so that the pressure of the two opposed surfaces may compress the vessels and stop the bleeding. The next pin should be introduced about half an inch above the first; and a third, or even a fourth, may be necessary. A piece of thread or stocking-cotton is then to be repeatedly wound round the ends of each pin, from one side to the other, in the form of a figure of 8, each pin being treated separately. Lastly, the steel points of the pins are to be taken off by a pair of cutting pliers, and collodion may be brushed over the threads until they are saturated with it.

Various kinds of plaster, compresses, and bandages have been used for pushing the cheeks forward and causing the lip to part, so as to take off all strain upon the stitches. By far the best is Hainsby's truss, so strongly recommended by Mr. Fergusson. (Op. cit. p. 571.)

In general, the pins may be removed on the fourth day. When collodion has been used, no plaster is required, as the threads saturated with dry collodion adhere for many days, and form excellent splints. When collodion has not been used, or the threads have come off, a strip of plaster may be applied to support a delicate cicatrix.

Mr. Allen Duke (*Lancet*, 12 March 1858) recommends the use of internal sutures to secure union of the mucous membrane, and his practice has been followed by others; but it is not to be recommended, as these internal sutures irritate the infant unnecessarily.

If union by first intention fail, the granulating edges may be brought together again, either by suture, or by careful application of the truss and plaster; and good union is frequently obtained in this way after apparent failure.

During the first few hours after operation, it is always necessary to be on the watch for quiet insensible hæmorrhage into the child's mouth. A good deal of blood is often swallowed, and melæna is frequently observed after hare-lip operations. In those cases where young children have been said to die of "convulsions" after these operations, the convulsions have most probably been hæmorrhagic.]

The pins should be introduced at least two thirds of the way through the substance of the lip, lest a furrow should remain on the inside of the part which might allow pieces of food to lodge in it. There is, however, a stronger reason for attending to this circumstance, viz. the hæmorrhage which may take place when it is neglected. As soon as the edges of the wound have been brought together by means of the suture, and the pins are properly placed, the bleeding ceases; but when the pins have not been introduced deeply enough, and the posterior surfaces of the incisions are not applied to each other, the blood may continue to run into the mouth, and give the surgeon an immense deal of trouble. In the memoir written by Louis there is a case in which the patient died in consequence of such an accident. Persons who had undergone the operation were formerly advised to swallow their spittle, even though mixed with blood, in order to avoid disturbing the wound by getting rid of it otherwise. In the case alluded to, the patient, who had been operated upon for a cancerous affection of the lip, swallowed the blood as he had been directed to do, and he bled so profusely that he died. On the examination of the body, the stomach and small intestines were found full of blood.

When there is a fissure in the bones forming the roof of the mouth, it usually diminishes, and gradually closes, after the hare-lip is cured. But this does not always happen; and when the parts remain so considerably separated as to obstruct speech and deglutition, or cause any other inconvenience, a plate of gold exactly adapted to the arch of the palate may sometimes be usefully employed. In such cases dentists usually fix the plate of gold by means of springs of the same metal. Platina, which is cheaper, might be used for the same purpose. [The subject, however, of artificial palates is one on which much mechanical ingenuity has been usefully exerted, especially of late, since the hardened rubber called vulcanite has been used by dentists. Mr. Parkinson has published some interesting cases, showing how admirably this substance may be employed for artificial palates. Fissure of the soft palate may be closed either by operation, or by the addition of a sort of curtain of rubber to the vulcanite palate. (See Palate; Staphyloraphy.)

In cases where the notch or indentation has been allowed to remain after the cure of hare-lip, it may easily be remedied by paring off the red margin of the lip on both sides and uniting the raw surfaces accurately. The mucous ring formed by the lips is so extensible that this proceeding is very easy and successful.]

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HEAD, INJURIES OF THE. [Under this division are included all injuries affecting the scalp and pericranium, the skull itself, the membranes of the brain, and the encephalon.

The position of the human cranium at the summit of the spinal column, and the remarkable structure and arrangement of its bones, afford evidence of an all-wise provision against external injury; but its exposed position renders it liable to accidents from which no foresight could have protected it. The pulpy tissue of which the brain is composed is obviously predisposed to concussion, contusion, and laceration, from the unyielding nature of its bony walls, and this predisposition to injury increases as the skull becomes consolidated by growth; nevertheless the effects of external violence are very materially modified, by the elasticity and springiness of the processes of the *dura mater*, which are interposed between the segments of the brain, and by the soft cushion of cerebro-spinal fluid on which this delicate organ rests.]

Injuries of the Scalp.

[In this article will be considered, first, injuries of the scalp. The scalp is composed of the following tissues arranged in strata. The common integument constitutes the first layer; this is comparatively inelastic, and connected to the subjacent tendon of the occipito-frontalis muscle by aponeurotic slips, in the interspaces of which is found a large quantity of firm granular fat: numerous blood-vessels and nerves are distributed upon it, and it is endowed with a high degree of sensibility. Beneath this lies the occipito-frontalis muscle with its broad flat tendon stretched between its anterior and posterior muscular bellies. Laterally are the temporal aponeuroses and the temporal muscles.

The occipito-frontalis is loosely connected with the external pericranium by a distinct layer of cellular membrane, in which also are distributed innumerable small vessels. The intimate connection between the skin and the occipito-frontalis tendon is not without its interest in a surgical point of view, for it explains the fact that in extensive lacerations of the scalp it is rare that a part of any magnitude becomes completely detached; and as, from the same cause, the skin cannot retract after laceration, the edges of the wound are easily retained in apposition after they have been re-adjusted. A close sympathy between the various strata which compose the scalp results from the union of their blood-vessels,—a sympathy which from a similar cause exists between the pericranium and the bones, and between the bones and the dura mater: thus a continuous sympathy may be traced between the surface of the scalp and the cerebral meninges.

Contusions of the Scalp.— Independently of ordinary bruises, to which this part is obviously very liable, there are two forms of contusion of considerable interest, and which vary materially in their character and result: thus it happens that in bruises of the scalp effusion of blood occurs in some cases beneath the tendon of the occipito-frontalis to an enormous extent, whilst in others the effusion is limited to a circumscribed space, and from its peculiar position assumes a shape and condition which often lead the inexperienced to an entire misconception of its true character. There is scarcely any limit to the extent of the extravasation beneath the tendon of the occipito-frontalis: every surgeon of experience can bear witness to the truth of this assertion. We have seen the scalp raised up in the form of a soft undulating bag extending on either side as far as the zygoma, and protruding the skin of the forehead so as to produce a deformity in this direction which totally altered the outline of the features. Experience leads us to believe that these extensive effusions are more common in children. The effusion is occasionally bounded by an irregular line of coagulum which seems to limit its extent. Such effusions under simple treatment usually disappear in a few days, but occasionally partial suppurations occur, necessitating more active surgical interference. Rest, slightly elevating the head, cold applications, gently supporting but not compressive bandaging, comprise the category of external remedies; whilst free purging and a moderately anti-inflammatory regimen, succeeded by a more generous diet, are necessary to promote absorption of the effused blood. It happens occasionally that a portion remains unabsorbed for weeks; nevertheless it is better to abstain from cutting the scalp, unless a blush of inflammation indicates approaching suppuration: the formation of matter may be advantageously anticipated by an early opening.

When effusion of blood takes place in the meshes of the condensed tissue connecting the skin to the tendon of the occipito-frontalis, its extent is more limited, but it gives rise to a very remarkable condition. When the part is examined the impression communicated to the fingers is as if the surface of the scalp were depressed into a cuplike form: this is most probably due first to the limited extent of the effusion, and next to the imperfect coagulation of the blood, the centre being in a fluid state. Such cases may be mistaken for depressed fracture of the skull: the diagnosis is, however, very easy. If the thumb-nail is firmly pressed against the margin of the apparent depression an indentation is made, whilst if the bone is really depressed no impression can be made on it in this manner. It certainly happens that cases occasionally occur of such ambiguity that a surgical exploration is quite justifiable, even where the cupping arises from effusion of blood; for although no surgeon, in the absence of symptoms of pressure on the brain, would willingly cut through the coagulum to the bone for the purpose of examining the skull, yet if symptoms of pressure, however obscure, exist, he has no alternative, but must make an incision, as a fracture may be found beneath the extravasation, and effusion of blood upon the dura mater may be detected under the fractured bone. We have seen many instances of this. The local and general treatment for the relief of these limited effusions is similar to that recommended in the preceding class of cases, but bandages may be dispensed with. The effusion will be found generally in the meshes of the subcutaneous cellular tissue. We have verified this statement by necessary explorative incisions during life, and by post-mortem examination. Similar appearances may no doubt result from extravasation into the loose cellular membrane connecting the occipito-frontalis and the pericranium. In some severe contusions of the scalp a distinct pulsation may be detected in the centre of the bruised part: this arises from a rupture of numerous small arterial branches, and generally ceases after a time under the employment of ice and pressure. But a distinct small spurious aneurism is formed occasionally, requiring pressure for its cure; and if this fails it may be transfixed with pins and tied, or it may be incised and the wounded vessel sought and tied. We witnessed a doubtful case of spurious aneurism of the posterior branch of the temporal artery cured by the latter method: the aneurismal dilatation was very distinct, but there was some doubt as to whether a branch of the temporal artery had not been punctured.

In all cases of severe contusions of the scalp there is a great risk of suppuration beneath the tendon of the occipito-frontalis. When matter is formed, however limited the extent of the collection, it should be let out at once by a free pendent opening made through the tendon, the larger branches of the arteries being avoided. When suppuration occurs as a consequence of injury to the pericranium, the bones themselves may die; and, further, as a result of the continuous sympathy established between the parts, matter may be formed on the surface of the dura mater.

Of Punctured Wounds of the Scalp.—A puncture may penetrate all the tissues of the scalp: the generality of such cases usually soon get well under simple treatment; but it often happens that erysipelas supervenes, especially in persons who have led a debauched and irregular life, and this may be followed by sloughing of the occipito-frontalis tendon, or, as is much more common, by abscess. The characters of this form of inflammation are elsewhere considered, and the treatment to be pursued for its cure is so fully discussed that we forbear to make any further especial allusion to the subject. Although we cannot hesitate to admit that in these cases there is much risk of inflammation attacking the membranes of the brain or the brain itself, nevertheless experience leads to the belief that the principles of treatment which ought to guide our practice here differ in no material respect from those which are usually employed in the management of cases of traumatic erysipelas wheresoever existing. Pott and others have attempted to define the symptoms characterising the inflammation as it attacks the separate tissues of the scalp ; but much importance cannot be attached to this point, as in most cases all the strata of the scalp are simultaneously affected.

Incised Wounds of the Scalp require few special remarks: they vary in extent and depth, and are frequently accompanied by troublesome hæmorrhage when in the vicinity of the large arteries. As in the management of incised wounds in any other part, the surgeon's attention should be directed first to the arrest of the hæmorrhage, and pressure may be conveniently applied over almost any part of the skull for this purpose. We have a strong predilection for the ligature in all cases of bleeding where the ligature can be used. In hæmorrhage from wounds of the scalp, there is occasionally much difficulty in the application of a ligature; but generally this may be accomplished, especially in cases of recent wound, as the divided end of the artery can usually be seen projecting from the skin, into the dense structure of which it cannot retract: it may then be seized with the forceps, or a hook, and tied. When the bleeding has ceased the wound should be accurately adjusted with strips of simple plaster, and a retentive bandage should be applied.

With respect to the employment of sutures in wounds of the scalp, there need be no serious apprehension of any risk of erysipelas resulting from their use; but, as the scalp is but slightly elastic, and as there is consequently no disposition to retract after division, there can be no necessity for the use of sutures, unless under the extraordinary circumstances of extensive wounds, where large pendulous flaps hang loosely, and cannot otherwise be conveniently retained in apposition. These remarks apply to lacerated rather than to incised wounds. Incised wounds vary in extent and depth, and it can readily be believed that cases occurring in military practice are generally of far greater extent and importance than those which surgeons are in the habit of seeing in hospital or private practice : but all bear equal testimony to the fact of the ready curability of such cases, however extensive, by careful means, especially in healthy constitutions. Absolute rest in bed, with free purging, and the application of cold after the head has been shaved, are to be steadily enjoined, and we need fear no unfavourable result.

Lacerated wounds of the scalp vary in extent according to the force applied; but they have an undoubted tendency to assume a rectilinear direction. Wherever they are very extensive, the occipito-frontalis tendon is lacerated and raised with the integument. The most extensive wounds of this description we have ever seen have been those caused by the machinery used in our large cotton-mills; and they frequently happen in consequence of the long hair of the female operatives becoming entangled whilst the machinery is in rapid revolution. The extent of the laceration under such circumstances can be readily imagined. The entire scalp is sometimes completely torn away, or is left hanging by a slender piece of skin. But it fortunately happens that in such cases the pericranium is left entire. We have seen the whole surface of the calvarium, as well as the temporal fascia, the seat of healthy florid granulations after an injury of this description. These wounds eventually cicatrise completely. The scalp frequently becomes detached by falls upon the ground, or by the passage of heavy carriage-weeels over the side of the head. In such cases dirt, gravel, and other foreign bodies, are ground into the edges of the wound or beneath the pendulous flaps of skin, and the scalp is bruised so as to appear thoroughly spoiled. Troublesome hæmorrhage frequently attends extensive lacerations of the scalp, but it is occasionally absent. Hæmorrhage occurs from the torn arteries at the edge of the wound, and now and then it arises from the lacerated blood-vessels in the cellular tissue beneath the occipito-frontalis tendon. Although absent in the first instance, its occurrence is always to be apprehended after an accident and during the progress of the case, if suppuration and gangrene attack the part.

The treatment of lacerated wounds of the scalp is highly important, yet the principles of conduct are comparatively simple. If there is much bleeding, or indeed any hæmorrhage, pressure should be tried, or the bleeding vessel must be sought for and tied ; a ligature on the proximal end of the divided artery is sufficient. When there is no hæmorrhage at the time, it is better by the use of the sponge rather to encourage it than to leave the case with a risk of its occurring at a more unfavourable season. The source of hæmorrhage from the subjacent vessels is also to be sought for by carefully everting the torn scalp, and if the hæmorrhage be severe and difficult of control by pressure, it is advisable to make a free incision in the direction of the bleeding artery, and thus expose it. Pressure, if carefully and accurately applied, will usually suffice to stop all bleeding from the torn subjacent arteries; but, if the hæmorrhage continue, it may distend the scalp to a very great extent, and the artery must then be sought for and tied. There is nothing more embarrassing than the frequent recurrence of hæmorrhage in scalp wounds; amongst other modes of treatment, we have occasionally seen troublesome bleeding effectually arrested by the careful employment of the clamp tourniquet : of course this could not well be used in cases where the hæmorrhage arose from a wound of the scalp on the vertex of the skull, but the screw tourniquet could be used under such circumstances. We have spoken of the paramount necessity of directing attention first to the hæmorrhage : the next important point to attend to is the cleansing of the wound from all foreign bodies; but it is scarcely necessary to insist on this essential piece of simple surgery as especially requisite in wounds of the scalp. Having therefore carefully cleaned the wound, the hair being first shaven off, the separated parts are to be readjusted with the nicest accuracy. No part of the lacerated scalp, however damaged, is to be removed. We should not have alluded to this point had we not witnessed, within the last twenty years, a case where a surgeon had removed the whole scalp from a patient, which was hanging by a slender piece of skin : he had thus severed the only connecting medium of vascularity in a part which might have continued to live, and which by careful treatment would probably have again adhered to the surface of the calvarium. We cannot doubt that such barbarous surgery is now wholly exploded. There is no part of the body which adheres so readily to the subjacent parts as the scalp, and there are few parts which have so slight a tendency to slough after contusions, a condition evidently resulting from its great vascularity. If the surgeon prefers the suture, the parts may be kept together by interrupted sutures of silver wire or common silk, after which either strips of mild unirritating plaster may be laid down at intervals, or lint dipped in warm water may be employed, if the surgeon apprehend sloughing from the bruise the part has sustained. We are very averse, in the coaptation of lacerated wounds of the scalp, to the use of small pieces of adhesive plaster, so sedulously applied that no opening is left for the escape of blood and matter: it is far better to apply strips of plaster with intervals between them, leaving open spaces here and there, and to retain the whole by gently supporting bandages, over which wet lint may be lightly laid. We readily adopt the doctrine laid down by Pott, that sutures are highly advantageous in many cases of extensive and irregular lacerations of the scalp, although we are equally averse to their indiscriminate employment, as being in a vast majority of cases unnecessary. We do not recollect a single instance in which erysipelas could be fairly ascribed to their use. Lint soaked in warm water is preferable to cold applications where there is any risk of sloughing, but in a great many cases it is a matter of comparative indifference to which the preference is given. The dressings should not be renewed in less than forty-eight hours, and if there is no evidence of suppuration a much longer period may elapse before their renewal; but it is wrong to allow them to remain very long, particularly where, from the known or suspected habits of the patient, erysipelas may be expected. There is one thing the surgeon should be prepared for after extensive detachment of the scalp, namely, a partial union of the edge of the wound with suppuration beneath the detached scalp: this is attributable to the retention of slight effusions of blood. The matter must be pressed out through the wound, and compresses and bandages should be carefully applied; or it will become necessary to incise the scalp in dependent parts, taking care to avoid the track of large blood-vessels. Portions of the occipito-frontalis tendon often slough, especially when there has been much contusion of parts, and suppuration often results from this cause; therefore, if it is necessary, as is frequently the case, to give exit to the matter by incision, the surgeon should after the evacuation of the pus use gentle pressure with a sponge, and any piece of dead tendon may be carefully removed by the forceps, and thus a continual source of irritation will be at once removed. After the removal of all sloughs a bandage should be employed to retain without undue pressure the scalp in apposition with the subjacent parts, and a complete union will often be found to have occurred even in cases where the subjacent bone has been denuded of its pericranium.

By persisting steadily in this simple method, most extensively raised portions of scalp are found to unite completely to the subjacent parts, and at the edges of the wound; and the surgeon, as well as the patient, is astonished at the rapidity and completeness of the cure. It hence becomes an axiom in surgery, in the treatment of contused and lacerated wounds of the scalp, on no consideration whatever to remove the smallest portion of the damaged integument; and a favourable prognosis may generally be safely advanced. The modern improvements in surgery are in no class of cases more perceptible than in these; and much credit is due to the surgeons of the French and English schools for substituting this simple treatment for the barbarous mutilations of the older surgeons, who appear to have endeavoured rather to see how large a portion of the scalp they could sacrifice than how much they could save and restore to a sound condition. We cannot assent to the indiscriminate censure which has been passed on Pott's writings in reference to this subject. There is no doubt that in Pott's time it was the custom to cut away large portions of bruised scalp, but he distinctly cautions his readers against doing too much in this respect.

The constitutional treatment in lacerated scalp wounds must be strictly attended to. Abstractedly, the general treatment is the same as in similar wounds in other parts of the body, and may be comprised under the head of mild antiphlogistic treatment, with careful attention to the state of the bowels, to be followed by generous support. In cases which come under the notice of hospital surgeons in this metropolis, it is very undesirable to diminish the constitutional powers by low diet and depletory measures; but it may be requisite to modify our plans if there is much fever, and especially in cases of young and vigorous subjects, whose constitutions have received no injury from irregularities in diet, &c.: under this condition a more strictly antiphlogistic regimen must be enjoined at first, to be succeeded by more liberal diet and tonics when suppuration has once been established.

The liability to attacks of simple erysipelas in cases of wounded scalp has already been spoken of; and before quitting this subject we cannot too strongly advise the strictest attention to quietude and rest so long as any scalp wound remains unclosed. After the opening of abscesses, whilst wounds are discharging, exposure to a cold north-easterly wind often induces fatal erysipelas. We have witnessed these attacks so frequently, that in hospital practice we never allow a patient to leave the ward before the wounds are completely closed. There appears to be a peculiar predisposition in the scalp and face to a repetition of attacks of erysipelas, and such attacks, if repeated, are frequently fatal.

Erysipelas also of the phlegmonous character, where, indeed, all the tissues external to the cranium are involved, occasionally sets in; and, the disease extending even through the bones of the cranium by continuous sympathy, the dura mater and membranes of the brain, and even the brain itself, become simultaneously affected. So also the cellular tissue of the neck and chest, the pleuræ and pericardium, may become the seat of a similar disease from an extension of the inflammation; and we have witnessed a fatal result from effusion into the pleura and pericardium. Mr. Hewett (*Medical Times and Gazette*, vol. xl. 1855) mentions similar cases, and we can confirm Sir Benjamin Brodie's remarks by our own experience, that such a condition is frequently co-existent with disease of the liver or kidneys, or both; and there can be no doubt that in some instances it may be fairly attributed to that fatal form of blood-poison now recognised under the term pyæmia.

Contused Wounds of the Scalp.—Our remarks have been thus far confined to cases of lacerated wounds of the scalp, and there is little to add on the subject of contused wounds: in fact, our observations on the latter class of cases have been in a great measure anticipated, for many of the most serious forms of lacerated wounds are accompanied by a great degree of contusion. It will necessarily happen that where the scalp is much contused there is a greater liability to slough than in the preceding class of cases, and, where sloughing occurs to any extent, there is a risk of troublesome hæmorrhage. The local treatment requires some modification, as the employment of pressure at the part, and cold applications, are inadmissible; but sutures and light warm-water dressings may be used with a greater probability of success. Hæmorrhage also, which is very apt to occur during the sloughing process, may become exceedingly troublesome, and can rarely be arrested by pressure: indeed, pressure to the part the seat of hæmorrhage would only tend to increase the bleeding by favouring the sloughing process. Under such circumstances, and where it is difficult to recognise the source of the hæmorrhage, we may adopt the plan pursued under somewhat similar circumstances by Mr. Hewett, who carefully pressed upon each main artery of the scalp in succession, and thus discovered the trunk whence the bleeding proceeded, and then, by the application of pressure on the trunk itself, he succeeded in arresting troublesome hæmorrhage. If pressure does not stop the bleeding, a free incision must be made through the sloughing to the sound scalp in the direction of the bleeding vessel, and the artery must be secured with a ligature.]

Contusion of the Bones.

[In considering all doubtful injuries of the cranial bones, the surgeon must take into account the varied degrees of thickness and solidity in the crania of different individuals, for it is well known that there is great difference in this respect, and that, if we examine carefully a large number of calvaria, we shall probably not find two exactly of the same thickness. This is well understood by all practical anatomists, and suggests at once a cause for the great diversity in the consequences of contusions of the skull in different persons. The comparative thickness and elasticity of the bones of children, and especially of infants, should also be well considered; nor ought the different degrees of thickness in different regions of the same skull to escape our observation. Contusion of the bones may happen without laceration of the scalp, or any detachment of the pericranium or dura mater, and such contusions are often followed by very serious consequences. In severe cases the pericranium is broken up or detached altogether, as where a bullet directed obliquely against the cranium has traversed a large extent of the exterior of the skull, and made its appearance at a spot remote from the point at which it had penetrated the scalp: the pericranium then suffers much contusion, and is generally detached to a greater or less extent. In military surgery such cases are not uncommon.

However severe the contusion, the bone may still retain its vitality, and the scalp may reunite to the subjacent bone, even if the pericranium itself is detached; but if the dura mater is at the same time separated from the bone, the latter necessarily perishes. The surgeon, however, in the absence of symptoms of cerebral mischief, endeavours to procure a speedy reunion, where the scalp is raised, by a careful adaptation of the parts; and, in young and healthy subjects especially, further inconvenience need not be anticipated. If, however, suppuration occurs beneath the scalp over the contused bone, as, for instance, in the track of a ball, death of bone generally happens, and the surgeon expects its exfoliation. Necrosis may nevertheless be still confined to the outer table of the skull, and may take place only to a trifling extent; but, in old and cachectic subjects, death of bone frequently happens after contusion, and repeated attacks of erysipelas, gradually diminishing the already enfeebled powers of the patient, protract the cure indefinitely, or lead to fatal suppuration on the dura mater. The treatment of contusion of the bones of the skull should be mildly anti-inflammatory at first, to be followed by generous and even stimulating diet, and no local applications are preferable to the constant use of warm-water dressings.

Contusion of the skull-bones may be limited to the external table, or it may extend to the diploe, or it may involve the inner table of the skull at the same time. So also necrosis, as the result of the injury, may be limited to the outer table, or it may involve the inner table simultaneously. In by far the greater number of cases the outer table is alone affected, and the dead portion becomes readily separated by the agency of the adjacent living vessels, assisted materially by those of the diploe. This latter part, being very vascular, becomes a very important agent in the separation of the outer table of the skull, for the granulations springing from it may be seen almost to lift the dead portion from the subjacent part, and thus assist its removal; or it may be sometimes seen that irregular apertures are made through the dead bone, and, the granulations shooting through these openings, a gradual crumbling takes place, by which the dead part is removed without any decided exfoliation.

The death of the inner, which often accompanies that of the outer, table seldom takes place to the same extent. The fact is not uninteresting, as in some measure illustrating the cause of death of the inner table, which we believe to arise frequently in consequence of its vascular communication with the dura mater having been broken up at the time of the accident. In the examinations which we have made after death in cases of severe contusion of the bones with fatal injury to the brain, we have frequently seen very slight effusions of blood between the bone and the subjacent membrane at the seat of injury; and there is no doubt, although it often happens that such limited effusions are absorbed and the bone lives, that this is not invariably so, and the inner table occasionally dies from being thus deprived of its source of nutrition from the meningeal vessels. That the inner table dies also, as a consequence of the extension of the injury from without, there can be no doubt whatever.

In cases of contusion of the bones of the skull, with effusions of blood beneath the scalp, it was formerly the custom to make free incisions through the scalp down to the damaged bone, to prevent inflammation and its consequences, and in some parts of the skull, as in the temporal regions, this was considered especially desirable; but the practice is obsolete, and no surgeon would, in the absence of cerebral symptoms, consider himself justified in wilfully mutilating the scalp, and laying bare the contused bones, unless there were other reasons than those of an anticipatory character to justify this procedure. But after severe contusion, thickening of the pericranium to a limited extent occasionally remains, and this is accompanied by pain on pressure, severe headache, and symptoms of great constitutional irritation, and even epileptic convulsions have been distinctly traced to such a cause: under these circumstances a free incision through the pericranium to the bone itself is often followed by the happiest results, and all further mischief is prevented. We have also occasionally seen much benefit from incisions where the pericranium has been more extensively implicated, as in deep-seated inflammation of the scalp, involving the pericranium, and attended with fever, headache, and a sense of great constriction. There is one precaution requisite in incising the pericranium under such circumstances, namely, the avoidance of the large branches of the arteries of the scalp, as no advantage is gained by the loss of much blood. The relief appears to arise from the removal of the tension of the part by the incision, and by the escape of a moderate quantity of blood.

In many cases of contusion fatal inflammation attacks the bones, and extends to the membranes of the brain and the brain itself, long after the original injury. We quote from the writings of Pott two illustrations of this:—

"An elderly woman riding in a hackney coach, by a sudden jolt struck her head with great violence against an iron hook at the top of it. The blow gave her exquisite pain at the time, but that soon ceased, and as it caused neither wound nor tumefaction she took no further notice of it. At the end of near two months she was seized with a violent pain in her head, so violent that for several nights she was obliged to have recourse to laudanum, in order to obtain a little broken rest. In about a week the pain went off, and a tumor arose just where she had been stricken, that is, just in the middle of the sagittal suture. I opened the tumor and discharged a considerable quantity of discoloured and very offensive matter. I passed my finger into the opening, and to my great astonishment found it touched the dura mater. I removed a circular piece of the scalp, and found the two ossa parietalia bare, and carious for a considerable extent on each side of the suture; and in the middle of this carious piece, just in the track of the suture, a hole large enough to admit easily any man's forefinger without touching the edges of the bone. The dura mater lay at a considerable distance from the skull in that part: the discharge from within was very large and offensive, and about three months from the time of the accident she died suddenly in a kind of fit." (*Pott's Surgery, by Earle*, vol. i. p. 115.)

"A sailor, in an engagement, received a severe blow on the head by a large splinter: a small wound and a considerable bruise were the consequence, but they were so soon well that the man did duty in a few days. At about seven weeks' distance from the time of the accident, he began to complain of great pain in his head, which pain rendered him so incapable that he was put into the hospital at Gosport. He remained there about three weeks, frequently but not constantly in pain, and during that time had three or four fits of an epileptic character. He was now sent to St. Bartholomew's Hospital, where, having mentioned the circumstances of the blow, I was requested to examine him. There was not the least degree of swelling or inflammation, no mark or vestige of scar, nor any elevation of the scalp, or fluctuation under it. While I was examining his head, he had a slight attack of spasm; but on my desisting he became easy and tranquil. The circumstance of this attack, while I was pressing upon the part, did not at that instant strike me as worthy of notice; but upon reflection it appeared much so. The next day I made the same experiment with the same effect; that is, upon hard pressure he became convulsed, which convulsion ceased upon removing the fingers, but was followed by a rigor. On the following day I ventured to repeat the experiment; but the man was so immediately and so terribly convulsed that I determined never to try it again. It was agreed in consultation that, considering the inefficacy of all that had hitherto been done, and what had lately happened, the most probable method of attempting his relief would be by denuding and perhaps perforating the cranium, in the place where the pressure produced so strange an effect.

"The next day I removed a circular piece of the scalp, and found the pericranium not of a healthy or sound colour, nor adherent to the bone. The bone was carious, and had several small holes in it through which a sanies rose and fell, according to the motion of the blood in the brain. I applied a large trephine, without any regard to the suture, and removed a piece of skull. During the time of the operation the poor man suffered greatly from spasm; but, that over, he became easy and quiet. The dura mater was detached from the skull, and had matter on its surface which was extremely offensive. The ensuing night he passed ill, and the next day had such a rigor, that I verily believed it was the last trouble the man would have. The day after this I found him vastly better: the discharge had been large, but he had not suffered any return either of spasm or rigor, and his principal complaint was extreme lowness.

"Everything for several days wore a favourable aspect. On a sudden he was seized with all the symptoms of a peripneumony, and on the third day from that seizure died. No apparent cause of mischief was found either within or on the outside of the head; the dura mater was well incarned, and no lodgment of matter was seen." (Op. cit. p. 119.)

Persistence of fixed Pain in the Head after injury to the Bone.—Quesnay (*Memoirs of the Royal Academy of Surgery of France*) has collected together many cases in which, after contusions of the bones of the skull, pain has continued in distinct spots of the cranium, leading eventually to the necessity of applying the trephine. In some cases the bone has been found much condensed in texture; in some no evidence of disease has been recognised, whilst in others the disease has been eventually discovered after death in the brain or its membranes. We shall briefly refer to a few instances mentioned by Quesnay. M. Marechal was called to a girl who some time before had received a blow upon the head, which was speedily cured, except that a fixed pain remained over one of the parietal bones. It increased to such an extent as to give rise to fever, which was relieved by bleeding and other appropriate remedies. But the pain having existed for some years, M. Marechal deemed it prudent to apply the trephine. He easily discovered the seat of pain, and on sawing through the bone he remarked that it had the appearance of bone which had been long buried. The pain never reappeared. Morel also operated on two cases with the same result; but the pain depended in the first on suppuration beneath the bone, and in the other nothing particular was observed. In a case operated on by M. Vacher, the disease depended on a fungoid condition of the cortical substance of the brain, the fungi adhering to the dura mater, and the bone was thinned so as to resemble a sheet of writing-paper.

M. Gervais operated on a girl who had some time before received a blow on the back of her head, which left a fixed pain in the occipital region. Whenever the part was violently handled, syncope invariably followed. On cutting down upon the bone the pericranium was found detached, and the bone carious; it exfoliated, and all the symptoms ceased. Scultetus mentions a case of a child seven years old, who fell upon the forehead, and suffered afterwards fixed pain and convulsions. Four months after the accident an opening was made in the spot, and the bone was found dead beneath: the bone was *rugined*, and, healthy granulations springing up, a cure was speedily accomplished. Forestus also operated in like manner on a similar case, and with the same result. Some further observations are recorded by Quesnay to prove the efficacy of trephining in some cases of epilepsy, where the bone was the seat of the cause of the disease, or where matter was found beneath, to which we must refer the reader. (See also *Guthrie*, *On Injuries of the Head*, in which some cases of this description are related from various sources.)

Mr. Curling performed the operation lately on a young man the subject of epileptic fits, and where pain was experienced on firm pressure at the part: no benefit eventually resulted. The bone presented no positive signs of disease.

The effects of contusion are generally limited to the immediate seat of the injury, but the two following remarkable instances are mentioned by Hewett (loc. cit.) in which most extensive disease of all the skull-bones resulted from local contusion.

"A woman æt. 48 fell down a stair and received various injuries, one on the head, which confined her to bed for some days. From this time her health was bad; she complained of fixed pain in the head, and had a disordered state of her stomach and bowels. She was able, however, to attend to the ordinary duties of her family till about three weeks before her death, when she was seized with fever and outrageous delirium. These symptoms subsided after a bleeding; and next day she had erysipelas of the face, which went off in a few days. She was then able to be out of bed, but complained of a fixed and deep-seated pain on the right side of the head, a little above the ear, and there was a discharge of matter from the right ear. She continued in this state, sitting up part of every day, till three days before her death, when she became comatose with partial paralysis of the left side, and frequent convulsive motions of the right arm. She died on the third day after the occurrence of these symptoms.

"The cranium was very easily opened, the bones being remarkably soft. On raising the skull-cap, the inner surface of the whole upper part of the cranium exhibited a singular state of disease. The inner table seemed to be wanting through its whole extent, and there appeared the rough, irregular, and cancellated structure of the central part of the bone. Betwixt this surface and the dura mater there was the deposition of an adventitious membrane of a yellowish colour, varying from one twelfth to one eighth of an inch in thickness. In raising the skull-cap, this membrane, in some parts, adhered to the dura mater, leaving exposed the irregular cancellated structure of the bone; and, in other places, it adhered to the bone, exposing the dura mater, of its natural appearance. The parts affected by this singular state of disease were the frontal bone above the orbits, the whole of both parietal bones, the squamous portion of both temporal bones, and rather more than the upper half of the occipital bone. The greatest erosion was on the parietal bone, where several portions were very thin and transparent, and a few points were perforated. The external surface of the cranium was of a natural appearance, except at a few points where the erosion had perforated the bones by very small apertures. The immediate cause of death was an extensive abscess, probably recent, which was found in the lower part of the right hemisphere of the brain."

The next case alluded to is recorded by Mr. Drummond. "A sailor having fallen down a flight of stone steps received a contused wound of the scalp on the left side of the occipital bone. Some time afterwards a large piece of the bone was found denuded of its periosteum; he had repeated attacks of erysipelas, and within the space of six years he lost about five square inches of the right side of the frontal, parietal, and squamous part of temporal bones; the whole of the occipital to within a short space of the foramen magnum had disappeared, except a portion of the centre, of about two square inches, which was detached and movable. A large portion of the left side of the frontal, parietal, and temporal bones was in a state of caries, and a portion of the posterior part of each parietal bone remained as a slender arch over the vertex. The man is now alive and in good health. In neither of the cases just mentioned does there appear to have been any indication of a syphilitic constitutional taint."

There is something very unusual in both cases, which implies a most unhealthy state of constitution; for it generally happens that the death of the bone is limited to the immediate seat of the original injury, and the process of exfoliation is confined to this part, without extending in any degree to the adjacent bones, whilst in the cases just quoted a slow and insidious disease had been set up, which led to the gradual and irregular destruction of a very large portion of the bones which form the vault of the skull, although it does not appear to have been confined to this part. At any rate, whatever the true explanation of the occurrence of these phenomena may be, the cases are highly interesting, as showing to what extent disease originating in local injury may proceed, and for how long a time it may continue. Hence the necessity of using the greatest precaution in the treatment of all cases of contusions of the skull cannot be too strongly insisted on, and our prognosis should be always guarded.

Mr. Hewett has also alluded in his lectures to a remarkable case of hypertrophy of the cranial bones as a consequence of a severe contusion: the case is here quoted in his own words. "A master-builder, æt. 50, slipped from a scaffold from fifteen to twenty feet high and struck his head violently, receiving a severe concussion of the brain. All symptoms of cerebral mischief disappeared in a few days; but, some time after his recovery, this man found that he began to have some difficulty in getting on the hat he had been in the habit of wearing: the enlargement of his skull went on increasing, so much so, that he was obliged to have a new hat made; and from this period, from time to time, he found it necessary to have the size of his hats increased. The enlargement of his skull went on increasing. He suffered no inconvenience beyond the increased size of his head, and died at the age of 70, twenty years after the accident. His head was examined, when it was found that the great size of the head was altogether due to a diseased condition of the bones, which was all but limited to the vault, the base presenting very little alteration in its appearance." (Loc. cit.)

The diseased calvarium is preserved in the Museum of the College of Surgeons. In some parts the bones are nearly an inch, and are in no part less than half an inch in thickness. The circumference on the outside from the nasal eminence to the occipital protuberance measures 26 inches; that on the inside 21. All traces of the compact table of the bones have disappeared, the whole structure being reduced to a fine cancellous tissue, with cells for the most part very small, and irregular in form. The outer surface is perfectly porous, as if pricked with small pin points. The inner surface is permeated by large deep channels for the meningeal arteries. The brain and its membranes were perfectly healthy.

After exfoliation of portions of the bones of the skull, and after the removal of bone by the trephine, the interval is filled up by a tough ligamentous substance, in which minute bony spicula here and there appear, or by a thin layer of bony matter. There is no doubt that in some cases a complete closure of the opening occurs by bony matter gradually pushed forwards from the edge of the sound bone. This subject has been fully illustrated in a paper by Mr. Russell. (*Edin. Medico-Chirurg. Trans.*) But in all cases of extensive exfoliation it is desirable that the patient should wear some artificial protection over the skull.

Suppuration of the Dura Mater.—Serious inflammation of the brain and its membranes arises often during the progress of exfoliation. This depends on the extent of injury the parts implicated have sustained at the time of the accident; or it is traceable in trifling cases of injury to a disordered state of constitution resulting from irregularities in diet, &c. In hospital practice such cases are by no means rare.

The dura mater, when both tables of the skull are dead, is one of the most important agents in the detachment of the dead bone, and it partakes of the general salutary actions which are essential to this object; but, under the circumstances just mentioned, it often becomes the seat of disease, and symptoms set in of a character which no experienced surgeon can mistake, and which are the harbingers of fatal inflammation of the membranes of the brain.

These attacks are often so insidious in their approach that they are scarcely recognised; but careful attention to the progress of a case of this nature will not fail to detect some indisposition in the patient,—as a slight shivering, followed by a febrile attack, or some other symptom of general irritation,—enough to justify a suspicion that the membranes of the brain are the seat of incipient inflammation. It is, however, remarkable, that most extensive disease of the brain may exist, and that an abscess may occupy an entire hemisphere, without causing in its progress symptoms sufficient to justify a suspicion of its existence.

The writer has lately had under his care a case of fatal cerebral abscess occurring during exfoliation of a portion of dead bone, in which the only unfavourable symptom was an occasional attack of somnolency, which disappeared for a time, and left no trace behind. But the recurrence of these attacks, at irregular intervals, led to some suspicion that mischief was lurking within the cranium. This case will be further considered after the symptoms and pathology of suppuration of the membranes of the brain have been described, as it illustrates a point of much practical importance.

The following is the ordinary history of meningeal inflammation. A patient, in whom a portion of dead bone is exfoliating, after exposure to a blast of cold air, or from some irregularity in diet, whilst apparently progressing favourably, is suddenly seized with a severe rigor, succeeded by fever accompanied with extreme restlessness and general indisposition. Vomiting of bilious matter frequently also occurs at the beginning of the attack, and the skin, which is hot and dry, assumes a dark yellow hue. The eyes are intolerant of light, the pupils contracted, and the conjunctiva of the affected side is infiltrated with serum. The rigors and bilious vomiting frequently reappear without any regularity. There is great pain in the head, with a low muttering delirium. This is accompanied by hemiplegia and dilated pupil, and is succeeded by coma and death. If the wound is examined at any period after the commencement of the attack, the discharge, which was before healthy, will be found to have suddenly altered its character, and to have diminished in quantity; and, instead of presenting a healthy purulent aspect, it has assumed the appearance of what is commonly termed sanies; and the granulations, before florid and luxuriant, now become at first glassy, and then gradually disappear, and the bone puts on a pale yellow, or a blackish aspect. If the dead bone is raised by operation, the membrane beneath is found either in a sloughy condition, or coated with an unhealthy pus, which is sometimes contained in a circumscribed cavity, limited in extent to the size of the dead bone, but more frequently diffused over the surface of the dura mater; and the arachnoid cavity is also the seat of an unhealthy purulent secretion, either limited by a barrier of lymph, or extending over a large portion of its surface.]

Pott has given an admirable account of this formidable affection in injuries of the head. He observes, "The symptoms attending an inflamed or sloughy state of the membranes, in consequence of external violence, are all of the febrile kind, and never, at first, imply any unnatural pressure: such are, pain in the head, restlessness, want of sleep, frequent and hard pulse, hot and dry skin, flushed countenance, inflamed eyes, nausea, vomiting, rigor, and, toward the end, convulsion and delirium. And *none of these appear at first, that is, immediately after the accident; seldom until some days are passed.*"

This last observation, made by Pott, is one that is well worthy of the practitioner's constant recollection, lest he wrongly fancy his patient secure too soon, and neglect the early use of the only means by which a recovery can be effected. Thus, as Sir Astley Cooper notices, the time when inflammation of the brain (and it may be added of its membranes) follows the violence, is generally about a week; rarely sooner. Frequently, it does not come on till a fortnight or three weeks after the injury; and even more time must elapse before the patient is quite safe, or ought to deviate from a strict and temperate regimen. In confirmation of this remark, a case is mentioned, where the neglect to keep the bowels regular brought on a fatal attack of inflammation of the brain, as late as four months after the receipt of a blow on the head. (*Lectures, &c.* p. 339.) In University College Hospital, I have had several cases in which the bad symptoms began at very late periods after the accident.

One set or class of symptoms is produced by an extravasated fluid, making pressure on the brain and origin of the nerves, so as to impair or abolish voluntary motion and the senses; the other is caused by the inflamed or putrid state of the membranes covering the brain, and seldom affects the organs of sense until the latter end of the disease, that is, until a considerable quantity of matter is formed, which matter must press like any other fluid.

"If there be neither fissure nor fracture of the skull, nor extravasation, nor commotion underneath it, and the scalp be neither considerably bruised nor wounded, the mischief is seldom discovered or attended to for some few days. The first attack is generally by pain in the part which received the blow. This pain, though beginning in that point, is soon extended all over the head, and is attended with a languor, or dejection of strength and spirits, which are soon followed by a nausea, and inclination to vomit, a vertigo or giddiness, a quick and hard pulse, and an incapacity of sleeping, at least quietly. A day or two after this attack, if no means preventive of inflammation are used, the part stricken generally swells, and becomes puffy and tender, but not painful; neither does the tumor arise to any considerable height, nor spread to any great extent: if this tumid part of the scalp be now divided, the pericranium will be found of a darkish hue, and either quite detached, or very easily separable from the skull, between which and it will be found a small quantity of dark-coloured ichor.

"If the disorder has made such progress that the pericranium is quite separated and detached from the skull, the latter will even now be found to be somewhat altered in colour from a sound healthy bone.

"From this time the symptoms generally advance more hastily and more apparently; the fever increases, the skin becomes hotter, the pulse quicker and harder, the sleep more disturbed, the anxiety and restlessness more fatiguing; and to these are generally added irregular rigors, which are not followed by any critical sweat, and which instead of relieving the patient, add considerably to his sufferings. If the scalp has not been divided or removed until the symptoms are thus far advanced, the alteration of the colour of the bone will be found to be more remarkable; it will be found to be whiter and more dry than a healthy one; or, as Fallopius has very justly observed, it will be found to be more like a dead bone: the sanies, or fluid, between it and the pericranium will also, in this state, be found to be more in quantity, and the said membrane will have a more livid diseased aspect.

"In this state of matters, if the dura mater be denuded, it will be found to be detached from the inside of the cranium, to have lost its bright silver hue, and to be, as it were, smeared over with a kind of mucus, or with matter, but not with blood. Every hour after this period all the symptoms are exasperated, and advance with hasty strides; the headache and thirst become more intense, the strength decreases, the rigors are more frequent, and at last convulsive motions, attended in some with delirium, in others with paralysis, or comatose stupidity, finish the tragedy.

"If the scalp has not been divided till this point of time, and it be done now, a very offensive discoloured kind of fluid will be found lying on the bare cranium, whose appearance will be still more unlike to the healthy natural one; if the bone be now perforated, matter will be found between it and the dura mater, generally in considerable quantity, but different in different cases and circumstances. Sometimes it will be in great abundance, and diffused over a very large part of the membrane; and sometimes the quantity will be less, and consequently the space which it occupies smaller. Sometimes it lies only on the exterior surface of the dura mater, and sometimes it is between it and the pia mater, or also even on the surface of the brain, or within the substance of it, &c.

"As the inflammation and separation of the dura mater is not an *immediate* consequence of the violence, so neither are the symptoms immediate, seldom until some days have passed; the fever at first is slight, but increases gradually; as the membrane becomes more and more diseased, all the febrile symptoms are heightened; the formation of matter occasions rigors, frequent and irregular, until such a quantity is collected as brings on delirium, spasm, and death."

"When the scalp has been wounded," Mr. Pott observes, "the wound will for some little time have the same appearance as a mere simple wound of this part, unattended with other mischief, would have; it will, like that, at first discharge a thin sanies, or gleet, and then begin to suppurate; it will digest, begin to incarn, and look perfectly well; but, after a few days, all these favourable appearances will vanish; the sore will lose its florid complexion and granulated surface; will become pale, glassy, and flabby; instead of good matter, it will discharge only a thin discoloured sanies; the lint with which it is dressed, instead of coming off easily (as in a kindly suppurating sore), will stick to all parts of it; and the pericranium, instead of adhering firmly to the bone, will separate from it, all round, to some distance from the edges.

"This alteration in the face and circumstances of the sore is produced merely by the diseased state of the parts underneath the skull; which is a circumstance of great importance, in support of the doctrine advanced, and is demonstrably proved by observing that this diseased aspect of the sore, and this spontaneous separation of the pericranium, are always confined to that part which covers the altered or injured portion of the dura mater, and do not at all affect the rest of the scalp: nay, if it has by accident been wounded in any other part, or a portion has been removed from any part where no injury has been done to the dura mater, no such separation will happen.

"The first appearance of alteration in the wound immediately succeeds the febrile attack; and as the febrile symptoms increase, the wound becomes worse and worse; that is, degenerates more and more from a healthy, kindly aspect." (*Pott.*)

The same intelligent surgeon further observes "that it is no very uncommon thing for a smart blow on the head to produce some immediate bad symptoms, which after a short space of time disappear, and leave the patient perfectly well. A slight pain in the head, a little acceleration of pulse, a vertigo and sickness, sometimes immediately follow such accident, but do not continue many hours, especially if any evacuation has been used. These are not improbably owing to a light commotion of the brain, which, having suffered no material injury thereby, soon cease. But if, after an interval of some time, the same symptoms are renewed; if the patient, having been well, becomes again feverish and restless, and that without any new cause; if he complains of being languid and uneasy, sleeps disturbedly, loses his appetite, has a hot skin, a hard quick pulse, and a flushed, heated countenance; and neither irregularity of diet nor accidental cold have been productive of these; mischief is most certainly impending, and that most probably under the skull.

"If the symptoms of pressure, such as stupidity, loss of sense, voluntary motion, &c., appear some few days after the head has suffered injury from external mischief, they do most probably imply an effusion of a fluid somewhere; this effusion may be in the substance of the brain, in its ventricles, between its membranes, or on the surface of the dura mater; and which of these is the real situation of such extravasation is a matter of great uncertainty, none of them being attended with any peculiar mark or sign that can be depended upon, as pointing it out precisely; but the inflammation of the dura mater, and the formation of matter between it and the skull, in consequence of contusion, is generally indicated and preceded by one which Mr. Pott has hardly ever known to fail; *a puffy, circumscribed, indolent tumor of the scalp, and a spontaneous separation of the pericranium from the skull under such tumor.*"

Sometimes the scalp is so wounded at the time of the accident, or so torn away, as to leave the bone perfectly bare; and yet no suppuration on the dura mater may ensue. Hence, if the pericranium be only turned back, along with the detached portion of scalp, there may be probability of its re-union; and it should be immediately made clean and replaced, for the purpose of such experiment; which, if it succeeds, will save time, and prevent considerable deformity. Should the attempt fail, it can only be in consequence of the detached part sloughing. Hence, removing it with a knife, though allowed by Pott, is now never practised. Frequently, when the scalp does not adhere at once, it becomes attached to the cranium afterwards by a granulating process. When the detached piece sloughs, the worst that can happen is an exfoliation from the bare skull.

Sometimes the force, which detaches or removes the scalp, also occasions the mischief in question; but the integuments being wounded or removed, we cannot have the criterion of the tumor of the scalp for the direction of our judgment. Our whole attention must be directed to the wound and to the general symptoms. The edges of the former will digest as well, and look as kindly for a few days, as if no mischief was done underneath. But after some little space of time, when the patient begins to be restless, and hot, and to complain of pain in the head, these edges will lose their vermilion hue, and become pale and flabby. Instead of matter, they will discharge a thin gleet, and the pericranium will loosen from the skull to some distance from the said edges. Immediately after this, all the general symptoms are increased and exasperated; and as the inflammation of the membrane is heightened or extended, they become daily worse and worse, until a quantity of matter is formed and collected, and brings on that fatal period, which, though uncertain as to date, very seldom fails to arrive.

The method of attempting the relief of this kind of injury consists in two points: viz. *to endeavour to prevent the inflammation of the dura mater;* or, that being neglected, or found impracticable, *to give discharge to the fluid collected within the cranium, in consequence of such inflammation.*

Acceleration or hardness of pulse, restlessness, anxiety, and any degree of fever, after a smart blow on the head, are always to be suspected and attended to. Immediate, plentiful, and repeated evacuations by bleeding have, in many instances, removed these, in persons to whom, Mr. Pott firmly believes, terrible mischief would have happened, had not such precaution been used. In this, as well as some other parts of practice, we neither have, nor can have, any other method of judging, than by comparing together cases apparently similar. Mr. Pott had more than once or twice seen that increased velocity and hardness of pulse, and that oppressive languor which most frequently precede mischief under the bone, removed by free and repeated bloodletting; and had often, much too often, seen cases end fatally, whose beginnings were fully as slight, but in which such evacuation had been either neglected, or not complied with. This judicious writer "would by no means be thought to infer from hence, that early bleeding will always prove a certain preservative; and that they only die to whom it has not been applied: this, like all other human means, is fallible; and, perhaps, there are more cases out of its reach than within it: but where preventive means can take place, this is certainly the best, and the most frequently successful.

"The second intention, viz. *the discharge of matter collected under the cranium,* can be answered only by the perforation of it.

"When, from the symptoms and appearances already described, there is just reason for supposing matter to be formed under the skull, the operation of perforation cannot be performed too soon; it seldom happens that it is done soon enough."

In short, whenever the dura mater, after the head has received external violence, separates, or is detached spontaneously, from the bone underneath it, and such separation is attended with the collection of a small quantity of thin brown ichor, an alteration of colour in the separated pericranium, unnatural dryness of the bone, chilliness, horripilatio, languor, and some degree of fever, Mr. Pott considers the operation indispensably necessary to save the patient's life.

"When the skull has been once perforated, and the dura mater thereby laid bare, the state of the matter must principally determine the surgeon's future conduct. In some cases, one opening will prove sufficient for all necessary purposes; in others, several may be necessary."

Notwithstanding the operation of perforation be absolutely and unavoidably necessary, as Mr. Pott remarks, "the repetition of bloodletting, or cooling laxative medicines, the use of antiphlogistic remedies, and a most strict observance of a low diet and regimen, are as indispensably requisite after such operation as before: the perforation sets the membrane free from pressure, and gives vent to collected matter, but nothing more; the inflamed state of the parts under the skull, and all the necessary consequences of such inflammation, call for all our attention, full as much afterwards as before; and although the patient must have perished without the use of the trephine, yet the merely having used it will not preserve him without every other caution and care." (*Pott.*)

In relation to this subject, a remark, made by Sir Astley Cooper, merits notice: when pus lies between the dura mater and skull, the application of the trephine, he acknowledges, is a successful practice; but, according to his experience, this situation of the purulent matter is comparatively rare, as it generally collects between the pia mater and surface of the brain, *for which case an operation will be useless.* (*Lectures, &c.* vol. i. p. 325.) It is stated by Sir Benjamin Brodie, that in hospital practice, suppuration between the dura mater and the bone, in consequence of fracture, is also less common at the present period, than when Pott wrote; a change which he refers to the stricter antiphlogistic plan adopted by modern surgeons, whether the early symptoms be or be not of a dangerous description. (See *Med. Chir. Trans.* vol. xiv. p. 411.)

My own observations agree with those of Sir Astley Cooper, respecting the greater frequency of purulent matter under, than upon the dura mater. Some months ago, I trephined a patient who had paralysis and other symptoms of pressure, preceded by those of inflammation within the skull. I was partly induced to do so for the purpose of removing a necrosis, which, I conceived, might extend through both tables, and be a source of irritation. The matter, however, was not under the sequestrum, which consisted merely of the outer table, but was diffused both between the arachnoid coat and dura mater, and also more deeply over the pia mater. The operation was therefore useless. In two other cases which proved fatal in University College Hospital, there was, indeed, pus on the surface of the dura mater; but there were also abscesses in the substance of the brain. Two fine specimens of this are preserved in the College Museum. The operation of trephining, therefore, in suppuration on the dura mater, will often fail, not merely on account of the circumstances here adverted to, but because the brain and its membranes are actually in a state of inflammation. The matter may be discharged, but its pressure is not the only mischief. La Peyronie relates a case in which an incision was made in the dura mater, and a basin of pus discharged, leaving a cavity that reached to the corpus callosum. The patient recovered. (*Acad. de Chir.* t. i. p. 250.) Baron Dupuytren ventured in one instance to make a puncture, an inch deep, in the brain, and was fortunate enough to reach the abscess: the case ended well. (*Pathol. Med. Ch.* t. iv. p. 308.)

I think it not improper to recommend again the practice of applying cold wet cloths to the head for the prevention and relief of inflammation of the dura mater; a plan to which, as already explained, Schmucker ascribed a good deal of the success with which he treated injuries of the head.

Both tables of the skull sometimes exfoliate in consequence of external violence. Here the dead bone must be removed, as soon as loose; and, if necessary, the scalp divided for the purpose. M. Velpeau sets down this as a case requiring the trephine, without exfoliation being awaited, and this whether symptoms of pressure exist or not; and he gives three cases in support of this doctrine. (*De l'Opér. du Trépan*, p. 23.) I have seen cases in which the patients recovered by the exfoliation of both tables; but some of them encountered so much danger, that I suspect their chance of recovery would have been increased by acting on the principle inculcated by M. Velpeau. Yet, where the symptoms are not urgent, I should recommend awaiting exfoliation. M. Velpeau is, perhaps, rather too zealous an advocate for this practice. (*De l'Opér. du Trépan*, p. 79.)

[The puffy tumor of the scalp, mentioned by Pott as indicative of suppuration on the dura mater, although occasionally found, is generally absent. When the scalp is entire, and the bone beneath is carious or dead, there is necessarily suppuration under the scalp, and the tumor is then developed; this, however, happens wholly irrespective of the formation of pus on the dura mater. But when matter forms under the dead bone during its exfoliation, it is generally preceded by sloughing of the scalp, and the bone is consequently bared of its external covering. After injury to the skull bones, however, if symptoms of meningeal irritation occur, and if it is necessary to examine closely the condition of parts with a view to an operation, an incision should be made in any part of the cranium where there is swelling or puffiness. Hewett (loc. cit.) has carefully collected information from various sources on this subject, and he has come to the conclusion that the puffy tumor as pathognomonic of suppuration on the dura mater rarely exists. The writer's experience corroborates this opinion.

Suppuration is not commonly confined to the dura mater, but it is so occasionally, and the disease is sometimes limited to the space between the dead bone and this membrane: the symptoms are then milder in their character, and rather indicate pressure on the brain than great cerebral irritation. Hemiplegia, preceded by a slight attack of fever, is frequently the only symptom present. Such cases are remediable at once by the escape of matter when the bone is elevated. But nature often accomplishes the cure in a very simple manner: thus, small openings are formed through the bone by the granulations underneath, or at the margin of the necrosed bone, and the matter gradually oozes through, or is forced up by the heaving motion of the brain. The surgeon should now, from time to time, insinuate the flat end of a probe, and endeavour to elevate the bone, the parts being kept continually moistened with wet lint lightly laid over: soon the bone will become gradually loosened, and there will be no difficulty in raising it.

The dead bone, however, is sometimes firmly fixed in position, as if held *in situ* by atmospheric pressure, so that considerable force is required to detach it; the force should be so directed as not to risk injury to the parts beneath: a small screw attached to the end of an ordinary probe, may be carefully introduced into the dead bone, and it may be thus readily elevated, a contrivance adopted by Liston in a case of this description. If the bone cannot be raised, it must be at once perforated by the trephine, in order to relieve the brain from the pressure of matter beneath it.

Suppuration is seldom limited to the upper surface of the dura mater; it generally extends far deeper than this, and the arachnoid cavity, the meshes of the pia mater, and the cerebral hemisphere in many cases are the seat of suppuration. The symptoms mentioned by Pott, whose remarks have been quoted *in extenso*, are really not those of suppuration of the dura mater; they indicate, as it is shown from the writings of other surgeons which have been alluded to, a disease of a far more formidable character, and which the trephine is by no means calculated to rectify.

Arachnitis is indeed the prominent feature in these cases, and it is not difficult to assign a proper cause for this: in fact, there are two causes in operation at the same time in many of these cases: first, inflammation from the irritation of the dead bone, and this is common enough; and, secondly, pyæmia, which may arise during the suppurative process, and thus give rise to fatal arachnitis, terminating in suppuration in the cavity of the membrane. In suppuration resulting from the latter cause, no advantage can be expected from the trephine, and the danger is often materially enhanced by the coexistence of purulent deposits in the lungs and liver, or inflammation of the pleuræ or peritoneum.

In corroboration of the opinion as to the inutility of trephining, the cases adduced by Mr. Hewett may be referred to. These cases tend to prove that, notwithstanding they were accompanied by general pyæmia, the damaged bone and its consequent irritative effects were the primary cause of the subsequent fatal mischief. In all Hewett's cases, five in number, pus or diseased dura mater, was discovered under the denuded bone. In three, pus extended along the course of the corresponding middle meningeal artery; in all pus or sero-purulent fluid was found in the arachnoid cavity on the corresponding side; in two, pus was found in the superior longitudinal sinus; in three, the lungs were infected with pus.

Certainly the most serious cases are those in which symptoms of pressure, as hemiplegia and coma, are combined with signs of meningeal and cerebral inflammation, and which frequently coexist with abscess in the brain. In these cases, and they are such as frequently come under observation in our large metropolitan hospitals, the operation of trephining is generally had recourse to to relieve the brain from pressure; but the pressure is really not the worst feature in the disease. Although the operation is seldom attended with any beneficial result, it would be unwise to discard it, for no harm can possibly arise from perforating a bone already dead. Hewett mentions eight cases collected from the experience of the surgeons of St. George's Hospital, illustrating this practical point; in all, symptoms of pressure coexisted with those of cerebral inflammation and effusion into the arachnoid; in all, the operation was performed with no relief to the symptoms; but no harm in any instance resulted from the use of the trephine. This collection of cases is valuable also, as demonstrating a most serious complication of pathological conditions revealed after death, as suppuration in the diploe, matter and lymph on the dura mater, sero-purulent fluid in the arachnoid cavity and sub-arachnoid cellular tissue; pus in the sinuses of the dura mater, secondary deposits in the lungs, liver, &c.; thus showing a deep-rooted pyæmia, over which no treatment whatever appeared to have had the slightest influence. Yet in all these cases, wherever pressure existed, the seat of pressure was indicated by the hemiplegia on the side opposite to that where the effusion took place. This circumstance is important, as leading to the site where the trephine should be applied, and in this very important respect it forms a strong contrast to cases mentioned by Pott. So also the seat of the purulent effusion on the dura mater corresponded in all with the disease of the bone.

When the abscess in the arachnoid cavity is circumscribed, the pus is usually similar to that in other abscesses, and it is contained in a cavity bounded by a wall of lymph. Under these circumstances the case may ultimately do well. Hewett quotes a case from Mr. Guthrie of this description: in this, "after the removal of bone by the trephine, the dura mater rose up in the opening without any pulsatory motion." Mr. Guthrie punctured this, "and a considerable quantity of matter escaped. This continued for some time; granulations formed, and the patient was eventually cured."

Mr. Hewett also gives an interesting case from Roux, in which a fistulous opening remained in the back part of the parietal bone in a young man who some years before, had a blow on the back of the head. This discharged a considerable quantity of matter at various times. The patient became subject to attacks of drowsiness when the discharge ceased. The bones were exposed, and the trephine was applied; three ounces of matter escaped. "An opening, the size of the top of the finger, was found in the dura mater, leading into a cavity, the deep surface of which was red, and presented a cup-like depression. No untoward symptom followed the operation, and the patient was cured at the end of two months." (*Hewett*, loc. cit.) It is not improbable that the abscess was situated in the brain itself; at any rate it points out the necessity and occasional advantage of applying the trephine.

When a piece of bone has been removed by the trephine, and the matter on the surface of the dura mater has been discharged, if the latter membrane is pushed up so as completely to fill the opening; and especially if this occurs where no matter has been discharged on the surface of the dura mater, it is the duty of the surgeon to puncture this membrane, provided the pressure is unrelieved, and the membrane is altered in character; as a cerebral abscess may exist beneath, and the escape of matter may save the patient's life. If, however, the opening is made into the arachnoid cavity, we cannot anticipate much benefit: if well-formed pus escape, the prognosis is more favourable than where the fluid is of a sero-purulent character, for the latter is characteristic of diffused arachnoid inflammation, the former of a circumscribed collection of matter.

But, perhaps, the membrane has been punctured, and no matter is discovered, either circumscribed or diffused; and the opening is found then filled by the rising up of the brain itself. What is to be done under these circumstances? In other words, are we to puncture the brain itself, and to explore it with the grooved needle? This question is not so readily answered, for the diagnosis of cerebral abscess is by no means easy; indeed, there is so much difficulty and uncertainty on the subject that prudence dictates the greatest caution. We would suggest, in the absence of positive signs of pressure, that no puncture should be made.

We ourselves have seen, and the same has occurred to other surgeons, the brain pushed up into the aperture of the skull after the dura mater has been opened; and the surgeon has been tempted to puncture the brain under the impression that an abscess had formed in it, and no matter has escaped. We have had a case recently under our own care, in which it was thought requisite to trephine; and immediately, on dividing the dura mater, the convolutions of the brain were pushed upwards through the opening. The brain was not punctured, but it was thought that matter existed in some part of the organ; and this really was the fact, for although there was an exceedingly small collection of matter found in the brain near the opening, this might be attributed to the inflammation which occurred after the operation; but there was an abscess in the anterior lobe of the opposite hemisphere, and another in the ventricle of the same side. The result of the examination of this case is given, because the matter was very different to that which is usually found in common abscesses, and the examination may possibly illustrate the ordinary condition of cerebral abscess: it was of a greenish-yellow colour, such as is generally found in cerebral abscess; the internal wall of the abscess was smooth, yellow, dense, and friable, but not membranous. Immediately external to this, the cerebral substance was of a deep yellowish-red colour, and dotted with red specks, and increased in density. About half an inch external to the abscess, the brain exhibited its normal character. The matter contained in the cavity consisted of *a fluid holding in suspension hyaline globules, granule cells, blood discs and free granules.* The wall of the abscess appeared to be made up of disintegrated brain substance mixed with free granules, granule masses, and granule cells. Immediately external to the wall of the abscess, the cerebral substance was found infiltrated with a homogeneous substance. The nerve tubules in this part were remarkably large and varicose, and granule cells were abundantly present between them.

The simultaneous occurrence of abscess in the substance of the brain, with suppuration on the dura mater during exfoliation, especially if the abscess is formed at a distant part, is not unfrequently the cause of much obscurity. The case just related is an instance of this; for, although hemiplegia, which we regard as the most important symptom of pressure, was by no means well developed, it existed, nevertheless, to a slight extent on the right side, and on this side the bone was necrosed. It was therefore evident, on careful consideration, that, according to the known law of the cross-action of the brain, it could not depend on the effusion of matter beneath the dead bone, for in that case the hemiplegia, slight as it was, would have been on the left side; the inference, therefore, was, that the principal mischief was to be sought for on the left side, and on this side an abscess was discovered in the cerebral hemisphere, and far out of the reach of any surgical relief by operation. The trephine was applied in this instance with scarcely any expectation of benefit, and we were not much disappointed at the result. A recent and better marked instance of this source of embarrassment has occurred under our own observation, which exemplifies the same circumstance more clearly, and may be regarded as a proof of the unerring nature of the phenomenon that paralysis on one side of the body is always dependent on pressure on the opposite side of the brain. A man was admitted into the London Hospital, with a granulating wound of the scalp in the forehead, slightly out of the mesial line on the right side. The accident had been caused by a blow from a stone, which rendered him senseless for half an hour; in falling he struck the back of his head against the kerbstone. He went afterwards to his work as usual, and was admitted in about three weeks after the accident. When first seen he looked ill, but made no decided complaint. A piece of dead frontal bone was found at the bottom of the wound, which was removed with great facility; there was another dead portion, which was left, as it was not separated. In about three days after this he had slight paralysis of the right side of his face, and was very unwell, and on the sixth day after the whole right side of his body became paralysed. Mr. Ward judiciously removed a piece of bone with the trephine, and found about a drachm of pus on the dura mater. As matter seemed to well up in the direction of the left side, another portion of bone was removed, and the angles between the openings in the bone were sawn off. He appeared somewhat relieved at first, but he gradually became worse, and, in consequence of the persistence of the paralysis on the right side, and as the wound was close to the mesial line over the longitudinal sinus, the trephine was applied on the left side, but no matter was discovered on the dura mater. He sank gradually with symptoms of pressure about a fortnight after the first operation. There was found, on examination after death, a large abscess in the *left* hemisphere of the brain, which had gradually made its way upwards to the surface, and some of the matter had escaped through an ulcerated opening of the dura mater.

Both these cases are valuable illustrations of the fact of the hemiplegia being on the side corresponding to that on which the original injury was inflicted, although it was dependent on an abscess in the opposite cerebral hemisphere; they also prove that, when a piece of bone is exfoliating on one side of the cranium, the opposite cerebral hemisphere may be the seat of fatal inflammation, and, further, that such fatal inflammation resulting in abscess may occur, as it did in the first case, without any very appreciable symptoms.

In the treatment of meningeal inflammation occurring during exfoliation of bone, we are not disposed to advise the free employment of bleeding either by the arm or by leeches, as recommended by Pott in such cases. The disease so commonly attacks patients of a depraved state of constitution, in whom no violent depletory measures can be borne, and in whom the loss of many ounces of blood from the arm would irretrievably depress the vital powers beyond all hope of recovery. Nevertheless, a mild anti-inflammatory treatment, as is implied in the careful administration of mercury and saline medicines, with cold applications to the head, is infinitely preferable to the indiscriminate use of stimulants, which it is too much the custom to administer in the present day. It is, however, very necessary to employ the greatest circumspection during the entire treatment of all cases of exfoliation of bone necrosed from injury, for the prognosis, after meningitis has set in, is in most cases exceedingly unfavourable.]

FRACTURES.

[Under the head of fractures will be included all solutions of continuity of the bones immediately resulting from external violence: thus in this classification are enumerated incised wounds of the skull, penetrating or punctured wounds, diastasis or separation of suture, simple fracture or fissure, indented fracture, depressed fracture, and fractures of the base. Many fractures of the skull, being complicated with wounds of the scalp leading to the fracture, are necessarily compound, according to the recognised surgical nomenclature; whilst fractures of the base for the most part belong to the class of simple fractures. Fractures have been also arranged under the heads of direct fractures and fractures by *contre-coup*. But, whatever the nature of the fracture, its practical importance has a distinct relation to the state of the brain resulting directly or indirectly from the fracture. Hence it is customary in allusion to this subject to speak of a fracture of the skull with or without symptoms of concussion or compression; and in forming a prognosis of such cases, or in laying down a plan of treatment, a knowledge of the condition of the brain, as indicated by certain symptoms, is of essential importance.

Incised wounds of the skull.—Injuries produced by cutting instruments, such as sabre-cuts, will be first considered, as they approach in character nearest to simple incised wounds in other parts. It must be at once apparent that no clean incision can be made through the cranium without the application of immense force. As the occurrence of such accidents is comparatively rare in civil life, we may refer principally for their description to writers on military surgery. Incised wounds of the skull may be arranged under the following heads: — First, the simple section of the outer table, in which a mere superficial mark is left; secondly, the division of both tables by a perpendicular section; thirdly, an oblique or horizontal cut, where both tables are divided, but not completely detached; and fourthly, the entire ablation of a piece comprising both tables, in which the bone adheres to the soft parts, or is completely removed with them. In the first two it should be borne in mind that the internal table of the skull may from the peculiarity of its structure be injured to a much greater extent than the external, and it is absolutely impossible from the mere inspection of the wound to ascertain the amount of injury the inner table has suffered; for, notwithstanding the apparent slightness of the incision, and even when there is no ocular evidence of the instrument having penetrated the cranial cavity, a piece of the vitreous table may be broken off, and may eventually become a cause of the most serious irritation to the membranes of the brain. From the vaulted form of that part of the skull in which these accidents most frequently occur, it is almost impossible that any lengthened vertical section of both tables can be made without a wound of the dura mater, a complication of the greatest interest. The simple incision of the skull is readily ascertained by inspection, and if there are no signs of compression, or any other injury to the brain, the edges of the divided scalp should be accurately brought together; cold applications, as ice, should be employed, and a strictly antiphlogistic treatment be enjoined. If, however, decided symptoms of pressure on the brain exist, the surgeon is justified in removing a piece of bone with the trephine, as it is possible that the inner table of the skull may have been fractured and detached, or one of the large arteries of the dura mater may have been lacerated. The position of the injury, and the gradual supervention of the symptoms, afford a clue to the nature of the case, as such an accident in the temporal region would suggest the possibility of a division of the spinous artery. When the instrument has penetrated both tables of the skull, the nature of the case is recognised at once by the visible pulsation of the brain through the fissure; and, the blood gradually welling up, no pressure takes place from accumulation on the surface of the dura mater. If the dura mater is intact, and the blood which is effused escapes freely, the case must be treated as in more simple forms of injury; but if the dura mater is divided the danger is materially enhanced, as there is great risk of arachnitis with all its consequences. Nevertheless, in the absence of all signs of pressure on the brain, the trephine is unnecessary, as the operation may increase the danger. Cold lotions must be sedulously applied to the head; bleeding locally and generally, with free drastic purging, comprise the category of remedies, to allay any cerebral mischief. The scalp should be carefully but lightly adjusted, and retained in position by sutures; an exit must be given to the blood, which otherwise is either pent up on the surface of the dura mater, or escapes into the arachnoid cavity, and thus gives rise to pressure on the brain. Although in wounds of the skull by sabre-cuts, or by any other means, there is some suspicion that the inner table of the skull is splintered, or a portion of it detached, if no symptoms indicating pressure or meningeal irritation, as coma, convulsions, &c. are present, it is desirable to abstain from the introduction of the probe to ascertain the extent of mischief. But we are averse to give a positive opinion on a subject on which military surgeons only are competent to decide: experience alone can justify a proceeding which is at any rate somewhat hazardous. Mr. Guthrie advises that a blunt or flat-ended probe should be carefully passed into the wound, and, being gently pressed against one of the cut edges of the bone, its thickness may be measured, and the presence or absence of the inner table may thus be ascertained. It must be confessed that this appears to be a most unsatisfactory mode of proceeding, nor is it clear what information can be gained by it, and in the absence of symptoms, we think, notwithstanding such high authority, the case had better be let alone. If, however, symptoms of meningeal irritation exist, then it may be advisable to introduce the probe to ascertain the condition of the inner table; if this is found loose and movable, it will be necessary to remove it, lest it become a source of further irritation to the dura mater. On the subject of the re-application of the partially detached parts in sabre-cuts, Hennen (*Military Surgery*) says, "Sabre-cuts admit frequently of being at once replaced, and in many instances, with the aid of a few stitches and proper supporting bandages, they adhere without further trouble. In some inflicted by our own and the French dragoons in Spain and Belgium, sections of the scalp, cranium, and even of the brain, were frequently made, and in many instances were successfully treated by simply laying the parts together. Lamotte mentions a case where, by a stroke of a dragoon's sabre, the skull was cleft through the right parietal bone to the depth of two inches, and the left between three and four, down to the ear. This severe wound was cured in less than three months. Professor Thomson mentions a remarkable instance, in which a considerable portion of the occipital bone with the dura mater had been removed; a tendency to protrusion of the brain took place during an attack of inflammation; a slight degree of stupor with loss of memory occurred; but, the inflammatory state having been subdued, the brain sank to its former level, the stupor disappeared, and the memory returned. And in another case the cerebellum was even pulsating for a period of eight weeks, yet the injury was unaccompanied by any peculiar symptoms."

Hennen remarks that the opinion is current amongst writers on military surgery, "that sabre-cuts on the top of the head are not by any means so dangerous as those on the sides. This I have often had occasion to observe in my own practice as well as from the report of others. In some sabre-cuts which divide the skull across the sagittal suture, the longitudinal sinus has been occasionally opened and bled profusely, but without inducing fatal consequences. I have seen this sinus opened by splinters, but never saw anything approaching to dangerous hæmorrhage from it: in truth, the bleeding from wounds of the head is one principal source of the patient's safety." (*Hennen*, op. cit.)

Punctured wounds of the skull.— Punctured wounds of the skull are invariably attended with the greatest possible danger, as the brain is necessarily wounded if the instrument has penetrated to any depth. They occur from bayonet thrusts, and were frequent when the arrow was the principal weapon used in war. There are but few situations where an instrument can penetrate the cranium without fracturing the bone; but it is nevertheless possible: for a sharp-pointed instrument can be directed into the skull through the foramen lacerum orbitale, or from the back part of the neck, between the first and second cervical vertebræ, and through the foramen magnum. The extent to which the instrument has penetrated cannot generally be ascertained; and it has sometimes happened that the external wound has become completely healed, whilst destructive mischief lurked within the cranium.

In the *Clinique Chirurgicale* of Baron Larrey the case of a grenadier is mentioned, who during the escape from Moscow received the stroke of a lance from a Russian soldier at the posterior part of the head. The instrument passed deeply into the skull in the direction of the posterior lobe of the brain. The man recovered, but with the loss of the functions of most of his organs of sense. His intellect remained unimpaired, and his limbs were but slightly affected, there being a trifling paralysis. His voice became hoarse and was gradually lost. His hearing, taste, and smell became impaired; the muscles attached to the larynx being paralysed, this organ was depressed half an inch below its natural level. From the difficulty he experienced in drawing the air through the larynx in inspiration, he was obliged by a sudden action to raise the larynx and pharynx, and to gulp the air something after the manner of a frog in the act of breathing; the diaphragm being also partially paralysed. Larrey presented him to the Philomathic Society, and the man was nearly choked whilst his jaws were held apart during his examination by that learned body. The muscular structure of the pharynx, œsophagus, and stomach, were partially paralysed, as deglutition was accomplished with difficulty, and vomiting could not be excited. The pulse was slow and feeble, indeed scarcely perceptible. But his intellect remained unimpaired, and he wrote all his answers to questions put to him.

Larrey also mentions another instance of punctured wound of the cranium through the right orbit, inducing paralysis and other signs of cerebral injury, and this patient survived beyond the third month after the injury. The course of the instrument was indicated after death by an oblique canal which traversed the right hemisphere, and, entering the left, passed over the left optic nerve, injuring the root of the right, and was arrested at the floor of the left lateral ventricle. The canal was lined by a thin coagulum of blood.

The orbital plate of the frontal bone, from its position and extreme thinness, is liable to punctured fracture. We have seen this accident as the result of the introduction of the prongs of pitchforks in agricultural labourers. In one case a man was drawn up from the hold of a ship in consequence of the hook attached to a basket of coals having given way and entered the orbit: these bodies, necessarily directed upwards, enter the skull through the orbital plate of the frontal bone, passing first through the skin of the upper eyelid, or through the conjunctiva; the brain is generally penetrated, and the consequences almost invariably fatal. In these cases a surgeon may be deceived as to the extent of the injury, for the wound is small, and in some instances speedily heals; and as there is much ecchymosis of the orbit and eyelids, the aspect of the case is that of a simple contusion. Moreover, symptoms of severe cerebral mischief rarely make their appearance until after twenty-four hours from the time of the accident. Sometimes, however, from the very commencement cerebral symptoms, as convulsions, insensibility, and stertorous breathing, appear, and indicate severe cerebral injury; or a slight shivering or strabismus leads to the suspicion of the true nature of the case. In all cases the orbit is distended with blood, and the eye is sometimes protruded, extensive ecchymosis being visible beneath the ocular conjunctiva.

Morgagni says: "Numerous cases are registered in medical works in which the patient survived an injury of the brain occasioned by a wound through the orbit, for nine, twelve, fourteen, or even twenty-one days; but I have met with no instance in which there was a more complete exemption from inconvenience than this. In some cases alluded to, the animal functions indeed appear to have been but slightly disturbed till near the period of decease. But injuries of this nature have not invariably proved fatal, for, even where amaurosis of the corresponding eye and paralysis of the opposite side have resulted, the patient has been known to survive."

"The upper part of the orbit is so thin that wounds inflicted with a pointed instrument in that direction are not to be lightly regarded, especially if there be a supervention of sleepiness, nausea, fever, vertigo, or any sign of paralysis." (*Cooke's Translation of Morgagni.*)

In cases of recovery after supposed penetrating wounds of the orbit, it is probable that the instrument has not passed beyond the boundaries of this cavity, and that amaurosis and strabismus have resulted from simple lesion of the nerves of the orbit. This observation is inapplicable to cases where hemiplegia has existed. Hewett has collected many cases of this character, and they tend to exemplify the same facts: namely, the obscurity as to their precise nature at first; secondly, the supervention of severe symptoms within a comparatively short time from the accident; and, lastly, their almost invariable fatality.

The fatality in these cases results from the injury inflicted on the brain, and the consequent extravasation and subsequent inflammation; and it is obvious that, whatever treatment be pursued, there can be no possible room for escape of the extravasated blood, or the necessary products of the inflammation. The opening through the bone is generally too small to admit of the escape of the damaged brain, and the pent-up matter produces pressure, from which there can be no hope of relief. We entertain a very strong opinion that if the brain is wounded through the orbit, recovery is almost impossible. South, however, in his translation of Chelius' *System of Surgery*, quotes a remarkable instance of recovery from a wound of the brain through the orbit. The case is given by Dr. Selwyn, of Cheltenham: "A knife, a common cheese-knife, about four inches and a quarter long in the blade, and averaging three-quarters of an inch broad, entered the right orbit nearly horizontally, to the depth of three inches and a quarter, immediately beneath the supraciliary ridge, and penetrating, through the posterior part of the orbital plate of the frontal bone, the substance of the brain, injuring in its course the optic nerve and the levator palpebræ muscle or the nerve supplying it. It required all the father's force to dislodge the knife from its situation. The hæmorrhage was very slight. After the removal of the knife some portion of the brain protruded; more was discharged on the eighth day after the accident. He did not sleep for a fortnight after the accident, and was delirious during the night. The treatment consisted of low diet, little or no medical treatment, and the application of strips of adhesive plaster to the wound, which was healed in six weeks. There was never any exfoliation of bone. The vision is entirely lost in the eye, the pupil dilated, and wholly insensible to the stimulus of light. All the senses are perfect except the vision of the injured eye. The memory is very defective, and he is incapable of applying to any pursuit requiring mental activity. His health is good, and he has the free use of his limbs." (*South's Chelius*, vol. i. p. 397.)

Punctured fractures may occur in other parts of the cranium. Many cases of this description are on record. The following instance is recorded in the *Dublin Journal*, 1851, p. 347, and is mentioned by Mr. Hewett, in which it was found, after death, that the brass point of a broken end of a cane had pierced the left ala of the nose at the junction of the cartilage with the bone, and taking a direction upwards, backwards, and inwards, it had grazed the inferior and middle turbinated bones, passed through the sphenoidal sinus, and thence into the skull, breaking off and carrying before it the posterior clinoid process, but not rupturing the visceral membranes, which were however extensively inflamed. "A trumpeter of the 12th Lancers was admitted into the hospital, and was seen by the assistant surgeon on the following morning, who found him in bed with some confusion of ideas, which the surgeon attributed to indulgence in drink the previous night. The patient, on being questioned, stated that he had been fencing with a walking-cane, and that he had received a thrust from the cane in the face; but the only appearance of injury was a small puncture on the left ala nasi, which did not appear larger than a leech-bite. He was somewhat taciturn, but answered questions put to him. On the following morning there were no alarming head symptoms, but he was evidently labouring under a considerable amount of stupor. Towards the afternoon he became violent; his breathing was stertorous, and he puffed with his lips; the right eye was staring, and its pupil greatly contracted; the left was widely dilated, and there was ptosis of the lid. In the evening he was seized with violent convulsions, attended with great discoloration of the face, and he died. The brass ferule of a small walking-cane projected into the skull upwards and backwards, and was lying close to the left side of the sella Turcica, and pressing on the optic nerve."

Dr. Hennen (op. cit.) mentions the following: "In a squabble between two soldiers, one of them was struck at by the other whilst cleaning the barrel of his musket. He raised the ramrod to deter the man from prosecuting his blow. The unfortunate fellow, however, slipped in the act of striking, and received the point of the ramrod just above the root of the nasal process of the frontal bone, and instantly dropped down dead. It was found that the iron had entered obliquely, running a little towards the left side, slanting upward, and penetrating the anterior lobe of the left hemisphere of the cerebrum to the depth of an inch. There was no effusion of any kind, nor any unnatural appearance except the hole made by the weapon." Hennen also alludes to the "remarkable case given by M. Larrey. The patient survived to the second day, in whom a ramrod had actually passed through the os frontis, between the hemispheres of the cerebrum, through the thick part of the sphenoid bone, and through the condyloid foramen of the occipital bone, without injuring any important organ. The skull is in the collection of the Faculty of Paris." No apology is requisite for quoting after Hennen the following case by Briot: "At the battle of Pultuska, in Poland, a soldier was wounded by a bayonet which had been fixed, but was dismounted and propelled forward by a ball. The bayonet entered the right temple, two inches above the orbit; it inclined backwards and downwards, and traversed the maxillary sinus of the opposite side, where it passed out and projected about five inches, having penetrated to the hilt. The patient and two of his comrades tried in vain to extract the instrument. The surgeon-major, M. Fordeau, repeated the same attempts on the field, but without success. A soldier who assisted thought himself stronger than the rest, and, seating the patient on the ground, placed one foot against his head, and with both hands disengaged and extracted the bayonet. A considerable hæmorrhage followed, and the patient fainted. M. Fordeau, who believed him dead or dying, left him to attend to others of the wounded. He revived, however; the wound was dressed, and he travelled, partly on foot, partly on horseback and in waggons, to Warsaw, twenty leagues from the field of battle. Three months after, M. Fordeau saw him, perfectly cured, but with the loss of the right eye, the pupil of which was immovable and much dilated." A somewhat similar case is mentioned by Dr. Rogers, in the *Transactions of the Medico-Chirurgical Society*, vol. xiii. of a boy through whose frontal bone the breech-pin of a gun had been driven, above the left supraciliary ridge, into the substance of the brain, and which was removed, on the thirty-sixth day after the accident, by means of an elevator, and the boy completely recovered, with the loss of the sight of the left eye; no symptoms of any importance having arisen during the treatment of the case. The wound through the bone was as large as a crown-piece, and portions of the substance of the brain escaped. In this case it is more than probable that the large size of the aperture afforded a ready exit to the escape of blood and matter, and was thus favourable to the successful issue of the case.

The removal of the penetrating body should be always accomplished speedily, and with the least possible force; and where it is found firmly wedged into the bone and broken off, the operation of trephining may be had recourse to with advantage.

In all cases of punctured fracture through the orbit or elsewhere, if there is the least suspicion that any foreign body is broken off into the cranium, it is advisable to introduce a probe and attempt its removal; but it is not desirable to make any minute exploratory examination to ascertain the fact. It is better to trust to nature, in such cases, than run the risk of increasing the mischief by the too sedulous use of the probe. The general treatment should be strictly anti-inflammatory, for this affords the only chance of relief. Free venesection and leeching, with active drastic purges and mercury, together with bladders of ice, comprise the remedies to be employed to obviate the formidable effects of these most intractable injuries.

Separation of Sutures.—Diastasis, or a separation of the bones at the sutures, may be produced in young persons by causes which, at a more advanced age, would necessarily give rise to fracture. But such accidents are exceedingly rare without fracture.

In violent blows upon the head, it not unfrequently happens that the skull-bones yield at that point where an epiphysis originally existed: thus the petrous is often separated from the squamous portion of the temporal bone in the line of its epiphysis; this also happens at the point of junction between the occipital and sphenoid. Such cases, however, differ in no respect from ordinary fractures. A diastasis may happen to the sutures at the base of the skull, or to the coronal, sagittal, and lambdoidal sutures. We have seen it occur in the two latter at the same time; but have never witnessed it without extensive fracture. Pott says: "In cases of great violence offered to the head, whether the skull be broken or not, it sometimes happens, more particularly in young subjects, that we find a suture considerably disjoined, in which circumstance I do not remember to have seen one single instance of recovery." It is impossible to distinguish a diastasis of the sutures at the base of the skull; and even in the vault this is frequently difficult, unless the scalp is wounded. In the case, however, of diastasis of the sagittal suture, an oblong swelling beneath the scalp after the infliction of extraordinary violence might lead to a suspicion of the true nature of the injury; for it is highly probable that the longitudinal sinus would be wounded, as the dura mater must be detached from the bone in any forcible separation of the two parietal bones. If firm pressure is made on the part, an interval may be felt between the bones, and the edges of the sutures may be traced. In the course of the coronal and lambdoidal sutures, there would not be much difficulty in recognising the diastasis, if the bones were separated to any extent. But the separation is usually limited by the close adhesion of the dura mater to the bone: occasionally, however, this membrane is extensively lacerated.

Diastasis of the sutures cannot happen without very great violence, and, as has been stated, is usually accompanied by fracture. The danger in such cases is very great, from the conditions generally attending extensive fractures; it is often materially increased by hæmorrhage into the arachnoid cavity from a lacerated sinus. That accidents of this description are generally speedily fatal there can be no doubt, but that a patient may survive for some time after an injury of this description is attested by the case recorded by Mr. Russel, in the *Edinburgh Medico-Chirurgical Transactions*, of a young man who had a diastasis of the sagittal suture, and who died two years after the accident.

In the absence of symptoms of pressure the general and local treatment must be conducted precisely on the same principles which guide us in the management of fractures of the skull whether simple or compound: if, however, as in the case of the separation of the sagittal suture, there is a wound of the scalp, and the longitudinal sinus is lacerated and pours out a large quantity of blood, the first duty of the surgeon is to stop the hæmorrhage, and a small compress of lint is to be carefully applied to the bleeding point. Where symptoms of pressure exist, as in the following case recorded by Quesnay, and the scalp is entire, an incision is to be made, and even the trephine may be requisite. The case occurred in the practice of M. Mouton, who was called to a man eleven days after a fall. The patient was quite insensible and almost dying. He examined his head, and found a small tumor or longitudinal elevation extending the whole length of the sagittal suture, into which he made an incision three inches long, and found the suture separated. By means of this incision a portion of the blood effused on the dura mater flowed away through the opening in the suture; fever and delirium came on on the following day. The trepan appeared indispensable, and it was applied on each side the suture; the blood had escaped from the left side, but there was a good deal accumulated under the right parietal bone, to which the operation gave vent, and the threatening symptoms immediately ceased. (*Memoirs of the French Academy of Surgery, Sydenham Society.*)

Where the effusion takes place into the arachnoid cavity from laceration of the walls of a sinus, and the dura mater becomes distended with blood, if unmistakable symptoms of pressure exist, the trephine must be immediately employed, and an opening made into the arachnoid cavity, as in cases of fracture under similar circumstances.

Fractures of the skull may be conveniently divided into fractures of *the vault* and fractures of *the base;* and the division is essentially practical. They may, however, implicate simultaneously both base and vault, for it happens frequently that a fracture, the result of great violence, commences at the base and terminates by a minute capillary fissure at the vault. Cases demanding the use of a trephine are often of this nature, for, where the fracture extending from the base traverses the petrous and squamous portions of the temporal, and terminates at the anterior inferior angle of the parietal bone, the spinous artery is often divided, and blood is poured out upon the dura mater, causing pressure on the brain. Unfortunately such cases usually terminate fatally, and the blood is found extensively effused between the dura mater and the bones at the base as well as at the side of the skull. There is no doubt also that a fracture commencing at the vault may make its way to the base.

Fractures of the cranium are either simple or compound; in the latter the scalp is lacerated and the fracture exposed to view. Fracture may also be further complicated with a laceration of the dura mater and of the substance of the brain itself; this is sometimes called a compound fracture. This remark applies to simple fractures of the vault, because in fracture of the base it is impossible to tell before death what complications have resulted. A fracture of the vault may be confined to the outer, or it may extend through both tables of the skull; of the former may be mentioned fracture over the frontal sinus. A similar fracture may occur to the mastoid process of the temporal bone; indeed, the outer table may in almost any part of the vault of the cranium be broken independently of the inner table: it has been frequently seen depressed into the diploe. Fractures may be either direct or indirect: the latter are termed fractures by *contre-coup.* Fractures may be simple or depressed: they may consist of mere capillary fissure, or may be comminuted to almost any extent.

The following classification comprises all fractures which happen to the vault:—

Simple or compound.
- Capillary fissure.
- Fracture without depression.
- Fracture with depression
  - Of outer table only
  - Of inner table only.
  - Of both tables.
- Starred or radiating fracture.
- Comminuted fracture.
- Indented fracture.
- Penetrating or punctured fracture.
- *Ecrasement.*—Smash or crash.

It is important to know that fracture of the inner table may take place whilst the outer remains intact: this accident is rare. Hewett relates a remarkable instance of this sort; the skull is preserved in the Museum of St. George's Hospital. The fragment may be completely detached, or it may remain partially connected to the outer table. It is rare that both tables are fractured to an equal extent; but this inequality depends on one of two causes, namely, the direction of the force applied, and the difference of density of the tables of the skull. In fractures arising from severe blows the inner table is generally fractured to a greater extent than the outer; but if the force is applied from within, the reverse occurs, and the outer table is more extensively fractured than the inner. These remarks apply particularly to fractures resulting from foreign bodies driven into the skull, as bullets and pointed instruments; such cases are necessarily compound fractures. Mr. Erichsen (*Principles of Surgery*) mentions a case which illustrates the mode in which the unequal splintering of the two tables of the skull arises, and which shows that it is the direction in which the force is applied which determines whether the inner or outer table gives way to the greatest extent. Thus a man fired a pistol into his mouth, and the ball passed through the vault; the outer table was much more splintered than the inner. Such cases are not uncommon. The one just mentioned is quoted by Mr. Hewett, who has taken great pains in describing the different varieties of fracture to which the vault of the cranium is liable. (Loc. cit.)

Fractures by contre-coup, or counter-fractures.—It is rather difficult to understand the precise meaning of this term, for if we admit the following to represent this form of injury, it is clear that fracture of the skull scarcely ever happens without counter-fracture. Thus counter-fracture has been said to occur:—1st. When a blow is received at one part of the skull and the fracture takes place at another. 2ndly. Where the fracture occurs to a bone contiguous to one which has received the blow. 3rdly. Where a fracture is situated at a part *diametrically* opposite to that on which the blow is inflicted. 4thly. Where a fracture happens to the inner table, the outer remaining entire.

(*Quesnay, Memoirs of the French Academy, Sydenham Society.*) Perhaps it is better to restrict the term to those fractures which occur to a part of the skull far removed from, if not diametrically opposite to, the seat of the original blow; and this definition corresponds to the idea which Hippocrates seems to have had of such cases. (*Genuine Works of Hippocrates, Sydenham Society,* p. 451.) The vaulted form of the skull favours the transmission of vibrations from one part to another, and from experiments on the cranium after death it appears that counter-fracture is by no means impossible; but its occurrence in the living subject, if it ever happen, is excessively rare. (*Humphry on the Skeleton*, p. 205.)

Where the cranium is forcibly compressed in any direction between two forces, fracture may happen on either side: thus, in falls upon the vertex from a great height, the base of the skull is broken, not by counter-fracture, but in consequence of the violence with which the spinal column, representing the whole weight of the body, impinges on the condyles of the occipital bone. In *Guy's Hospital Reports* (3rd Series, vol. v.) the case is mentioned by Mr. Bryant of a labouring man, aged thirty-six, who in falling from a scaffolding pitched on his head: he was taken up perfectly unconscious, and brought to the hospital, where he died in a few seconds after admission. Upon examining the body after death, it was clear that the weight of the body, as conveyed through the spine, had completely driven the spinal column into the skull, the base for about an inch round the foramen magnum being detached and pressed inwards on the brain. This case is one which would formerly have been regarded as illustrative of fracture by *contre-coup.*

If the skull is driven forcibly against a hard unyielding body, and a fracture occurs in that part which is last struck, this is no counter-fracture, but must be ranked as a direct fracture. Most of the cases which have been considered as examples of counter-fracture, are in reality examples of simple direct fracture. The writer has never seen an instance of true counter-fracture, and the only approximation to this accident he has ever witnessed was in a case of fracture of the orbital process of the frontal bone, in which a piece was completely broken out, and where there was no connection whatever between this and any other fracture: there can be no doubt that this arose from the general concussion of the skull. The case is published in the *Medical Gazette* for June 1838. (*See a case by Humphry*, loc. cit.)

Mr. Guthrie collected from the writings of the older surgeons a vast mass of supposed cases of fracture by *contre-coup*, but he sums up his observations on the subject in the following words:—"In spite of these great authorities, modern surgeons seem to have repudiated the idea of counter-fracture, as of one parietal or temporal bone caused by a blow on the opposite side; and, whatever may have happened formerly, there is so little proof of such occurrence having taken place of late years, that the accident is generally altogether unnoticed by writers on injury of the head." (*Guthrie*, loc. cit.)

Symptoms of fracture of the skull. — There are no physiological signs positively indicative of fracture of the skull. The symptoms which so frequently attend a fracture are obviously dependent on injury to the brain resulting in concussion, compression, contusion, and laceration of this organ. They may all exist without fracture, and in most extensive fractures are often altogether absent. Even in fractures of the base of the skull symptoms of injury to the brain are often exceedingly obscure, or are altogether absent; and, *e contrario*, cases of simple fracture of the skull may be attended with alarming symptoms of cerebral mischief from the commencement. Fractures which occur in civil life, and which arise from falls or the application of enormous violence, are often more fatal than those which occur in military practice, the effects of which, however severe, are in a great number of cases limited to the part injured. This observation applies most forcibly to fractures resulting from gunshot wounds, which often produce great local comminution of bone. The treatment of fractures of the skull is consequently more successful in military practice than in the surgery of civil life.

In considering, therefore, the simple signs of fracture, we come to the conclusion that no reliance is to be placed on the physiological symptoms which usually attend a fracture of the skull. But we are led to this important practical deduction, derived from repeated observations,—first, that although an extensive fracture may exist with very few symptoms, yet where symptoms, however mild, of injured brain attend the infliction of unusual violence to the skull, and more especially if such symptoms persist for a lengthened period, we may reasonably suspect the existence of fracture.

We cannot always detect a fracture by simple inspection of the skull in the absence of a wound of the scalp, for the inequalities which are visible may all depend on natural formation, or on the effusion and coagulation of blood: of course it may happen that the mischief is so great that no doubt can exist as to the nature of the case from the great deformity of the skull, but such cases are necessarily speedily fatal. Simple ocular inspection is nevertheless not to be neglected, for, aided by careful manipulation, it may lead us to the seat of a fracture of great importance. The surgeon therefore stands with a good light thrown upon the patient's head, previously shaved, and observes an inequality, say, for example, in the temporal region: he presses the part firmly with his fingers, and the patient gives indications of unusual sensibility: he is induced to cut down upon the bone, and he at once detects a fracture, probably traversing the groove of the spinous artery. In many fractures, however, he is obliged to depend in his diagnosis upon his fingers rather than his sense of sight, and often both will fail him. In comminuted fractures crepitation is sometimes felt if the finger is lightly pressed over the damaged scalp; but all manipulation should be conducted with great care and tenderness, and in the absence of symptoms of damaged brain it is unnecessary to be over-solicitous on the subject. Emphysema in the frontal, or even in the mastoid region, may be detected with the finger, and is a sign of fracture into the frontal sinus or into the mastoid cells.

These remarks apply especially to simple fractures of the vault. Where there is a scalp wound there is generally no difficulty in detecting a fracture, unless it be a simple capillary fissure, which sometimes eludes our sight; it may be necessary, even with the bone exposed to view, to scrape the pericranium to detect a fracture. We do not advise this, unless urgent symptoms of pressure demand the minutest examination. We have, however, seen it requisite in cases of pressure from hæmorrhage arising from a laceration of the spinous artery.

Fracture of the base of the skull. — It may be said that in the detection of fractures of the vault we must be guided by the senses of sight and touch combined. This cannot be said of fractures of the base. Are there any pathognomonic signs of fractured base of the skull? Here, of course, all manipulation generally is out of the question, and ocular inspection can only be applied to the result of the fracture, as in cases of extensive ecchymosis, and not to the fracture itself. Physiological considerations are not wholly irrelevant in suspected fractures of the base. Thus stupor, loss of the sense of smell, amaurosis, deafness of one ear and paralysis of the corresponding facial nerve, paralysis of the muscles of deglutition, with aphonia, may be enumerated as probable signs of fractured base when they succeed severe injury to the head, accompanied by violent commotion of the brain. Nevertheless, although affording strong presumptive evidence of fractured base, they may all depend on the damage done to the brain without fracture.

But there are external signs, some of which point unmistakably to fractured base as a cause, whilst others are of too doubtful a character to be relied on. Amongst the latter may be mentioned ecchymoses about the orbit, and hæmorrhage from the nose, mouth, and ears. As to hæmorrhage from the ear, it is so common in severe injuries of the skull that generally no very great importance is attached to it, unless it is of great extent and continues for a long time. The source of the hæmorrhage is various: thus it may arise from a rupture of the vessels of the meatus, or from laceration of the membrana tympani; or the blood may escape from a divided lateral sinus, or even from a rupture of the carotid artery itself. The latter can happen only in extensive fracture of the petrous portion of the temporal bone attended with a rupture of the membrana tympani. The source of the hæmorrhage would be at once apparent from the rapidity of the flow and the colour of the blood. Mr. Hewett has found in thirty-two cases of fracture of the middle fossa in which the petrous bone was implicated, that the membrana tympani was ruptured in fifteen. The flow of blood in most of these cases was profuse and continuous: in all the diagnosis was clear. In reference to the hæmorrhage from the nose and mouth, the same surgeon remarks, that where the bleeding is copious, and continues for any length of time, the symptom may become of great value. Vomiting of blood also occurs occasionally in such cases. Thus Hewett says that bleeding occurred from the nose and mouth, or by subsequent vomiting, in fourteen cases out of thirty-two of fractured base; in four the fracture was confined to the ethmoid bone, in three to the body of the sphenoid, and in one to the basilar process: in five cases the fracture involved both the ethmoid and sphenoid. We do not attach much importance to the ecchymosis in the orbits as a sign of fractured base, having so often witnessed it in ordinary cases of injury to the skull where there could be no suspicion of such an accident. It is said that in fractured base the ecchymosis takes place first in the lower part of the orbit; but there can be little doubt that if fracture of the orbital plate of the frontal bone occurred, the upper part of the orbit would be the first infiltrated.

The infiltration is said also to commence from behind, and gradually to make its way forward. In some cases it distends the ocular conjunctiva, and protrudes the eye to such an extent as to induce amaurosis from the pressure on the nerves around the eye. This occurs generally in those most fatal punctured fractures of the orbital plate of the frontal bone, and may be the only symptom present at first to lead us to a suspicion of such a serious accident. Nevertheless, in cases where no suspicion of such an occurrence could arise, it is not altogether to be lost sight of, especially if taken in connection with other signs. The same remark applies to extensive effusions of blood occurring after injuries to the skull about the occipital and upper cervical regions, when attended by unusual violence, and when symptoms of deep cerebral injury persist.

In a very interesting paper on the subject of injuries to the nervous system (*Guy's Hospital Reports*, *third series*, vol. v. for 1859, p. 58), Mr. Bryant states, as the result of his examination of thirty cases of fractured base, "that twelve cases, associated with concussion, recovered. In three the fracture extended through the orbit, as indicated by *subconjunctival ecchymosis.* In eight examples there was *hæmorrhage from the ears:* in all this was followed by a discharge of serum, in seven cases associated with facial paralysis of the same side. In these cases it is quite fair to conclude that the line of fracture extended through the petrous portion of the temporal bone. In two instances there *was bleeding from the nose.* In one case there was a serous discharge from the ear, accompanied with paralysis of the facial nerve, and in one following hæmorrhage from the ear, but unaccompanied with paralysis."

He further remarks: "To test the value of these different symptoms, as indicating fracture of the base in various positions, the following analysis of the fatal cases will prove of value; and, taking the symptoms separately, subconjunctival hæmorrhage will first claim our attention, as being a symptom tolerably accurately marking a fracture through the orbital plate. In the eighteen fatal cases this symptom was manifested in four instances, and in all the line of fracture extended through the orbit. In two cases there was copious hæmorrhage from the ear; in both these the fracture passed through the petrous bone. In three examples there was some epistaxis: in one of these the fracture extended across the ethmoid bone; in one the frontal sinus was full of blood, and fractured; and in the third the tympanum was found full of blood, and the membrana tympani perfect, and upon examination the lateral sinus was found to have been lacerated. Seven of the eighteen fatal cases died of direct injury to the brain, as contusion or laceration of the brain substance, with effusion of blood upon the surface of the brain or its membranes. Another seven died from arachnitis as the result of the injury. In three the cerebral mischief was complicated with other injury, and in one instance hæmorrhage was the immediate cause of death." We are sceptical, nevertheless, of the true nature of the successful cases in this category, and we think that ecchymosis of the orbit, as a sign of fractured base, is overestimated.

When hæmorrhage occurs from the nose and mouth in fractured base, it is usually traceable to the mischief done to the ethmoid and sphenoid bones. Under these circumstances the blood is often swallowed and passes into the stomach, whence, after accumulation, it is ejected by vomiting; but this is so frequently the result of simple concussion that no great reliance is to be placed on it as a sign of fractured base.

Severe injuries to the skull, with or without fracture, result occasionally in some curious change in the arteries of the orbit, which it is exceedingly difficult to explain; we allude to cases of supposed traumatic aneurism. Whatever be the nature of such cases, they are always characterised by distinctly pulsating swelling of the orbit. They are usually accompanied by pain in the orbit and in the globe of the eye, and impaired vision, and the eye is often protruded to a considerable extent. We have witnessed two cases of this description at the London Hospital; they are both alluded to by Mr. Hewett, and are described in the *Medico-Chirurgical Transactions.* In both the pulsation commenced in the orbit a very short time after the accident; in the one the pulsation was general over the upper and lower part of the orbit, in the other it was principally confined to the upper part of that cavity. The first case occurred to the late Mr. John Scott, and was remarkable from the circumstance that profuse arterial hæmorrhage suddenly occurred into the corresponding nostril on two occasions. The common carotid artery was tied. The other was treated in a similar manner by Mr. Curling, and both with complete success. In the latter case the disease was not recognised, and possibly did not exist, until five weeks after the original injury to the head. There is no doubt that in the former case a fracture of the os planum of the ethmoid had happened, and that the bleeding took place through this into the nose: it is impossible, however, to verify this opinion. But Hewett quotes another instance from the same work (*Med. Chir. Trans.*), which is remarkable from the fact that the disease did not make its appearance until six months after the accident, when a pulsating tumor appeared at the upper and inner part of the orbit, just within the supraciliary ridge; it was attended with a loud whizzing noise when examined with the stethoscope over the inner canthus of the eye. The case presented unmistakable signs of fracture of the base of the skull, and Mr. Busk, who attended the case, having ascertained that pressure on the common carotid stopped the pulsation in the tumor, placed a ligature on that vessel, and the pulsation entirely ceased.

There is some difference of opinion as to the precise nature of the lesion in these cases. Most probably there are three distinct conditions occasionally existing: in one there can be little or no doubt of the existence of a spurious aneurism, whilst in the second the disease represents that curious alteration in the arteries recognised as aneurism by anastomosis; and in the third we suspect the aneurism becomes diffused. The first and last forms of disease occur in cases of injury to the skull; the second is the most probable condition in those cases of spontaneous aneurism which arise wholly independent of any accident.

The signs of fractured base hitherto considered are by no means positive, for they may exist separately or collectively without fracture; but the escape of cerebral matter and serum from the ear may be regarded as truly pathognomonic symptoms of this accident. The escape of serum from the ear in large quantities has been long observed by surgeons, and has been especially mentioned by Colles as clearly indicating a fracture through the petrous portion of the temporal bone. We have witnessed two cases of this; but as both recovered, although they each offered other signs of fractured base, some doubt may exist as to their true nature. In one of these cases a very large quantity of limpid fluid oozed through the auditory meatus, amply sufficient to keep the pillows constantly wet.

The discharge commences usually three or four days after the accident, and continues for an indefinite period.

Mr. Colles, in allusion to this accident, quotes the following words from Dease: "As a patient with one of these injuries lies in bed, it will sometimes be perceived that the external auditory canal will be filled with clear lymph, which rises to a certain height, but does not overflow. You get a piece of sponge and sop up this; but the ear again quickly fills, as often as you try the experiment." Dease believed all such cases to be fatal.

Mr. Hewett has traced the history of our knowledge on this interesting point, and has exhausted the subject in all its practical bearings. The fact was noticed as early as 1518, and two cases were published by Stalpertius van der Wiel, in 1727. In the first case it was supposed that at least a pint of fluid must have escaped, and yet the patient recovered; in the second the patient was believed to have lost as much as 8lbs. of watery fluid from the ear, but the result is not given. Mr. Hewett quotes two cases which came under his own observation; the first was under the care of Mr. Cæsar Hawkins; it occurred to a man æt. 52, who had fallen four days before, and struck the back part of his head. He was admitted into St. George's Hospital with a profuse discharge of clear watery fluid from the ear: it had been observed immediately after the accident. The fluid was of a pinkish hue, dropped freely from the ear, the flow being increased when he was speaking. He had symptoms of pressure on his brain. On examination after death, a fracture was traced across the petrous portion of the temporal bone; it had traversed the meatus internus and superior semicircular canal; it had passed through the vestibule, and had reached the tympanum, the cavity of which was widely open. The membrana tympani was ruptured in two places. It was found that a bristle passed to the bottom of the meatus internus made its way into the tympanic cavity, and was brought out through the rent in the membrana tympani, thus clearly indicating the course of the fluid.

The second case was that of a boy æt. 11, who had fallen from a considerable height, and was admitted with profuse bleeding from the ear. The boy went on improving for three days, during which a quantity of dried blood, which blocked up the meatus, had disappeared; the ear then became moist with a fluid filled with epithelial scales and fat globules. On the fourth day a thickish seropurulent fluid, of a pinkish colour, oozed from the ear. On the fifth day the discharge, still of a slight rose colour, had become all but limpid, and much increased in quantity, so that, when the patient was lying on the right side, the concha of the left ear was filled with fluid; the pillow-case was extensively stained with the fluid which had run from the ear. On the sixth day the watery discharge continued; it was clear, but suspended in it was a thick puriform-looking secretion, which contained lymph and pus cells. This after a time wholly ceased. He sank sixteen days after the accident. The fracture was found to have traversed the petrous portion of the temporal bone, across the superior semicircular canal: it had crossed the cavitas tympani, and the membrana tympani was torn from its connection. The tympanum was filled with lymph of a reddish colour, and in several places pus was detected between the bones. (*Hewett*, loc. cit.)

These cases are highly interesting as showing the course of the fracture through the tympanum, and the probable source of the fluid. What is the nature of this fluid?

There are three opinions on this subject. The first is that the fluid is nothing more than the serum of the blood; the second, that it is an escape of the *aqua labyrinthi* of Cotunnius; and the third, that it is true cerebro-spinal fluid. The first opinion is advocated by Laugier, who attributed it to an escape of the serum separated from a clot after extravasation. Chassaignac, deriving it from the same source, endeavours to account for it on the hypothesis that it is the watery portion of the venous blood contained in the sinuses near the seat of fracture; but the fluid is quite different from the serum of the blood, and therefore these theories cannot be supported. That some of the thin watery fluid which escapes under the circumstances mentioned is occasionally due to the secretion from the lining membrane of the labyrinth, we would not deny; but there can be no doubt that the quantity is far too copious to be derived wholly from this source, nor can we always trace the fracture through the labyrinth of the ear, so as clearly to make out the true course of the fluid from the inner to the middle ear. Indeed, there can be no doubt that the fluid is mainly, if not wholly, derivable from the sub-arachnoid space, and is really true cerebro-spinal fluid. The notion that the fluid is from the sub-arachnoid space has been supported by M. Robert, M. Chatin, is advocated by Hewett and most other surgeons, and appears to me confirmed by the experiment of Hilton. M. Chatin has analysed the fluid, and finds it identical in chemical composition with the cerebro-spinal fluid; it contains very little albumen, and a large quantity of chloride of sodium. M. Robert fractured the base of a skull after death by means of a chisel and mallet, thus imitating the course of a fracture through the tympanum; the cerebro-spinal fluid immediately escaped, and the discharge became continuous and copious as soon as the head was made to hang over the table. We abridge Hilton's observations on this subject:—"The escape of the cerebro-spinal fluid does not always take place through the external ear, for, if the membrana tympani is intact, the fluid may find its way through the Eustachian tube into the mouth; and if after a diffused blow on the skull you observe hæmorrhage from one or both ears, with no external lesion, you may be almost certain you have a case of fractured base before you. But if, further, you observe a clear fluid running from the external ear, or trickling down the pharynx, you may at once regard this as pathognomonic of fracture of the cranial base." (*Hilton, On the Cranium*, p. 62.) Hilton performed the following experiment:—"A boy, who had sustained a severe injury of the head, was admitted into Guy's Hospital. He presented the ordinary signs of fractured base, and a small quantity of thin clear fluid was seen oozing from his ear. It occurred to me that, if this consisted of cerebro-spinal fluid, it ought to escape in much larger quantity on artificially inducing congestion of the cerebral circulation. I therefore pressed upon the jugulars, and with the other hand closed the patient's mouth and nose, so as to suspend the respiratory process for a short time; as I had anticipated, in a few moments the fluid began to flow much more rapidly, so that I was quickly enabled in this way to collect half an ounce of it." (*Hilton, On the Cranium.*)

Hewett and Hilton both trace this fluid very distinctly to the same source, namely, the sub-arachnoid space which is continued by a tubular prolongation into the meatus auditorius internus; this is intersected by the fracture, which also passes across the petrous portion of the temporal bone into the tympanum, the membrane of which is lacerated. A large quantity of thin watery discharge sometimes takes place from the nose and mouth in cases of fractured base; and there is some reason to believe that this also is derived from a similar source as in the preceding cases, namely, the sub-arachnoid space. On this subject Hewett is very explicit, and we quote his observations upon it:—"Whenever carefully examined, the characters of this fluid have been found to be precisely the same as those belonging to the profuse watery discharge from the ear. Whence then does this fluid come?" The anatomical disposition of the cerebral membranes in the central parts of the base of the skull is such that a fracture of this region might involve these membranes, and thus account for the enormous quantity of watery fluid observed in some of these cases. Hewett quotes the following case:—"A man æt. 30 was murderously assaulted and beat about the head; one of the wheels of a cart passed over his head. He was conveyed to the Hospital Beaujon. The eyelids were very much bruised and swollen, the ocular conjunctiva on the left side was extensively infiltrated with blood, and the eyeball was protruded. There was also bleeding from the nose and mouth, and he had just brought up a large quantity of grumous blood. He was almost insensible. On the following day he was somewhat better; but as he was leaning his head over the right side of his bed, a watery discharge was observed running from the nose: the fluid, slightly roseate, flowed freely drop by drop, and in less than half an hour ten grammes were collected. Chemically examined, the fluid was found to contain but little albumen, and a large amount of chloride of sodium. He died on the night of the fourth day in a state of violent delirium, the watery discharge having somewhat diminished. The body, when examined after death, had been placed with the face downwards, and thirty grammes of a watery discharge were poured from the nostrils. A fracture was found to have commenced in the right parietal bone, to have passed through the occipital, to have traversed the mastoid and petrous portions of the temporal bone, and thus reached the great wing of the sphenoid, and the sella Turcica which it cut across, thence passed into the ethmoidal cells and cribriform plate of the ethmoid bone, &c.; a careful examination proved most clearly that the dura mater corresponding to the fracture in the sella Turcica was torn. The laceration was about an inch in length. Some water, dropped on this spot, made its way into the nostrils. The visceral arachnoid corresponding to the anterior lobes of the brain was also torn. The state of this membrane on the side of the pituitary body was not exactly made out."

It is unnecessary to multiply cases of this description, of which many are now recorded. They all point to very similar conditions, namely, watery discharges in large quantity from the nostrils and mouth after severe injuries to the skull, in which, when death occurs, fracture is discovered in that portion of the base which forms the roof of the nose.

In some cases, but they are few, recovery takes place; to these exception may be taken. There is one circumstance which ought not to be wholly overlooked in estimating the value of this phenomenon as a symptom of fractured base, namely, the Schneiderian membrane itself, which under inflammation is well known to secrete an enormous quantity of clear watery fluid, in appearance resembling the cerebro-spinal secretion from the arachnoid cavity.

That similar watery discharges may occur after compound fracture of the vault of the cranium when the arachnoid membrane is lacerated, is proved also by cases collected by Mr. Hewett. We shall content ourselves with relating two cases alluded to by him, as they illustrate the fact that there are two distinct sources whence the fluid flows. The first case is mentioned by M. Robert, and is that of "a man æt. 23, who was admitted into the Hospital Beaujon with a compound fracture of the right parietal bone in the top of the head; on the following morning the lips of the wound were slightly united except at the posterior angle, where there was a small opening through which was flowing a clear watery fluid. In oozing through the wound this fluid presented pulsations synchronous with those of the arteries; and when the patient coughed or made any effort, these pulsations became more marked, and the fluid came away in larger quantities. The fluid was decidedly watery, perfectly limpid, and saltish to the taste. On the third day there was no more watery discharge, and the wound appeared to be united in its whole length; but shortly afterwards, as the patient was laughing with one of his comrades, the wound gave way, and the fluid appeared again. It then continued to flow for two days, and finally ceased altogether. He was soon discharged cured."

"A man who was rather the worse for liquor was knocked over by the explosion of a box containing fireworks. He received an enormous wound, laying bare an extensive fracture on the left side of the forehead. A large piece of the frontal bone was detached, and the brain protruded through a rent in the dura mater. Large portions of brain subsequently sloughed away, after which the wound put on a healthy aspect, and became covered with granulations. A discharge of watery fluid from the wound now took place: the fluid, perfectly clear and limpid, came away in drops, and sometimes in a jet, at each pulsation of the brain. The discharge of watery fluid, which went on for days, was traced to a minute opening buried in the midst of the granulations. The man ultimately died. At the examination of the head, the minute opening through which the watery discharge had taken place was found to lead directly into the left lateral ventricle, the fluid of which had thus escaped."

In a case recently under our own observation, and to which allusion is made in another part of this article, a cyst containing a thin limpid fluid protruded through an opening in the skull of a child who was the subject of hernia cerebri, which had been completely cicatrised. In consequence of irregular symptoms of pressure and the sudden increase in the size of the swelling, it was punctured, and at least half an ounce of thin watery fluid escaped. On examination after death, an opening was found in the centre of the fungus which led directly into the lateral ventricles. Hence it is apparent that the watery discharge accompanying wounds of the dura mater in fractures may arise from the sub-arachnoid space, and from the ventricles of the brain. In both the termination is generally unfortunate. But recovery, as has been already shown, occasionally happens under the former condition, but we are not aware of any recorded instance of this in the latter; it is clear, however, that the source of the discharge in this can only be made out accurately after death.

We quote from the *Medical Times and Gazette* for May 21st, 1859, a remarkable case of fractured base of the skull with discharge of brain and watery fluid from the ear, in which a recovery took place. The case is taken from the American *Journal of Medical Science* for April, p. 354. A sailor, in an epileptic fit, fell from the spar to the main deck, down the fore hatchway, and struck the crown of his head. He became insensible, with stertorous breathing, and blood flowed copiously from the right ear. It was estimated that from fifty to sixty ounces had thus escaped. The next day serum was discharged from the ear with small particles of brain. The serous discharge continued for several days; but in rather more than a month after he was able to return to his duty, the watery discharge continuing for another month, at one time putting on a purulent character. It is very necessary, however, to be cautious in concluding from a cursory examination that the substance resembling brain is true cerebral matter, for the fibrine of extravasated blood has been occasionally mistaken for it.

A well-marked case of recovery after all the admitted signs of fracture of the base occurred in St. Mary's Hospital in 1854, under the care of Mr. Spencer Smith. The patient, a lad æt. 15, was injured by a large van passing over his head; he had long-continued bleeding from both ear and nose, and so much discharge of watery fluid from the ear that an ounce was collected in half an hour on more than one occasion. On regaining consciousness he was found to have paralysis of the portio dura on the injured side, deafness, and considerable difficulty of speech. He recovered, and has been employed ever since as a porter in the hospital. He has lost the deafness, the paralysis has nearly passed away, and the articulation is as perfect as before the accident.

There are various reasons for the fatality of fracture of the base of the skull: unquestionably the most common cause for this is the enormous violence generally required to produce the injury and the damage the brain sustains in consequence; and the event is seldom postponed for many days. Thus it is generally found that the brain has undergone most extensive contusion or laceration, and that hæmorrhage from its ruptured vessels or from the lacerated sinuses of the dura mater has taken place. In considering the almost necessary fatality attending fractured base, we ought not to lose sight of the fact that all the cranial nerves either take their origin at the base of the brain or are traceable somewhat deeper into the cerebral substance, and that they all make their exit through the foramina at the base of the skull, and are consequently implicated individually or collectively in fracture of this part. The situation of the medulla oblongata, with which the respiratory nerves are connected, is not unimportant; for fractures frequently occur in the direction of the foramen magnum, and thus involve this important part of the encephalon.

It is impossible to ascertain the result of all cases of fractured base, and there can be no doubt that many cases recover completely. The mortality from this source is, however, exceedingly high. From personal examinations of a great many cases we have ascertained that of all fatal cases of injury of the skull examined after death at the London Hospital, those of fractured base constitute above eighty per cent. We have alluded to cases of recovery in which there can be no doubt whatever of their true nature. Hewett has collected accounts of thirteen cases of recovery, and he gives the result of dissections made some time after the original accident. In the greater number of these cases the patients appear to have survived the injury only a few months,—from two to seven months; but there is one solitary instance of a man who died in St. George's Hospital of ulceration of the stomach three years after an injury of the skull: he was pitched from his horse, the result of which was an injured scalp, followed by delirium, &c. "In the preparation a distinct line of fracture can be traced through the left side of the occipital bone from the upper part to the point where the groove of the lateral sinus terminates in the jugular foramen. In its upper part this extensive line of fracture is closely united by inlaid bone; externally there is merely a linear groove, and internally the union is more perfect, the line of fracture being visible here and there only. All this part of the bone is very much thickened, and extensively perforated by minute holes, some distance even beyond the line of injury. In the lower half of the fracture the edges of the bone are thin, and bevelled off by absorption; here there is a slight gap, which was filled up by dense fibrous tissue. At the end of this fissure, where the groove for the lateral sinus terminates in the jugular foramen, the bone looks as if it had been broken up into several pieces. The union is perfect, but the lateral sinus is at this part all but obliterated, and the occipital is here ankylosed, on the one hand, to the petrous bone at the jugular articulation, and, on the other hand, to the atlas at the condyloid articulation."

In the Museum of the College of Surgeons there is a specimen of a fractured base taken from a man who lived seven months after the accident. The fracture traversed the squamous and petrous portions of the temporal bone, the former part of which was closely and smoothly united, with the exception of a few minute apertures; but in the part which traverses the petrous bone there are only a few small points at which union has taken place. At the upper surface of the base of the petrous bone there is a considerable loss of substance, leaving a large hole leading directly into the cavity of the tympanum. The margin of this hole, and the bone around, are smoothly rounded off, as if from absorption.

These dissections prove that patients occasionally recover from fractured base; they show also that wherever the fracture occurs, if life is prolonged, union to a certain extent occurs; and further, that fractures of the base generally implicate the petrous portion of the temporal bone. Hilton has illustrated this in the following way: he fixed a skull with its base upwards and its vertex downwards, and placed a strong bar of wood across the occipital condyles, and then by means of a hammer he applied a strong blow as evenly as possible over its centre. The result was a fracture through the petrous portion of the temporal bone, the line of fracture intersecting the membrana tympani.

Mr. Humphry, in his work *On the Human Skeleton*, has detailed some experiments performed on the dry skull to show the course of fractures through the base: he found that a skull allowed to fall several feet on the vertex upon a brick pavement was fractured in the following manner:—"A fissure, starting from the junction of the frontal with the parietal, ran through the left temporal fossa behind the zygoma, through the external auditory passage and the tympanic part of the temporal bone. Here the fracture was very severe, a portion of bone being quite loose, and the cavity of the tympanum largely exposed. From this it reached the foramen lacerum anterius, crossed the sella Turcica to the opposite foramen lacerum, and terminated in the right temporal fossa. A secondary fissure ran, nearly at right angles to the former, from the right foramen lacerum anterius, through the line of junction between the petrous and occipital bones, to the jugular foramen, and terminated in the right side of the occipital bone." The experiment is also supposed to illustrate fracture by *contre-coup*, as before observed.

Mr. Hewett mentions two very remarkable cases in which the condyles of the lower jaw were forcibly driven through the glenoid cavity into the interior of the skull. We quote them in consequence of their extreme rarity. "A boy, aged twelve, was admitted into St. George's Hospital in February 1853, having fallen from the top of a house into an area. He was perfectly insensible, never rallied, and died four hours after his admission. There was a general contusion of the brain, and a fracture of the middle fossa of the base of the skull, corresponding to the bottom of the left glenoid fossa, and through this opening the condyle of the jaw projected into the cavity of the skull." The other is taken from Chassaignac, *Plaies de Tête*, p. 158, *Jour. Hebdom.* tom. iii. p. 37, Sept. 1834. "A sailor, when drunk, was thrown out of a second-story window, and fell upon his chin; he was conveyed to the Naval Hospital. The jaws were closely set, so that it was impossible to open his mouth; the under part of the chin was bruised, and the lower jaw was driven backwards and to the left. The right temporo-maxillary region was painful and bruised. The motions of the jaw gradually became easier under antiphlogistic treatment, and he left the hospital. But it was noticed that ever since the accident his disposition was much altered. He was afterwards readmitted into the hospital complaining of his head. Pains in his head continued, and he had great difficulty in swallowing. After being transferred from one hospital to another he was seized with violent convulsions five months after the accident. In consequence of the violence he exhibited it became necessary to put him under restraint. He died after a severe attack of convulsions, accompanied with great congestion of the face. At the examination of the head, the right condyle of the lower jaw was found projecting into the middle fossa of the skull, into which it had been driven through a starred fracture of the glenoid cavity of the temporal bone. The neck of the condyloid process was partially destroyed. Some spicula of bone had wounded the dura mater, which was extensively inflamed and thickened. There was also a large abscess at the under part of the middle lobe of the brain." (Loc. cit)

Before dismissing the subject of fractured base, it is requisite to mention some remarkable instances of extensive fracture which cannot be enumerated under the head of fractures of the vault or of the base. Sir Astley Cooper (*Lectures*, vol. i. p. 295) mentions a fatal instance of a circular fracture of the entire cranium by a blow on the vertex: the case oocurred in the practice of Mr. Chandler, of St. Thomas's Hospital. Mr. Luke mentioned to the writer the remarkable case of a child on whose head a heavy weight had fallen, where a separation between the anterior and posterior parts of the cranium appeared to have occurred, for one could be moved readily on the other. A curious train of symptoms existed after the accident, the child having an irresistible desire to turn round and round, as happens in the experimental sections of the cerebellum and optic tubercles. The patient is supposed to be alive now, the accident having occurred more than thirty years ago. Guthrie mentions a fracture of a similar nature, which, however, was fatal. (*See also Guthrie, On Injuries of the Head*, p. 66.)

Treatment of Fractured Skull.—The treatment of fracture of the skull, when unaccompanied by depression of bone or by any signs of pressure on the brain, is to be conducted on principles of a strictly anti-inflammatory character; and in cases of severe injury to the cranium, it is better to act on the presumption that a fracture has happened, than to resort to rude manipulation to detect a supposed fracture. Any attempt to adjust a fracture of the skull is rarely called for, as no displacement generally happens; and even in cases of comminuted fracture, where crepitation can be distinguished, it is better to leave the case to nature than to divide the scalp to adjust or remove the injured bone, and thus convert a simple into a compound fracture. Where cases of this nature progress favourably the bone will often reunite, and no mischief need be anticipated from the mode of union of the disjoined pieces.

Therefore, in all suspected fractures of the skull, whether of the vault or base, the all-important indication to be held in view is to prevent by energetic measures the access of inflammation to the brain or its membranes. It is very true that in many cases there is not the slightest tendency to this condition, and every surgeon of experience will acknowledge that it is quite unnecessary to resort to those extensive venesections which were invariably had recourse to formerly in all injuries of the skull, however trifling. Nay, in many cases, bleeding does harm, as it tends to prolong a condition of extreme debility, which is by no means an uncommon attendant on injuries of the skull, and which probably depends on the concussion and contusion the brain has suffered. We need not, however, pursue this subject here, as the treatment of concussion and other affections resulting from injury will be treated of further on.

In all cases, however, it is requisite to be exceedingly cautious in treating cases of injured head, and, where symptoms of cerebral injury exist, the head should be slightly raised, the hair should be cut close, or the head should be shaved if leeching is necessary, and cold lotions or ice should be kept constantly applied. Calomel purges and small and repeated doses of this mineral may be employed with the greatest advantage under careful inspection: these, together with bleeding generally or by leeches, saline medicines, and low diet and absolute quietude, comprise all that is necessary in the treatment of fractures of the skull. But it often happens that a persistence in this lowering treatment is injurious, and it becomes absolutely necessary to give a moderate support to the system from the very commencement. The condition demanding this altered plan may be recognised by the state of the pulse and skin and general aspect of the face; the pulse is weak and unsteady, the skin is cold, and the general aspect indicates extreme depression. Under these circumstances beef tea and weak wine and water may be administered with very great advantage.

No positive plan can be laid down as applicable to all cases of fractured skull; much must necessarily be left to the discretion of the surgeon, who will do well to use great circumspection and avoid being led into the old routine practice, totally inapplicable to many cases, of bleeding indiscriminately in all cases of injured head.]

DEPRESSED FRACTURE.

[When the skull is fractured, and one piece of bone is placed below its natural level as a consequence of the fracture, it is termed a fracture with depression, or depressed fracture. The importance of such cases is materially enhanced, because the capacity of the cranium is diminished, and the brain may thus become the subject of inconvenient pressure. The symptoms of pressure and its attendant phenomena will be considered under the head of COMPRESSION.

The most simple form of fracture with depression is represented by those slight indentations of the cranial bones which occasionally happen to very young children from falls or blows upon the head. Some cases of this have come under our own observation, and we shall refer to two instances. The first was the case of a child nine months old; the nurse having fallen down whilst carrying it, the head of the child came in contact with some hard body: a very extensive depression of the right parietal bone was the consequence. When first raised, the child was insensible, in which state it was brought to the London Hospital. Half an hour after the accident, the child was quiet, pale, and its pupils were contracted; its skin was warm, and pulse natural: it had vomited. A cold lotion was applied to the head. On the following morning the child was as lively as usual, and was perfectly well. The depression became gradually less apparent, but the bone remained depressed for some months. The child afterwards ceased to attend, and the condition of the bone at this time is unknown; but we have no doubt that it was gradually raised to its proper level.

The slight elasticity and comparatively yielding state of the bone at this early period of life explain the facility with which this form of injury occurs in the cranial bones of children. The thinness of the scalp renders it easy to distinguish the case from those limited forms of effusions of blood with central depression which not unfrequently, in the adult, embarrass the diagnosis of the surgeon. The simple movements of the brain appear sufficient to effect a gradual elevation of the depressed bone to its natural level; and generally no permanent deformity results. We are unable to solve the problem as to whether there is really a fracture of the bone, or not, under such circumstances. We think there is; but the question is quite unimportant.

But, even in young children, depressed and indented fracture may be followed by serious consequences. This happens when the bone is driven in forcibly by contact with a pointed instrument. In the second case, which was witnessed at the London Hospital, death took place from suppuration of the brain ten months after the accident; the child, during the greater portion of the intervening period, having remained free from any signs of cerebral disorder. In this case, on readmission, convulsions and other signs of deep cerebral mischief had set in, and the child sank soon after admission, no operation having been had recourse to. In all cases, therefore, it is best to give a guarded prognosis, as at any period, especially if the bone has not attained its natural level, fatal cerebral mischief may arise. In the case just referred to, some absorption of the depressed bone had occurred, for the pulsations of the brain were distinctly perceptible. In the absence of any signs of cerebral disturbance, it is quite unnecessary to interfere by operation in these cases; and even in a case of compound fracture the trephine is unnecessary, unless the dura mater or the substance of the brain is penetrated,—a condition which would be recognised at once, and would probably be attended by convulsions, coma, paralysis, or other signs of cerebral disturbance. The persistence of such symptoms would lead a prudent surgeon to raise the bone.

A fracture with depression of the outer table alone may happen in almost any part of the vault of the skull, but it is not very common: in the child it can only occur over the frontal sinuses, or into the mastoid cells, in consequence of the thinness of the bones generally. We have seen many instances of fracture of the outer table covering the frontal sinuses; they are cases of a very simple character, and as the inner table remains entire, the cranial cavity is not injured, and the case is one of fracture of the face rather than of the cranium: it is quite unnecessary to raise the bone. The same remark applies to a fracture with depression into the mastoid cells. But the outer table may be depressed into the diploe, and if the case is unattended with any injury to the inner table, it is unnecessary to interfere with it.

There are great varieties of depressed fracture. Thus, a simple depression of bone in a nearly circular form, and of very limited extent, may happen; or a piece of bone may be depressed below the level of the adjacent portion, or it may be driven forcibly beneath it. Sometimes the bone is comminuted and depressed; this frequently happens from gunshot wounds, as where a bullet impinging on the bone obliquely produces a starred and depressed fracture. Lastly, the bone may be depressed and driven into the substance of the brain. Every variety of depressed fracture may be simple or compound.

Treatment of depressed fracture. — In reference to the treatment to be pursued in the various descriptions of depressed fracture, the following extract from the last edition of this Dictionary embodies the opinions of Pott, Abernethy, Samuel Cooper, and others, on this subject, and contains much important information on the subject of depressed fracture in general, and on other cases of unusual occurrence and great interest.]

Mr. Pott says: "In fractures with depression, the depressed parts are to be elevated, and such as are so separated as to be incapable of reunion, or of being brought to lie properly and without pressing on the brain, are to be totally removed. These circumstances are peculiar to a depressed fracture; but although they are peculiar, they must not be considered as sole, but as additional to those which have been mentioned at large under the head of simple fracture: commotion, extravasation, inflammation, suppuration, and every ill which can attend on or be found in the latter, are to be met with in the former, and will require the same method of treatment." That loose splintered pieces of the cranium, when quite detached, and already in view, in consequence of the scalp being wounded, ought to be taken away, no one will be inclined to question. That they ought also to be exposed by an incision, even when the scalp is unwounded, and then taken away, whenever they cause urgent symptoms of irritation or pressure, I believe will be universally allowed. But the reader will already understand that several excellent surgeons do not coincide with Pott in believing that every depressed fracture of the skull necessarily demands the application of the trephine.

"There certainly are (says Mr. Abernethy) degrees of this injury which it would be highly imprudent to treat in this manner. Whenever the patient retains his senses perfectly, I should think it improper to trephine him, unless symptoms arose that indicated the necessity of it." (P. 21.)

It is extraordinary and unaccountable, but it is not less true, that no calculation of the bad effects can be made by the degree in which a part of the skull is depressed. This is a fact which has been long known. It has also been particularly adverted to by an eminent modern writer. "Various instances also presented themselves, in which, though a considerable degree of compression must have been occasioned, sometimes by the depression of both tables, and at other times by the depression of the inner table only, of the skull, yet neither stupor, paralysis, nor loss of memory was produced. In one of these cases the middle of the right parietal bone was fractured, and considerably depressed, by a ball, which was extracted on the twentieth day. In this case neither stupor nor paralysis appeared. In another a musket-ball had struck the right parietal bone, fractured it, and was flattened, and lodged between the tables of the skull. The inner table was much depressed, yet no bad symptoms supervened." (See *Thomson's Obs. made in the Military Hospitals in Belgium*, p. 59, 60.) The same author also saw a singular case, in which a ball, entering behind the right temple, and passing backwards and downwards, had fractured the bones in its passage, and lodged on the surface of the brain, over the tentorium, from which place it was extracted on the seventeenth day after the injury. No bad symptom had manifested itself previously to the operation; and the man recovered under the strictest antiphlogistic regimen, with little or no constitutional derangement. Dr. Hennen has recorded two cases, fully proving the correctness of Mr. Abernethy's opinions, about the impropriety of using the trephine in cases of depression unattended with urgent symptoms: in one of these instances the upper and posterior angle of the parietal bone, which had been struck by a musket-ball, was depressed exactly *an inch and a quarter from the surface of the scalp*, *yet no bad symptoms followed*, and with the aid of bleeding and other antiphlogistic remedies, the soldier recovered perfectly in a few weeks. "In a similar case, where the man survived thirteen years, with no other inconvenience than occasional determination of blood to the head on hard drinking, *a funnel-like depression to the depth of an inch and a half* was formed in the vertex." (See *Hennen's Military Surgery*, p. 287, ed. 2.)

If then the violence of the symptoms is not always in proportion to the compression, but is sometimes considerable when the pressure is slight, every surgeon cannot be too fully impressed with the following truth, that *existing symptoms of dangerous pressure on the brain*, which symptoms will be presently related, *can alone form a true reason for perforating the cranium.*

Although the doctrines of Sir Astley Cooper, generally speaking, coincide very much with the preceding maxim, which I regard as a very important one, there is an exception to it in his advice, in relation to compound fractures of the skull, as will be understood from the following passage. "The old practice used to be, the moment an injury of the brain was suspected, and the least depression of the bone appeared, to make an incision into the scalp. This is putting the patient to considerable hazard; for the simple fracture would, by the incision, be rendered compound. In simple fracture, then, when it is attended with symptoms of injury of the brain, deplete before you trephine; and when it is unattended with such symptoms, deplete merely, and do not divide the scalp, &c. If the fracture be compound, the treatment must be very different, because a compound fracture is very generally followed by inflammation of the brain; and it will be of little use to trephine, when inflammation is once produced. If the inflammation come on, the patient will generally die, whether you trephine or not;" and it is added that the operation will even be likely to increase the inflammation, which has been excited by a depressed portion of the skull. "The rule (says Sir Astley) which I always follow, is this: when I am called to a compound fracture, with depression, which is exposed to view, whether symptoms of injured brain exist or not, I generally use an elevator, and very rarely the trephine. I put the elevator under the bone, raise it, and, if it has been comminuted, remove the small portions of bone." (*Lectures, &c.* vol. i. p. 304, 308.) Of the propriety of using the elevator in such cases, and also of taking away loose fragments, there cannot be a doubt; but many surgeons object (and I confess myself one of the number) to saw out a portion of the skull while the patient is free from urgent symptoms. I believe, also, that the inflammation, when it does arise, is mostly the effect of the violence itself, not of the depression of the bone, and, therefore, more likely to be increased than prevented by the application of the trephine. I think a better reason for elevating the bone, when it is exposed, and there are no bad symptoms, is the fact, that many patients, after their recovery from the imminent danger of the accident, become subject, whenever the circulation is hurried, to insanity, or epilepsy, or remain in a state of hebetude, with dilated pupils, and more or less impairment of some of the external senses, as the eyesight, &c. (See *Case by H. Larrey, in Hist. Chir. du Siége de la Citadelle d'Anvers*, p. 114.) Yet here it is to be considered, that it may be quite time enough to trephine when such ills follow the continuance of the depression, and that, perhaps, the operation would then be in itself less dangerous, inasmuch as the tendency to inflammation, arising from the first violence, must then have subsided. Much would depend, however, upon the frequency and severity of the fits, and the degree of annoyance and suffering; for, as M. H. Larrey well observes, the result of an operation would be doubtful, and it might even prove fatal. (Op. cit. p. 116.)

The view of this part of the subject, taken by M. Velpeau, does not exactly coincide with that entertained by Abernethy. "The cases (says he) of recovery, notwithstanding a depression to the depth of an inch, or an inch and a half, as recorded by numerous former observers, by no means prove that in such examples trepanning is never useful. The same remark applies to the cases brought forward in modern times by Dorsey, Dupuytren, Paillard, Graefe, &c. These instances must all, or nearly all, have been fixed depressions, without any great inequalities internally, or manifest laceration of textures. Most of them had given rise to but slight symptoms of compression, and many of them to none at all. The case of a rich banker mentioned by Dupuytren, and who is still living with the bone depressed, although the injury took place many years ago, forms a kind of exception. I know (observes M. Velpeau) that it is not the only one; but these are rare cases, on which it would be dangerous to lay a foundation. For one patient thus saved, ten would perish who might be preserved. I saw a woman who had a depression on the frontal bone half an inch deep, and whom I deemed it improper to operate upon, because she had no alarming symptoms. Yet, at the end of six weeks, she died of inflammation and suppuration of the anterior part of the brain. Would this have happened had she been trepanned?" (*De l'Opér. du Trépan*, p. 57.)

I believe few surgeons in London would have any difficulty in replying, that if the operation had been performed, the result might, or might not, have been the same. It seems to me, also, that when signs of suppuration under the cranium first presented themselves, the operation might have been indicated, though not so in an earlier stage; but, without being in possession of all the particulars of the case, I offer this remark without any intention of being critical.

M. Velpeau is not on the whole an over-zealous advocate for the operation; and some of his advice approximates very much to that delivered by Sir Astley Cooper, with a modification, depending upon whether the depression is immovable and fixed. If it be of this kind, without manifest compression, he recommends delay, and antiphlogistic treatment. But when there is a wound, with denudation to the bottom of it, the operation seems to him called for, even though urgent or unequivocal symptoms of compression may be absent. He would not trepan, however, if the depression were broad, and of no great depth; if the intellects were uninterrupted, and there were no marks of paralysis. M. Velpeau regards a depression with mobility of the bone as far more dangerous. An effusion of blood first and pus afterwards, he sets down as frequent consequences of it; and the case is almost sure to prove fatal, unless the trepan be employed. (Op. cit. p. 58.) A movable depressed fragment, I may observe, may often be removed with the forceps without any occasion to perforate the cranium with the trephine or trepan; and, if not removable in this simple manner, may frequently be taken away by dividing a small portion of the bone with one of Hey's saws. (See TREPHINE.)

M. Velpeau adverts to one species of depression, in which no good is derived from the trepan, namely, that in which the fracture is usually extensive and the edges of the fragments overlap one another, in consequence of a violent concussion of the skull. Here, says he, the degree of crushing, contusion, and extravasation at different points, makes the patient's recovery almost impossible.

In another place, M. Velpeau points out the practical importance of studying the differences in the symptoms of compression according as they depend upon a depression of bone, either simple or comminuted, a foreign body, an extravasation of blood, or an effusion of pus. A simple depressed fracture he sets down as the most favourable of these cases; for if the operation is not done, the brain in the end frequently becomes habituated to the pressure and resumes its functions. If no extravasation take place, the pressure arising from a depressed fracture is really less than might at first be imagined. If the operation be decided upon, it presents the greatest chances of success, provided the compressing cause has not seriously wounded the brain. The rule which M. Velpeau here lays down, is, that in cases of depression, if the symptoms are not urgent, or begin to abate after twenty-four hours, the trepan may be dispensed with; but if they are at all intense, or make progress, the operation is strictly required. (*De l'Opér. du Trépan*, p. 120.)

In children, a portion of the skull is sometimes depressed, or indented by a blow, but in a few days regains its natural level, without the aid of the surgeon. In such examples, it is conceived by Sir Benjamin Brodie, that the earthy part of the bone gives way, while the animal part remains entire, so that there is not an actual solution of continuity; and he supposes that the restoration of the bone to its proper level is brought about by the constant pulsations of the brain against its inner surface. (See *Med. Chir. Trans.* vol. xiv. p. 332.)

M. Velpeau denies the possibility of indentations without fracture. (Op. cit. p. 36.)

Sometimes a considerable depression of the bone arises from the external table being driven into the diploe, while the inner table is entire. To trephine, therefore, merely because there is a depression of the bone, would be completely erroneous, and the only safe principle is that which I have just now specified. The depression of the outer table in the foregoing manner I have never seen myself, except over the frontal sinus. Sir Astley Cooper, however, mentions it as a frequent occurrence; but that it is confined to persons of middle age, as in very young and very old persons the skull is thin and without diploe. (*Lectures*, vol. i. p. 302.) Another sort of depression, I believe, is more frequent; at least, I have seen several examples of the case: it consists in a fracture and depression of the internal table, while the external one continues unbroken. A case of this kind, attended with urgent symptoms of compression, I trephined at Brussels after the battle of Waterloo; a large splinter of the inner table was driven more than an inch into the brain, and, on its extraction, the patient's senses and power of voluntary motion instantly returned. The part of the skull to which the trephine was applied, of course, did not indicate externally any depression, and it was selected because the appearance of the scalp showed that there the external violence had operated. I rather expected to find extravasated blood than a depression of the inner table of the skull. (See also *Saucerotte, in Mém. pour le Prix de l'Acad. de Chir.* t. iv. ed. 1819, p. 322. *Bilguer*, two examples as quoted by *M. Velpeau, De l'Opér. du Trepan*, p. 29. *Hennen's Military Surgery*, p. 323, ed. 2.; and *Sir B. C. Brodie*, in *Med. Chir. Trans.* vol. xvi. p. 331.)

In military surgery, particular cases present themselves, which scarcely admit of being comprehended within the tenour of any general rules and principles. Thus it sometimes happens that a ball breaks the os frontis, and the whole or a part of it lodges in the frontal sinus, with or without fracture of the inner boundary of this cavity. In cases of this description, Baron Larrey recommends exposing the course of the fracture by a free incision, and the use of the trephine for the removal of the extraneous body. When the inner side of the sinus was found broken and depressed, he next perforated that part of the cavity with a small conical trephine, took away such pieces of bone as required removal, and let out any extravasated blood. Sometimes, however, the front of the sinus is so splintered, that the fragments, when taken away with the forceps, leave the cavity sufficiently opened, not only for the extraction of the ball, but for the application of the trephine to the inside of the sinus, as we find exemplified in one of the two cases of this nature which Larrey met with in the Egyptian campaign. (*Mém. de Chir. Militaire*, t. ii. p. 138.) After the battle of Witepsk, in 1812, he was called to two Russian soldiers, whose cases were remarkable; one of them had been struck above the right eyebrow with a grape-shot, which, after breaking and penetrating the frontal bone, entered the cavity of the cranium, so as to lodge upon the anterior right lobe of the brain, and the orbital process and internal crista of the os frontis. Notwithstanding the large sise of the ball, little of it could be seen externally, and the aperture through which it had passed was not more than three or four lines broad; every attempt to extract it, therefore, was in vain. The patient experienced a painful sense of oppression and weight in the head, and, whenever he inclined it backward, was seized with syncope. He kept himself constantly in a sitting posture, with his head on his knees. Larrey adds, that every symptom of compression of the brain also prevailed, though this account is rather difficult to comprehend, considering that the patient could sit up and choose his posture. As for any description given by himself of his sufferings, that is another circumstance, on which I should not be inclined to dwell, because in all probability the baron was not able to converse in the Russian language, and the inferences respecting the man's feelings were made in some other way. But, whatever might be the real state of the symptoms (and in a case of this kind a correct account of them would have been interesting), the ball was plainly ascertained, by means of a probe, to be of iron, and of much larger diameter than the opening through which it had entered; and that, for the purpose of extracting it, the application of the trepan was urgently necessary. The fracture was fairly brought into view by suitable incisions; three perforations were made with a small trephine at its upper part, and, after the removal of the angles of the bone between these perforations, the ball, which weighed seven French ounces, was readily extracted with the aid of a strong pair of forceps and an elevator. A considerable quantity of coagulated blood was also removed, under which the brain was found with a depression three or four lines deep. As soon as some splinters of the bone had been taken away, the part was dressed with a bit of fine linen dipped in warm wine, over which were placed charpie, several compresses, and a bandage. With respect to the application of warm wine, and other stimulants, to the surface of the brain, in wounds exposing or interesting that organ, it seems to be an invariable practice with Larrey, as well as Schmucker and the older surgeons. On what principle the custom is still kept up, and whether it is truly right and useful, are questions which may be rationally put. In whatever way experience may hereafter decide these matters, suffice it to add, that the patient was relieved by the treatment, and fell into a quiet sleep for two hours; but in the evening he became feverish, and the wound acutely painful. A copious quantity of blood was then taken from the vena saphena (and why bleeding was not practised at first seems extraordinary). The dressings, which, according to my ideas, were highly objectionable, were removed, and a large emollient poultice applied. Cooling beverages, containing a small quantity of tartarised antimony, and antispasmodic anodyne medicines, were prescribed. The following day the patient's state appeared satisfactory, without the slightest disturbance of the senses, and, in due time, he perfectly recovered.

The other soldier had been wounded in the left temple, with a leaden ball, five days before Larrey saw him. One half of the ball had gone into the cranium, through a very narrow breach; the other had burrowed under the temporal muscle, and lodged near the mastoid process. The right side of the body was paralytic, the senses were annihilated, and the man was in a state of incessant agitation. After dilating the wound in the temple, and exposing the fracture, Larrey discovered the track of the piece of lead, which had gone towards the mastoid process, and which he immediately extracted by a counter opening. At the lower part of the temporal wound, he applied a trepan, very near the spot where the other portion of the ball was lodged. This, with some fragments of the bone, and a quantity of extravasated blood, was easily extracted. The patient, however, was not saved, the operation having been done too late.

In another case, one of the Imperial Guards, wounded at the battle of the Moskowa, died with symptoms of compression, and, after death, a quarter of a bullet and a fragment of bone were found under the skull, attended with an ulcerated or wounded state of the adjacent portion of the brain. Larrey expresses his opinion, that this soldier would have had a chance of being saved, had the trepan been used. (See *Mém. de Chir. Mil.* t. iv. p. 183, &c.) The practice of trephining for the removal of balls situated near a fracture of the skull, within this bony cavity, or lodged amongst the fragments, or between the two tables forced asunder (see *Engel's case, in Vermischte Chir. Schriften von J. L. Schmucker*, b. i. p. 242), is not peculiar to Larrey, for it has been done by many other surgeons (see *Schmucker's Wahrnehmungen*, b. i. p. 298); but I do not know that he has been anticipated in his bold practice of making a counter-opening in the skull, when the ball is lodged at such a distance from the fracture that it cannot be extracted through any perforation made in the vicinity of the original injury; for it is a principle which he ventures to lay down, that, *when a ball has entered the cranium, without quitting the roof of this cavity, the case is one requiring the application of the trepan.* (*Mém. de Chir. Mil.* t. iv. p. 180.) In the second vol. of this work (p. 139), the reader will find the account of a soldier who was struck on the middle of the forehead with a ball which penetrated the os frontis, and then passed obliquely backwards, between the skull and the dura mater, in the course of the longitudinal sinus, as far as the lambdoidal suture, where it stopped. Larrey traced the situation of the ball, by the introduction of an elastic gum catheter into the opening; and measuring the distance between the fracture and the place where he felt the ball, he cut down upon that part of the skull, beneath which he concluded that the ball was lodged. The bone was then perforated with a large trepan; *a good deal of pus was discharged;* the ball was extracted, and the patient recovered. One thing here merits the attention of surgeons; Larrey tells us that a good deal of pus issued as soon as an opening had been made in the skull: there must then have been suppuration under the bone, and inflammation and detachment of the dura mater; circumstances always indicated, according to Pott, by a corresponding separation of the pericranium, and a puffy tumor of the scalp. Did these symptoms take place in the foregoing case, so as to be of any assistance to Larrey, in judging of the place where the ball was lodged? and has the mention of them been omitted only by accident? or are we to infer, that suppuration may happen between the cranium and dura mater, without any detachment of the pericranium and puffy tumor of the scalp; a thing which Bichat asserts is proved by daily experience in the Hotel-Dieu, at Paris? (See *Œuvres Chir. de Desault*, t. ii. p. 29.) Larrey, in his 3rd vol. (p. 82), gives us another case, in which a ball pierced the left parietal bone, and lodged near the lambdoidal suture. Its situation was detected with the aid of an elastic gum catheter, and partly in consequence of there being a slight ecchymosis over the part. Here a crucial incision was made through the scalp, and a small fissure discovered. As the symptoms of compression increased, the trepan was applied, so as to include the fissure. A half of the ball, flattened, was found directly under the perforation, and a good deal of blood was voided from the two openings in the cranium. For a fortnight the case went on favourably; but the patient was then attacked with what Larrey terms hospital fever, but which, in all probability, was inflammation and suppuration of the membranes of the brain, and died.

The records of surgery furnish numerous instances, in which the patients lived a considerable time with balls lodged in the cavity of the cranium. Thus, one is related by Paroisse, where the patient soon recovered his senses after the injury, and, at the end of six months, felt no inconvenience, except a difficulty of opening the mouth. (*Opuscules de Chir.* Obs. i. 8vo. Paris, 1806.) Ramdohr published another case, where a soldier was shot through the frontal sinus, and the ball was found after death in the medullary substance of the left hemisphere of the brain, half an inch above the ventricle; yet this patient lived four months after the injury, and soon recovered his senses after its occurrence. For a considerable part of this time, he was also free from any bad symptoms. At last, he was affected with a kind of stupor, and an inability to open his left eye, and fell into a lethargic and convulsed state. (*Schmucker*, *Vermischte Chir. Schriften*, b. i. p. 277.) A French soldier, at the battle of Waterloo, was wounded with a musket-ball, which entered at the anterior portion of the squamous suture, lodged in the substance of the brain, and on the fifth day, after an enlargement of the wound, and the removal of several fragments of bone, was extracted from the posterior lobe of the right hemisphere of the brain, where it was found resting on the tentorium. Yet, during the several previous days, the man, with the exception of a slight headache, and partial deafness of the right ear, seemed to enjoy perfect health. The case ended well. (See *Hennen's Mil. Surg.* p. 289, ed. 2.) M. Velpeau cites a case, where several small shots lodged for many years on the dura mater, and were the cause of epileptic attacks. (*De l'Opér. du Trépan*, p. 44.) He saw a soldier at the Invalides, with a ball that had remained fixed for many years in the opening which it had produced in the skull, the man having refused to permit its extraction to be attempted; from the account, however, I infer, that it lay partly in the frontal sinus, and that the inner table was not injured. The same surgeon also quotes a case from Schmucker (*Bibl. du Nord*, t. i.), where a wounded person remained senseless for six days, with a piece of the barrel of a gun within the skull: four perforations were made with the trepan, and a recovery took place. In the *Med. Chir. Trans.* are the particulars of a case, in which the linch-pin of a gun was driven into the os frontis, and penetrated the brain, so as to be concealed, and its presence not suspected, till the twenty-seventh day after the accident, when it was detected and taken out. The boy walked some distance directly after the accident, and then fell down senseless and convulsed. By means of antiphlogistic treatment, he regained his mental faculties the next day, and finally recovered, with the exception of amaurosis of one eye. Notwithstanding the instances on record of balls and other foreign bodies having lodged in the brain without proving fatal, (see *Ramdohr*, op. cit. p. 81, and *La Martinière, as referred to by Velpeau*), the rule in surgery is always to extract them when practicable. In a case, mentioned by Quesnay (p. 23), the patient, who was supposed to be entirely out of danger, died a year afterwards, and the ball was found in the brain at the depth of two inches. The example, published by Anel (*Acad. de Chir.* t. i. p. 236), terminated in the patient's sudden death, and the ball was found on the pineal gland. Many other interesting observations on this subject have been collected by M. Velpeau. (*De l'Opér. du Trépan*, p. 48.) All foreign bodies, occasioning irritation or laceration of the brain, seem to M. Velpeau formally to require the perforation of the cranium; but the chances of a favourable result are less than in a simple depression of the bone, on account of the risk of inflammation of the brain being greater. (Op. cit. p. 122.)

Remarkable instances of the duration of life, and even of the absence of very serious symptoms, after great and serious wounds of the brain, and the lodgment of balls, are recorded in the Essay of M. Quesnay. (*Mém. de l'Acad. de Chir.* vol. i. 4to.) Professor Sewall, of Washington, has reported two cases of fracture of the cranium, *with loss of a portion of the substance of the brain.* In one of them the injury was inflicted with a spade, which penetrated through the dura mater and into the medullary substance of the brain. The antiphlogistic treatment was relied upon from the commencement, and during the suppuration which followed some of the brain itself protruded and sloughed away, and subsequently portions of it were removed with a spatula. Nevertheless, in six weeks, the patient completely recovered. (See *Amer. Journ. of the Med. and Phys. Sciences*, No. iii.; and *Reese's Amer. ed. of this Dict.*) Twenty-two French soldiers, whose vertices, with more or less of the brain, had been cut off by sabre-strokes, had, at first, not a single bad symptom, and all performed a journey of thirty leagues after being wounded, and one-half of this distance on foot. Ten of them died. (See *Paroisse, Opuscules de Chir.* p. 41, &c.) Several cases, exemplifying the absence of bad symptoms in the first stage of a wound of the brain, and yet terminating fatally, I have seen in the army, as well as at St. Bartholomew's and University College Hospitals. A case is recorded by Fardeau (*Soc. d'Emul.* t. viii. p. 399), of a bayonet penetrating one temple and coming out below the cheek of the opposite side: the efforts of a strong man were required to get it out again: the patient recovered. Whether the brain was pierced in this example may, I think, admit of doubt.

[The necessary inference from these remarks is, that in cases of simple depressed fracture without symptoms of compression, as a general rule, it is better to abstain from using the trephine to raise the bone; and further, in cases of this description, where doubtful signs of compression exist, in combination with symptoms of concussion, operative interference may be delayed for a time, as it is probable that these symptoms may altogether disappear. We allude to such signs as stupor, somnolency, slowness of pulse, and general insensibility, as they probably depend more on the concussion the brain has sustained than on pressure from depressed bone, and under suitable treatment will altogether disappear. On this point, however, it is impossible to lay down any rule as to the period to which delay may be fairly advocated; experience leads us to regard the absence of dilated pupil and hemiplegia a most important element in forming our opinion. If, therefore, it is resolved to wait and see what nature will effect towards the restoration of the cerebral faculties, the state of the pulse, the respiratory system, and the condition of the pupils, must be most carefully watched, and a due attention must be paid to the state of the intellect; and if any amendment occurs, as evinced by a return of the general sensibility, delay is fully justified, as a further gradual improvement may be expected under such simple and appropriate treatment as has been recommended in cases of fracture without depression.

What are the exceptions to the rule here recommended? They are very few: the extent of the depressed bone will not afford an infallible criterion, for the greater the superficial extent of the depression, the less will be the risk of ulterior mischief to the brain. This remark applies especially to young subjects; but in cases where the bone is forcibly driven down on to the dura mater to such a depth and in such a manner as to justify a well-grounded suspicion that ulceration of this membrane will probably result, it is better to cut down and raise the bone by the elevator or the trephine, than leave the patient to the imminent risk of destructive inflammation of the brain and its membranes. In a person of advanced age, if one piece of bone is thrust completely under the edge of another, threatening mischief to the dura mater, it should be elevated; such a condition, however, could scarcely be recognised without a wound of the scalp, when the case, becoming compound, should be subjected to the treatment advised for compound fractures. In young subjects, the depressed bone should be left to nature, and all surgical interference by operation should be avoided in the absence of symptoms of pressure.

If, in a case of depressed fracture, symptoms of pressure are fully developed, the trephine should be applied at once, especially where hemiplegia on the side opposite the seat of injury is present; and even if there has been any delay in the use of the instrument, it may still be employed with success after an almost indefinite period, and after all inflammatory symptoms have been subdued by bleeding, &c. No prudent surgeon would counsel delay under such circumstances; but there are cases nevertheless where some doubt may be reasonably entertained as to the true interpretation of the existing signs; and it is satisfactory to know that, after all other means have failed to relieve the brain from pressure, the trephine can be used with a fair prospect of success. It is important to remember that a piece of bone may be depressed and exert no deleterious influence upon the cerebral system for a considerable period, and that symptoms of cerebral irritation may manifest themselves long after, and lead to the necessity of trephining; and in other cases, symptoms of pressure may continue even for many months, and may eventually be effectually relieved by the operation. A well-known case of the latter description, presenting circumstances of great interest, is given by Sir Astley Cooper, as having occurred in the practice of the late Mr. Cline. "A man was pressed on board one of His Majesty's ships, early in the late revolutionary war. Whilst on board this vessel in the Mediterranean, he received a fall from the yard-arm, and when he was picked up he was found to be insensible. The vessel soon after making Gibraltar, he was deposited in an hospital in that place, where he remained for some months, still insensible; and some time after he was brought from Gibraltar, on board the Dolphin frigate, to a depot for sailors at Deptford. While he was there he was visited by Mr. Davy, who found him insensible, lying on his back, with very few signs of life, and apparently deprived of all powers of mind, volition, and sensation. Mr. Davy examined the case, and found that there was a slight depression on one side of the head. Being informed of the accident which occasioned the depression, he recommended the man to be sent to St. Thomas's Hospital. He was placed under the care of Mr. Cline; and, when he was first admitted into this hospital, I saw him lying on his back, breathing without any great difficulty, his pulse regular, his arms extended, and his fingers moving to and fro to the motion of his heart, so that you could count his pulse by this motion of his fingers. If he wanted food, he had the power of moving his lips and tongue; and this action of his mouth was the signal to his attendants for supplying this want.

"Mr. Cline, on examining his head, found an obvious depression; and thirteen months and a few days after the accident, he was carried into the operating theatre, and there trephined. The depressed bone was elevated from the skull. While he was lying on the table, the motion of his fingers went on during the operation; but no sooner was the portion of bone raised than it ceased. The operation was performed at one o'clock in the afternoon, and at four o'clock, as I was walking through the wards, I went up to the man's bedside, and was surprised to see him sitting up in his bed. He had raised himself on his pillow. I asked him if he felt any pain, and he immediately put his hand to his head. This showed that volition and sensation were returning. In four days from that time the man was able to get out of bed, and began to converse; and in a few days more he was able to tell us where he came from. He recollected the circumstance of his having been pressed, and carried down to Plymouth or Falmouth; but from that moment up to the time when the operation was performed, his mind remained in a state of perfect oblivion. He had drunk, as it were, the cup of Lethe; he had suffered a complete death, as far as regarded his mental, and almost his bodily powers; but by removing a small portion of bone with the saw, he was at once restored to all the functions of his mind, and almost all the powers of his body." (*Sir A. Cooper's Lectures.*)

The same surgeon has mentioned a case where, in a fracture attended with depression, a small spiculum of bone projected into the brain, so as to produce and support epileptic symptoms. "A negro had a fracture from a blow on the head, and a portion of bone was depressed. Shortly after, he was seized with epilepsy, which continued for many years. When he was admitted into the hospital, it was found that there was still a portion of bone depressed, and the trephine was applied to it. When the circular piece of bone was completely sawn round by the trephine, Mr. Birch, under whose care the patient was, found a difficulty in raising it: he put the elevator under it, but still it adhered to something within. At last he took a pair of forceps, and, by using more force, he extracted a little piece resembling a spur or thorn, which had proceeded from the inner table of the skull through the dura mater into the substance of the brain, and was the cause of the epileptic fits. After its removal, he had but one more fit, and completely recovered." (loc. cit.)

The immediate benefit afforded in these two instances, proves decidedly the propriety of elevating the bone, at almost any period after the accident, if symptoms of cerebral irritation or compression continue. Many analogous instances might be collected from the experience of surgeons of extensive practice. Mr. Newberry of Hampstead trephined a man successfully in consequence of epileptic fits resulting from an injury he had received six months before, and Sir David Dundas performed the operation with equal success and at a similar interval; the patient had become partially insane from the effects of a depressed fracture of the cranium. (*Provincial Med. and Surg. Journal*, vol. i. No. 12.) Mr. Cock, of Guy's Hospital, operated successfully on a similar case. (See also cases by Guthrie, loc. cit.)

But if the depressed fracture is accompanied by a wound of the scalp, and thus becomes compound, is there any necessity to modify our practice? or, in other words, does such a complication necessitate the use of the trephine? That the danger of the patient is increased when the scalp is lacerated there can be no doubt, for there is a greater probability that inflammation, with its consequences, may attack the dura mater and the brain, and thus lead to suppuration. But this is no reason for laying bare the coverings of the brain by the trephine, or by the use of Hey's saw; for by such a proceeding we add to the mischief, and thus increase the risk already incurred. It is better to replace the scalp carefully, and to bring the edges of the wound lightly together, so as to favour their union, and thus, if possible, convert the compound into a simple fracture. It is not advisable by compresses and bandages forcibly to place the parts in coaptation, as such a mode of dressing would prevent the escape of any blood which might be effused beneath the scalp, or from between the edges of the bone. These remarks apply to cases of compound fracture, where there are no symptoms of compression of the brain.

If the bone is much comminuted, the fragments should be carefully removed, if this can be done without violence; but if there is any difficulty in effecting it, it is better to leave the bone to be separated by the suppurative process. If, after the union of the scalp, inflammation attack the bone and the dura mater, the united edges of the wound will soon separate, and the state of the parts beneath will at once become apparent. The supervention of erysipelatous inflammation of the scalp in compound depressed fracture enhances materially the danger of the case; and hence the most cautious treatment is requisite, as well as the most careful attention to diet; and the steady employment of cold applications, as advised by Thomson and Schmucker, should be persevered in.

It will be seen, therefore, that the practice of non-interference in cases of compound depressed fracture without symptoms of pressure, which is here inculcated, is reduced to the simple principles which guide us in the treatment of depressed fracture in general; nor do we see sufficient grounds for making any important distinction in the cases, being satisfied that, as a general rule, operative interference is not only unnecessary, but positively injurious. We will not say that the simple elevation of the bone by carefully insinuating the edge of the elevator is unjustifiable in the absence of symptoms of pressure, but we most strenuously condemn any forcible use of this instrument for the purpose of raising a compound depressed fracture, especially if this cannot be done without such injury to the dura mater as may result from its extensive exposure and laceration of its vessels. It is true that the simple sawing out of a piece of bone, as has frequently been done for the relief of epileptic fits and other consequences of depressed fracture, is seldom attended with any inconvenience; but in extensive depression of the skull, accompanied by a wound of the scalp, it is often impossible to raise the bone with the elevator, and to effect this object with the trephine would require numerous applications of the instrument.

In considering this subject, however, we may remark that a compound fracture of the skull, depressed or not, generally results from the infliction of extraordinary violence, and that the symptoms may consequently become more dangerous than where there is no wound of the scalp; but, giving to this fact all due weight and consideration, we still hold to the opinion already expressed in favour of non-interference as a general rule in compound depressed fractures without symptoms.

Sir Benjamin Brodie, referring to Sir Astley Cooper's opinion on this subject, says:—"Sir A. Cooper has stated in his lectures on Surgery, that there is great difference as to the danger of inflammation and suppuration of the membranes of the brain, between those cases in which the fracture and depression is complicated with a wound of the scalp, and those in which the soft parts are uninjured, such mischief being much more liable to occur in cases of the first kind than in those of the second; and on these grounds he recommends that where this complication exists we should not hesitate to employ the trephine. But many persons undoubtedly have recovered in whom there was at the same time a wound of the scalp, and a fracture and depression of the cranium, although no operation was resorted to. I have conversed also with several other surgeons, whose experience on the subject has corresponded with my own, and all these circumstances led me to doubt the accuracy of Sir A. Cooper's conclusion. The question, however, is not to be decided merely on these premises; and it may remain to be decided, what is the probability of suppuration taking place in these cases, as compared with those in which the scalp remains uninjured.

"For many years I have preserved notes of a large number of the cases of injury to the head which it has fallen to my lot to witness. Among them of course there are many in which there was a fracture, with or without depression, followed by suppuration between the dura mater and bone.

On referring to these for further evidence on this interesting subject, I find that the cases in which suppuration takes place when the scalp is entire, have been comparatively rare, bearing a very small proportion indeed to those cases in which suppuration has followed a fracture complicated with wound. Such is the result of my own experience during a considerable period of time, and which I am enabled to give, not merely from a general recollection of what I have seen, but on the authority of written notes, made at the bed-side of the patients, and for the most part before the question they illustrate had ever presented itself to my mind.

"Taking all these facts into consideration, and endeavouring to give its proper value to what may be urged on either side of the question, I cannot but acknowledge, whatever may have been my first impression on the subject, that it appears to me at this moment that Sir Astley Cooper's views are well founded; and that in those cases in which a depression of bone exists without any symptoms, or with only trifling symptoms arising from it, the surgeon can follow no better general rule than this: if the depression be exposed in consequence of a wound of the scalp, let him apply the trephine and elevate the depressed bone; but if there is a depression, without a wound of the scalp, in consequence of the accident, let him not make such a wound by an operation."

Drs. Lawrie and King, surgeons of the Glasgow Infirmary (*London and Edinburgh Journal*, 1844), on the subject of trephining in compound depressed fracture, accompanied *by comminution, with cerebral symptoms as nearly as possible absent*, say:—"A reference to these cases will show that this description of injury is exceedingly dangerous, that of the cases recorded not a single case recovered without operative interference, and that of the eleven operated on, three recovered and eight died. These facts, whilst they are not much in favour of operation, are still less in favour of non-interference. At the same time it must be granted that, as the majority of those admitted with extensively depressed and comminuted bone were operated on and died, non-interference cannot be fairly judged of, because the operation may have had an injurious effect in some instances, and if all had been left without operation, the result might have been more favourable. On this account we by no means affirm that these cases decide the question, but so far as they go are in favour of interference in cases of comminution and depression, irrespective of cerebral symptoms. We wish to be clearly understood, as recommending the operation in this class of cases only where the bone is comminuted or deeply depressed. In addition to the reason for this advice, based on the above statistics, it must be borne in mind that the portions of the bone driven down and shattered can rarely be expected to live, and they are exceedingly apt to cause suppuration, and after the formation of pus, their removal as a general rule (to which we are aware there are exceptions) does no good."

Out of seventy-seven cases of compound fracture, twenty-nine recovered and forty-eight proved fatal: twenty-six were not interfered with surgically, of these eighteen recovered and eight died; fifty-one were operated on, and of these eleven recovered and forty died.

Francis Adams, in his excellent translation of Hippocrates (p. 432, &c. *Sydenham Society's edition*), says: "This practice (of non-interference) was sanctioned by all the best army and navy surgeons, from about the beginning of the present century down to a very recent period. What then, it will be asked, have been the results? Has experience confirmed the safety of this rule of practice, or has it not? To enable us to solve these queries, we have most elaborate and trustworthy statistics, published by Dr. Lawrie. It deserves to be remarked that Dr. Lawrie's ample experience has led him to reject decidedly the rule of practice, established by Mr. Abernethy, namely, that in cases of depression, the symptoms of compression should be our guide to the employment of the trephine. He adds, 'However well this rule may sound, when delivered *ex cathedrâ*, it will be found of very little practical utility, for this reason, that if we limit interference to cases exhibiting urgent symptoms of compression, we had much better not interfere at all, inasmuch as such cases prove almost invariably fatal. Such at least has been the experience of the Glasgow Hospital; for out of fifty-six cases operated on, including, in point of time, a period little short of fifty years, there does not appear in our records a simple unequivocal instance of profound insensibility, in which the mere operation of trepanning removed the coma and paralysis, or in any way conduced to the recovery of the patient. We wish to be clearly understood as speaking of the trephine used in reference to the state of the bone in cases of profound insensibility, not employed to remove extravasated blood; nor does the cause of our want of success appear at all obscure. We believe that in practice cases of urgent compression dependent on depressed bone alone are very few indeed. From what we have said, it will appear that we coincide with those who, in using the trephine in cases of compound fracture of the skull, look more to the state of the bone than to the general symptoms, and who employ it more as a preventive of inflammation and its consequences than as a cure for urgent symptoms, the immediate result of the accident. The details are by no means favourable to the trephine. Of fifty-six cases operated on, eleven recovered and forty-five died.'"

From the experience the writer has had in a large metropolitan hospital, the conclusion he has come to is, that as a rule it is far better to leave the bone alone altogether in compound depressed fracture *without symptoms*, than to attempt to raise it by the elevator or the trephine. He would say that this is the *general rule*, and that cases which require an opposite mode of treatment are exceptions to this rule, and the exceptions are exceedingly numerous. This question should be regarded as one of vital importance; indeed, there is none relating to injuries of the head of such serious moment. It can only be decided by experience, and that of a most extensive character. The danger of suppuration in compound fractures is probably not in the least degree enhanced where the bone is allowed to remain depressed beneath its natural level; and there is great increase in the risk of producing inflammation by attempting a forcible elevation of the bone. Dr. J. C. Hall (*Med. Gazette*, Nov. 27, 1840) published a number of very interesting cases which bear very strongly on this point: they present every phase of compound depressed fracture. In no single instance was any attempt made to elevate the bone, yet they all recovered under the use of a strict anti-inflammatory treatment. Most of the cases given by Dr. Hall occurred in young subjects, varying from five years of age to twenty-one; and in this respect some exception may be made to them, as it is well known that children make most surprising recoveries under extreme circumstances, doubtless owing to the readiness with which they adapt themselves to any altered condition to which they are exposed. In the adult there is certainly a greater tendency to inflammation and its consequences, as suppuration, ulceration, sloughing of the dura mater, and deep seated abscess; these may result from the pressure of the bone on the surface of the dura mater; but is it not true that the forcible raising of the bone, either by the elevator or trephine, may lead to similar consequences? We confess that our own experience leads to the conclusion that the risk of inflammation is increased rather than diminished by any operation of the nature alluded to. Nevertheless, cases occur in which the bone is so forcibly and deeply depressed on the surface of the dura mater and brain, that a prudent surgeon would not feel justified in leaving it without an attempt to raise the bone. Thus, if one piece of bone is driven forcibly beneath another, and if the sharp edge of the depressed portion is pressing firmly on the dura mater, and from the depth of the depression is threatening ulceration, as previously observed, it is better to raise the depressed portion; the same rule applies also to the case in which the depressed fracture traverses the groove of the middle meningeal artery, or one of the sinuses of the dura mater. The trephine should be employed also where a pointed instrument has penetrated the skull, fracturing and depressing the inner table of the skull to a greater extent than the outer; and in cases of depressed radiating or star-like fracture, the consequence of direct topical violence from a heavy angular or blunted instrument; as well as in all cases of punctured fracture extending into the substance of the brain : and, lastly, where a foreign body is found beneath the dura mater, or is left in the substance of the brain, and which necessarily leads to suppuration, there can be no doubt about the propriety of trephining, although many of these cases would possibly do well without any operation whatever. In cases, however, of compound depressed fracture of very great extent, and especially where the depth of the depression is comparatively slight, a strictly anti-inflammatory treatment will often prevent any mischief to the dura mater, when any violent attempt to raise the bone to its proper level will assuredly increase the risk of inflammation; and even in cases of depressed fracture, where the brain itself is lacerated, a favourable termination of the case may occasionally under similar treatment be anticipated, in young subjects especially, provided a free exit to the damaged brain be given, aided by suitable external applications; but if any attempt is made to close the wound, death ensues, because the damaged brain and effused blood have no opportunity of escaping.

Mr. Lawrence, in his clinical lecture (*London Medical Gazette*, vol. xxi. p. 145), describes the case of a boy who was thrown violently from a cart, and whose head came in contact with a piece of timber. He was insensible, but could move his limbs; his breathing was natural, and he had been sick. "The upper and right part of the head was covered with a large mass of clotted blood, which contained a portion of brain, about sufficient to fill a dessert spoon, which had escaped through a wound of the scalp, about a third of an inch in length, just over the coronal suture. There was a fracture of the right parietal bone, which could be traced under the integuments from the back of the bone to the situation of the wound, at which there was a considerable depression. A further escape of cerebral matter was found to have taken place when he was brought to the hospital. At the end of two hours he manifested sensibility on being pinched; he moved his limbs readily ; the circulation, respiration, temperature, and colour of the skin, were natural." Mr. Lawrence proceeds to describe his reasons for non-interference in the case, thus: "As the bone was here evidently and considerably depressed, and as it was also probably driven in upon the brain, it would, I believe, have accorded with the principles of treatment generally admitted, to have performed an operation for the purpose of elevating and removing depressed and detached portions of bone. The considerations which determined me not to do it were, the favourable state of the patient generally, and in particular the absence of all symptoms indicating compression of the brain; the smallness of the external wound, which brought this case nearly into the state of a simple fracture; the extensive incision of the integuments, and exposure of the bone, dura mater, and brain, which an operation would have involved; and the almost invariably fatal termination of such proceedings, within my own experience, in hospital practice. On the whole, I consider the dangers attendant on such an injury which befel this poor lad, to be much less than those belonging to the operation which would have been required in this case. A strict antiphlogistic treatment was adopted, comprising perfect quiet, opening medicines and clysters, and tea diet. The head was shaved and kept cool by the repeated application of cold cloths, and the wound was kept open, that blood and effused liquids might escape rapidly. In thirty-six hours after the accident, the external senses and mental powers were completely recovered, and speech was restored. When questioned he complained of pain in his head, which continued more or less for about ten days, and was the principal symptom referable to the accident. The entirely favourable progress of the case seemed to justify the course adopted, but new and alarming symptoms appeared on the fourteenth day. There was some increase of temperature in the head, and general feverishness. Convulsions came on in the face and right limbs, while the left arm and leg were completely paralysed. The question of operation was again considered. I did not refer these symptoms to pressure of the displaced bone, believing that if any effect had been produced by that cause, it would have followed the accident immediately, and I thought the present symptoms might be ascribed to the inflammation of the brain which might be expected after such an injury. The external wound was opened and probed, and gave issue to some bloody matter. Four leeches were applied in the neighbourhood, and were followed by bread-and-water poultices. Four grains of the hydrargyrum cum cretâ were given every four hours. A blister was applied to the nape of the neck, and the vesicated surface dressed with strong mercurial ointment. The mischief was speedily and effectually arrested by these means. The convulsions which had come on in paroxysms did not return after the bleeding. The left arm and leg remained totally powerless for forty-eight hours, and he recovered slowly but completely."

Mr. Guthrie says, in summing up his observations on the subject of compound fracture of the skull with depression: "The result of my experience has rendered it imperative in my mind to remove at once all portions of bone or foreign substances which may have, or may be supposed to have, penetrated the dura mater in adults, although no symptoms of compression should be observed; and generally in children, whenever it can be done without difficulty, and especially when symptoms of compression are present. If the wound in the dura mater should not be sufficiently large to allow the offending body to be extracted through it, the opening must be increased to enable it to be withdrawn without further laceration; and all substances which are irritating, or are likely to irritate, the brain, should be removed in the first instance, unless the attempt should be forbidden by the occurrence of convulsions, by the inability of the surgeon to seize the extraneous body, or by the evidence of great suffering which it occasions." And Baron Larrey thus expresses his opinion upon the same subject: "On ne doit non plus appliquer le trépan à l'occasion des plaies de tête avec fracture des os du crâne, quellesque soient l'étendue de la fracture et la multiplicité des rayons qui en partent, si des pièces osseuses ne sont pas enfoncées et s'il n'y a ni corps étranger ni symptômes de compression bien évidens."

In compound fracture, where the inner table is alone depressed, if the case can be accurately made out, the trephine should be employed, although there be no symptoms of pressure, and the reason for its adoption arises from the irritation of the brain and its membranes which must almost inevitably result from such an injury. On this subject we prefer quoting the observations of Mr. Guthrie, who has entered fully into the subject. He says: "The establishment of principles which ought to regulate the practice of surgery in cases of fracture and depression of the inner table of the skull is of the greatest importance, and it is on this account that I have quoted so many authorities on the subject. The principle being laid down that it is right and proper to examine all such wounds with a blunt flat probe, in order to ascertain, if possible, whether the inner table is depressed and broken, the question necessarily arises, what is to be done when such depression and breaking down of the inner table is ascertained to have taken place? There can be no hesitation in answering that in all such cases the trephine should be applied, although no symptoms should exist, with a view of anticipating them. The old doctrine, it may be said, in regard to fractures generally, is revived in these cases, but on a principle with which our predecessors were not acquainted. A patient very often survives a mere depression of the skull: he may, and occasionally does survive a greater depression of the inner than of the outer table, but I do not believe that he ever does survive and remain in tolerable health after a depression with fracture of the inner table, when portions of it have been driven into the dura mater. If cases could be advanced of complete recovery after such injuries, I should not consider them as superseding the practice recommended, unless they were so numerous as to establish the fact that wounds of the dura mater and brain by pieces of bone are not extremely dangerous. If one trephine will suffice, the central point being applied close to the edge of the middle of the wound in the bone, it should be applied there; but if the cut be longer, and the spicula of bone extend upwards and downwards in its length, a small trephine should be applied as near each end as may be judged advisable, and one edge of the cut bone removed by the straight saw. By these means sufficient room will be obtained to remove the broken portions of bone which are irritating the dura mater and brain. I am satisfied that the danger resulting from the application of the trephine in such cases, bears no proportion to the risk incurred by leaving the broken portions of bone as a constant cause of irritation." (*Guthrie*, op. cit. p. 93).]

Concussion of the Brain.

[In the consideration of injuries of the brain, as concussion, compression, contusion, and laceration, it is important to bear in mind the extreme delicacy of the cerebral tissue and the peculiarity of the cerebral circulation, as well as the general sympathy which exists between this organ and the other parts of the body through the medium of the cerebro-spinal system of nerves. In describing the symptoms of concussion and compression it will be found that the outlines of these diseases are so indistinctly marked, and the shades of each are so imperceptibly blended, that it is frequently quite impossible, even with the most careful examination, to come to an accurate conclusion as to the precise nature of the case. This point will be further discussed when we consider the pathology of concussion, a subject of extreme interest. The most simple form of cerebral injury, resulting from the direct or indirect application of violence to the skull, is concussion or commotion, and a patient is said to be stunned who labours under this affection in its mildest form. Concussion is commonly indicated by the following symptoms:—The patient is at once deprived of sense and the power of motion. This sudden loss of sensibility is frequently partial, occasionally complete; it often lasts but for a short time, although it may endure for an indefinite period; generally in simple cases a slight degree of sensibility soon returns, and the patient, if a question is loudly asked, replies briefly and indistinctly and abruptly. So also the power of motion is either totally annihilated or to a great extent enfeebled; yet volition frequently speedily returns, and the patient staggers like a drunken man, or if placed in bed he exerts a certain amount of volition and carefully folds himself in the bedclothes, as if affected by cold and disposed to sleep. The pulse is weak, but regular, and generally increased in frequency; the temperature of the skin sinks below the natural standard, the breathing is regular and quite tranquil, and performed with scarcely any apparent movement of the parietes of the chest. The eyelids are closed and the pupils sometimes dilated, more commonly contracted. Frequently at the onset a general but feebly convulsive movement is felt in all the voluntary muscles. This is indicated by shuddering or a slight degree of shivering as if from the effects of cold;

the thighs are bent upon the body, and the arms are drawn up to the front of the chest, with the forearms bent upon the arms. These signs are characteristic of simple concussion of the brain, but in very mild cases a modification of the symptoms is observed, the ordinary functions of the brain being very slightly affected, a certain amount of sensibility and volition remaining from the commencement; concussion is then indicated by a momentary disturbance of the intellectual faculties, dizziness and tingling of the ears, giddiness, a slight feeling of chilliness, with paleness of the countenance and a pulse diminished both in power and frequency. If the hand is placed over the præcordial region, the heart will be observed to oscillate in its action, as if too much enfeebled to act forcibly upon its contents. The pulse in the milder forms of concussion is easily accelerated when the patient attempts to exert himself, and, in fact, by the slightest effort is occasionally raised from 70 to 130 beats in a minute. In the more severe forms of concussion the derangement of the cerebral functions is more complete, and persists for a much longer period; the loss of sensibility and volition continues, and the patient is incapable of being roused, or, if excited for a moment by any question, returns an indistinct and abrupt answer, and instantly relapses into his former state of insensibility and stupor. The pulse under these circumstances is usually slow but weak, and occasionally intermitting. The breathing is slightly stertorous, and the skin, especially that of the hands and feet, is cold; the pupils of the eyes are somewhat dilated, but evince a slight degree of excitability on the sudden application of light. Vomiting, which is very likely to occur if the stomach is distended at the time of the accident, often attends the simplest form, and is not unfrequently met with in the severer forms, of concussion; but it is often absent altogether, slight nausea being occasionally the only indication of derangement of the stomach. It may be regarded favourably, as a proof that the sensibility of the stomach still remains, and may be looked on as an indication of some importance as showing that the brain still exerts its influence through the par vagum on this viscus. It is, however, occasionally the harbinger of immediate dissolution. Much importance should not be attached to it as an indication of the degree of concussion which the brain has suffered. An increase in intensity of all the symptoms mentioned points to a still further extent of injury; and a total abolition of sense and volition, an evident diminution of power, and an increased frequency of the pulse, a universal coldness of the skin, an insensible and permanently dilated state of the pupils, with decidedly stertorous breathing,—these, and, superadded to these, incontinence of urine and fæces, prove at once that all hope of recovery is past.

To the symptoms just mentioned we may add delirium and convulsions. Delirium of a character resembling delirium tremens is met with occasionally, and might easily mislead a surgeon unacquainted with the fact; but the history of the case as related by those who had witnessed the accident would dispel all doubt upon the subject. This sign frequently attends concussion at the onset, and is not uncommon in those cases where the restoration of the cerebral functions is delayed for a long period; where it occurs immediately it soon passes off. Epileptiform convulsions succeeding each other with great rapidity, and from their violence apparently indicative of great cerebral injury, occur occasionally soon after the accident, and after a few days disappear altogether, leaving no sign whatever of any extraordinary mischief within the skull. And, as convulsions attend many instances of extensive laceration of the brain, in estimating the value of this sign considerable difficulty and perplexity arise. We know of no certain means by which the convulsions of concussion are to be distinguished from those of laceration of the brain, except that the latter are commonly accompanied by deeply stertorous breathing and paralysis, which are generally, but not always, absent in simple concussion; and in concussion they soon pass off. Although the intellectual functions are in severe concussion seriously affected, yet the will exerts its influence, and the patient is directed to perform those ordinary operations which are requisite to personal comfort and convenience. Thus, Sir Astley Cooper relates the case of a man who, while labouring under concussion, was found by his attendants with his feet in a chamber-pot, and by the motion of his hands evidently trying to throw water over his legs; and upon the servant going into the room some time after, he was found attempting to shave himself, having substituted some spermaceti ointment for soap. And he mentions the case of a gentleman who, whilst labouring under concussion, in the absence of his attendants got out of bed, bolted the door, made water, and returned to bed again, in the same manner as though he had been in perfect health. The symptoms here enumerated may be all present in the very first stage of concussion, but the existence of even a few of them is sufficient to characterise the affection; and hence the necessity of making some distinction as to the degree of concussion; but if the effects of concussion do not speedily pass away, some modification takes place in the signs, which renders it doubtful whether we ought strictly to range them under this head. And this leads to the consideration as to the duration of concussion as a distinct affection of the brain. In this there is considerable variety, dependent for the most part upon the degree of injury inflicted. Thus we frequently remark that the patient recovers his senses almost immediately after the accident, and no trace of injury remains; whilst in other cases a week or even a much longer period elapses prior to the entire disappearance of the symptoms, and not unfrequently cases apparently the most severe at the onset recover so quickly and completely that patients are unwilling to submit to that restraint which is essential to the perfect restoration of the cerebral functions. Restoration in simple cases is indicated by a gradual return of warmth to the surface, by an increase in the power of the pulse, by a general return of sensibility, the pupils acting readily; and the patient emerges as if from a comfortable sleep, and is much astonished to find that anything extraordinary has occurred, this resuscitation being frequently preceded by repeated yawnings.

It is quite evident from the consideration of the symptoms mentioned, that there are various degrees of concussion of the brain; but it is very questionable whether many of the signs enumerated may not be attributed to contusion or even laceration of the cerebral vessels, and to effusion of blood upon the brain, rather than to a mere shake of the organ, as the term concussion implies. Dupuytren recognises three degrees of concussion. The first degree is characterised by dizziness, tinnitus aurium, closure of the eyelids, weakness of the lower limbs and general lassitude, a remarkable incapacity for exertion, and a staggering gait.

In the second degree there is a sudden loss of consciousness and memory of recent events, prostration of body, trembling of the muscles, frequently spasms, involuntary discharge of fæces and urine, loss of volition, of sight, hearing, smell, and taste: the respiration and circulation nevertheless continue. At the instant of concussion the heart palpitates; the respiration, at first altered and irregular, soon resumes its natural regularity with such slight noise and movement of the chest that the patient appears not to breathe. The eyelids are closed, the levator palpebræ having lost its power of action. The pupil is dilated and insensible to light; the general sensibility is blunted, but not extinguished. Occasionally there is vomiting. In the first degree the disease lasts only two or three seconds; in the latter condition its effects are felt for two or three days or more.

The patient remains in any position in which he is placed, and appears plunged in a deep easy sleep, without any movement of the pectoral regions: the face is pale, the eyelids paralysed; the pupil is insensible on friction of the eyeball; it is sometimes intolerant of light, but does not contract. The patient swallows only when food is passed into the pharynx, otherwise the food remains in the mouth. The movements of the heart are almost imperceptible; the pulse is slow, remarkably compressible, but regular; digestion is arrested; there is often incontinence of urine and fæces. It requires frequent hard pinches of the skin to excite the retraction of the limbs. These effects, at first apparent enough, diminish by degrees; the movements of the limbs on pinching give evidence of returning sensibility, the eyes become fatigued by the action of the light, and the patient's hand is held up between the eyelids and the light; the patient changes his position, his speech returns, he asks for food, and afterwards relapses into his former lethargy for twenty-four hours or more; the intellectual faculties are restored, but he is still incapable of continuing his attention so as to support a conversation, but he gives a phrase which he is unable to complete; in fact, his movements excited by a powerful voluntary effort fail, and his words *stick halfway.* After four or five days volition is re-established, but there still remains a remarkable weakness, an incapacity for prolonged conversation and reading and for all former mental actions; he begins a letter which he is unable to finish; his digestion is somewhat embarrassed; weakness in the act of progression and debility of the generative system continue for some time: we have known it to remain three or four months and give rise to considerable annoyance. There is frequently a loss of memory of proper names and things, but after some time this faculty is restored.

In the third degree of concussion, nearly all the patients die immediately. They are at once deprived of all sense, of every intellectual function, and of all power of volition. There are frequently convulsive movements, involuntary discharge of fæces and urine; the pulse sinks in power and frequency, and for a short time is resuscitated; the respiration is weakened and gradually ceases; and in the course of a few seconds life is extinguished altogether.' (*Dupuytren, Leçons Orales de Clinique Chirurgicale*, p. 242.)

An analysis of the symptoms of concussion proves that, in its most simple form, those parts of the cerebral system in which the power of volition and sensation reside, are especially affected; that in the more severe forms of the disease not only are volition and sensation more profoundly influenced, but all those functions which are regulated by the true spinal system of nerves are also impaired; whilst in the extreme degrees death takes place almost momentarily, from the complete annihilation of all nervous power as a consequence of extensive lesion of the brain itself, or some other part in close sympathy with this organ.

Mr. Abernethy has with great truthfulness arranged the phenomena of concussion under three heads, which he considers characteristic of three stages of the disease.

He says: "The whole train of symptoms following a concussion of the brain may, I think, be properly divided into three stages. The first is that of insensibility and derangement of the bodily powers, which immediately succeed the accident. While it lasts, the patient scarcely feels any injury that may be inflicted on him. His breathing is difficult, but generally without stertor; his pulse intermitting, and his extremities cold. But such a state cannot last long; it goes off gradually, and is succeeded by another, which I consider as the second stage of concussion. In this, the pulse and respiration become better, and, though not regularly performed, are sufficient to maintain life and to diffuse warmth over the extreme parts of the body. The feeling of the patient is now so far restored that he is sensible, if his skin be pinched; but he lies stupid and inattentive to slight external impressions. As the effects of concussion diminish, he becomes capable of replying to questions put to him in a loud tone of voice, especially when they refer to his chief suffering at the time, as pain in the head, &c.: otherwise he answers incoherently and as if his attention could not be excited or was occupied by something else; he is, in short, like a man in a heavy sleep. The concussion of the brain, lastly, produces inflammation of the organ, and this constitutes the third stage, which is the most important of the series of effects proceeding from this cause.

"These several stages vary considerably in their degrees and duration; but more or less of each will be found to take place in every instance where the brain has been violently shaken. Whether they bear any certain proportion to each other or not, I do not know: indeed this will depend upon such a variety of circumstances in the constitution, the injury, and the after-treatment, that it must be difficult to determine."

That many cases of severe concussion pass through the three successive stages just described, there can be no doubt; but in by far the greater number of simple cases the first only is apparent, as the change from this to a perfect recovery takes place at once, and the only sign of any previous injury is indicated by a slight pain in the head, which, however, speedily passes off. It is the gradual transition of symptoms which renders the subject obscure. The practical bearing of the question is of the highest importance, as it leads us at once to the adoption of a mode of treatment generally successful provided no extensive lesion of the brain has occurred. After recovery from some of the most violent forms of concussion the memory is affected in a marked degree, and the patient is not only insensible to every occurrence subsequent to the injury, but he frequently loses all recollection of what had taken place just prior to the accident; whilst in other instances his recollection remains affected either permanently or, at any rate, for a very long period. We shall quote two instances, showing the effect on the memory, from the essay on injuries of the head by Sir Benjamin Brodie, in the 14th volume of the *Medico-Chirurgical Transactions.* "A groom in the employment of the Persian ambassador, in the summer of 1819, was engaged in cleaning one of the ambassador's horses, when he received a kick from the animal on the head. He did not fall, nor was he actually insensible or stunned; but he entirely forgot in what employment he had been engaged at the time of receiving the blow. Being unable to account for the time that had elapsed, he concluded that he had been asleep; said so to his fellow-servants, observing at the same time that he must set to work to clean the horse, which he ought to have done before instead of going to sleep."

"A boy, going down into the hold of a ship, fell from a considerable height and struck his head. He lay insensible, as it appeared from the observation of his shipmates, about half an hour, when he came upon deck without any assistance. Nevertheless on the following day all the circumstances of the accident had passed from his memory. Some time afterwards, when he was received into St. George's Hospital, I found that he knew nothing of the accident except from the report of others. He had not only entirely forgotten the accident itself, but he did not even remember his having gone down into the hold of the vessel before the accident, nor his having come upon deck afterwards; and he never regained his recollection on these points."

Sir Astley Cooper also mentions an instance of a man labouring under concussion whose memory was curiously affected. "A man was taken to Guy's Hospital in a state of insensibility, in which condition he remained for some time, but at length recovered; and when he did so, no person in the hospital could understand his language. A milkwoman happening to go into the ward one day, heard him, and discovered that he was speaking Welsh. He told her that he knew English well before the accident, but after it all knowledge of that language was obliterated from his mind. It had been recently acquired. The impression was less strong, and consequently the more easily effaced."

Dr. Abercromby also records many instances showing the effects of concussion on the memory. (*Abercromby, On the Intellectual Functions*, 10th ed. p. 148, &c.) These phenomena, however, if permanent, may be regarded as depending rather on some organic lesion of the cineritious substance of the brain than as the result of mere concussion. The gradual recovery after a longer or shorter period indicates the return to a sound condition; but facts are wanting still to prove the precise effects on particular portions of the encephalon, in cases where the permanent loss of memory has continued after all other symptoms have passed away.

The three stages described by Abernethy are not always present, but they may be taken as elucidating the type of many cases. The impossibility of accurately defining the periods between the first and second tends to confound the judgment; and the occurrence of the second stage points out to us a greater extent or a higher degree of concussion than is met with in ordinary instances. Nor is the third stage, or that of inflammation, invariably present; recovery often takes place without it, a simple restoration of all the functions of the brain being the only indication of what has been termed reaction, in which, however, a great tendency to inflammation exists. Although the symptoms of concussion are traceable generally to the immediate effect of the accident upon the brain, nevertheless these are occasionally at first so slight as to be scarcely recognised even by the patient himself, or they are absent altogether. And yet, after a longer or shorter interval, they gradually supervene, and, after increasing in intensity, disappear again. Thus a man receives a blow on the head, but he feels little or nothing of it. In the course of half an hour his head begins to ache, his eyes grow dizzy, his ears tingle, and he becomes insensible. After a short time, by suitable treatment, these symptoms all disappear, and no further inconvenience results. Mr. Alcock, in an able essay on injuries of the head, mentions the case of a soldier who, in the campaign during the civil war in Spain, was struck on the os frontis with a musket-ball. He walked to the hospital from the field of battle, and conversed intelligibly for some time. Soon after he became quite comatose, his pulse became slow and weak, his skin pale and benumbed. These symptoms were all relieved by purging, bleeding, &c., and he ultimately completely recovered. A short interval had elapsed before the symptoms of concussion could be said to have made their appearance, and it is very difficult to explain their immediate cause. It is most probable that the veins had become gradually congested, or the brain had suffered contusion, and slight hæmorrhage had occurred into the cerebral tissue from the rupture of the capillaries in the cineritious substance. (See *Lond. Med. Gaz.* vol. xxiv. 1839, p. 446.)

What is the pathological condition of the brain in concussion? This is a question very difficult to answer, for patients rarely die of simple concussion; indeed, it is exceedingly doubtful whether death ever occurs, after a severe injury to the brain, without laceration of the organ or an extensive effusion of blood upon its surface, or both combined. From our own experience we believe that death never happens in concussion without some appreciable lesion of this organ. Of the precise nature of the disease in question, it appears that the first symptoms are referable to a sudden discharge of nervous power, not unlike the discharge of accumulated electric fluid in a battery. And this takes place in consequence of some violent shock to the brain, by which the soft particles of neurine, of which it is composed, are affected in a manner we cannot comprehend. The effects of concussion on the brain itself may be, to a certain extent, exemplified by what happens when a sudden blow is inflicted on any of our sense-organs, as, for instance, the eye and the ear. Take the former for illustration. The eye receives a severe blow, and a sudden flash of light occurs. This is succeeded by temporary blindness, after which, if the retina is not injured in its organisation, its healthy function is gradually restored. Such is the case when the brain suffers from concussion. That there are slight physical changes in the delicate nerve-cells of which the brain is formed, may be reasonably inferred, although this is incapable of proof, because patients never die of concussion without unmistakable marks of organic lesion. Gamma's experiments on a solution of isinglass, permeated by minute threads, and contained in a glass vase, in my opinion throw no light on this subject, and cannot be admitted as explanatory of what happens to the brain when it is shaken in concussion. The cranium, especially in young subjects, is a structure which, from the peculiar arrangement of its bones and its natural elasticity, yields to a considerable extent in accidents. This anatomical condition is requisite for the defence of the soft material of which the brain is formed, especially in children, and without which the slightest blow would be followed by a jarring effect, and probably a laceration of the cerebral neurine. In more advanced age the skull becomes firmer and denser in proportion as the brain itself hardens. The walls of the skull having lost their former elasticity yield less under severe blows, and the brain consequently suffers more from the vibration thus readily propagated through the comparatively inelastic walls of the cranium.

Some important physical change must necessarily happen in concussion, the effect of which is certainly to alter the state of the cerebral circulation: this however may be regarded as an indirect rather than as an immediate consequence. It must be borne in mind that the brain does not completely fill the skull, and it is therefore readily driven from one side of the cranium to the other; and hence it happens that in fatal concussion we so frequently observe contusion and laceration at a part diametrically opposite the seat of the original blow. Littre, Delpech, and Sabatier believed that the brain was capable of a sudden expansion, and that it contracted and became diminished in size immediately afterwards; and they thought they had observed that in some fatal cases of concussion the brain had shrunk within its natural dimensions. We never saw a satisfactory instance of this, nor can we attach any importance whatever to this fanciful notion.

The observations of Mr. Hewett are well worthy of attention, as they tend to elucidate many points in connection with concussion of the brain, which were before involved in great obscurity. In reference to the fatal cases of Littre and Sabatier already referred to, and to which so much importance has been attached, he remarks that in all probability, had the post-mortem examination been more fully carried out, some serious organic lesion to the medulla spinalis would have been discovered sufficient to account for death, and thus the necessity for resorting to the absurd hypothesis of contraction of the brain as a result of fatal concussion would have been avoided. He further suggests that in cases of sudden death in which the brain is supposed to be the special seat of injury the cause of death may be found elsewhere: thus he mentions the case of a man who in attempting to lift a weight on his head died suddenly of a rupture of the heart, and remarks that the fatal termination of this case, from the imperfect mode of examination formerly in use, would have been attributed to concussion of the brain rather than to its proper cause. An interesting case is given by Mr. Hewett of a boy who fell from a great height and was brought into St. George's Hospital with urgent symptoms of concussion, of which he died in a few hours. On examination after death there were found a small quantity of extravasated blood beneath the arachnoid of both hemispheres, and a slight bruising of the substance of the brain; but on examining the chest, the septum of the heart was found extensively lacerated.

No doubt many such cases are to be met with, and a more careful inspection after death will often show other serious complications, as ruptured liver, spleen, kidneys, or laceration of the stomach and intestines, in cases of injury to the brain. But it is not likely that such conditions will be overlooked now as they formerly were. Obscure complications occur which may elude observation, as those in which the medulla spinalis is affected, as this is a part which is frequently left unexamined after death. Mr. Hewett gives a very good illustration of this in the details of a case from the records of the Hospital of St. Antoine.

A man fell from a great height on the pavement and died in a few hours. There was no trace of injury to the brain, and the case was at first set down as one of death from simple concussion of the brain. But on further examination it was found that the spinal canal was completely filled with extravasated blood, and that the extravasation had extended upwards almost into the cranium.

It not unfrequently happens that an extensive fracture of the skull is regarded as a cause of death where little injury to the brain can be detected. The remark applies more particularly to fractures of the base, and no doubt there is much difficulty in coming to a correct conclusion on the subject; but we are of opinion that the fatality of such cases could be frequently explained, if a careful examination of the medulla oblongata and the roots of the respiratory and other nerves were made, for in many of these cases, where there is little injury at first apparent, slight laceration and contusion of these parts so essential to the maintenance of the vital functions may be detected. And we think, in severe concussion of the brain from falls from great height, the nerves of the heart itself may from the general concussion become instantaneously paralysed, and thus the cause of death may be fairly attributed to this rather than to the cerebral injury. One thing has always appeared to us as very remarkable in injuries to the brain, namely, the length of time patients live with most severe concussion accompanied by contusion and laceration of this organ. It is difficult to explain this, as in other cases a comparatively slight laceration induces immediate death: a pistol bullet driven into the brain will destroy life instantaneously, whilst a large portion of the skull-cap may be broken away and the brain extensively lacerated, and yet life may be prolonged for hours. It is most likely that in the former instance death occurs from the damage done to numerous important nervous centres in the transit of the ball. We think it may be fairly assumed as the result of the observations of numerous pathologists that no fatal cases of concussion occur without leaving distinct marks of injury in the brain sufficient to account for death, to use a common phrase; but it is impossible to say what may have happened in those cases in which recovery has taken place, and it is probable, as Sir B. Brodie suggests, that in these cases "there may be changes and alterations of structure which our senses are incapable of detecting." (*Med. Chir. Trans.* vol. xiv. p. 337.)

The visible effects of concussion of the brain as revealed to us by examination after death may be classed under the heads of contusion and laceration. The capillaries of the brain, although possessing an independent diaphanous cell wall with cell nuclei disposed at intervals, are exceedingly delicate and easily ruptured, and hence it happens that, in persons dying from other causes after concussion, minute spots of extravasated blood have been frequently found disseminated throughout the brain tissue. This observation was made at nearly the same time by Dr. Bright, MM. Chassaignac, Sanson, and Nélaton, and no doubt is familiar to most surgeons. These minute extravasations have been found in parts of the brain near to and remote from the seat of the blow, and they have been met with in the cineritious and medullary tissues of the organ. That they are connected with the phenomena of concussion and are the pathological results of this condition, there can be little doubt, and it is obvious that they are identical with what is commonly termed contusion of the brain. In the main we accede to the opinion expressed by MM. Nélaton and Blandin, the former of whom remarks: "Now, if we bear in mind that the alteration we have just been describing is also constantly found in contusion of the brain, may we not be justified in looking upon concussion as a slight degree of contusion? We do not mean to say that these minute specks of extravasation must necessarily exist in every case of concussion. A contusion might rupture some of the nervous fibres without tearing any vessels; and then it must be borne in mind that we only have the opportunity of examining the morbid appearances peculiar to concussion in the most severe cases. The slighter ones recover." (*Hewett*, loc. cit.) We do not participate in this belief that any laceration of nerve fibre can take place without a corresponding rupture of the capillaries surrounding it.

The observation that visible signs of mischief are invariably found after death in fatal cases of concussion is confirmed by the experiments which have been made on animals by M. Fano, as quoted by Hewett (loc. cit.); and it is curious to observe, as this surgeon remarks, how frequently a blow on the top of the head led to extravasation of blood in the region of the medulla oblongata and the neighbouring parts, and it is still more remarkable that in most of these experiments there was no extravasation of blood at the seat of the blow. We add to these remarks a brief description of two cases of concussion mentioned by Mr. Hewett: they are interesting as showing the changes the brain had suffered. In these the genuine symptoms of concussion had passed off, death having occurred in one case from effusion of blood on the brain, in the other apparently from entirely adventitious circumstances. "A man fell out of a cart and struck his head. He felt giddy, but soon rallied and then vomited. He took a little stimulant, was soon quite himself, and proceeded for four hours about his business. He was suddenly seized with urgent symptoms of compression, and died within a few hours. An enormous extravasation was found between the bone and the dura mater. There was no blood within the arachnoid, but several patches of extravasated blood were found at the base of the brain in the sub-arachnoid tissues, and corresponding to these were patches of circumscribed contusion in the brain substance itself, marked by minute specks of blood closely clustered together: these patches were in two or three places of the size of a shilling, and extended in the structure of the brain about a line in depth."

"A woman had received a slight concussion of the brain, the symptoms of which were complicated with those of intoxication. There was also a small scalp-wound, not exposing the bone, at the back of the head, and the outer malleolus was broken. The brain symptoms soon passed off. Erysipelas and diffuse cellular inflammation of the scalp supervened, but the patient was recovering from these when suppuration made its appearance in the ankle-joint: the foot mortified, and she died within eight days after the accident. In the cavity of the arachnoid were thin layers of extravasated blood, adhering to the parietal layer, corresponding to both hemispheres, and still retaining their colouring matter. No laceration could be detected in any part of the serous membrane, neither was there any extravasation of blood in the sub-arachnoid tissues. The brain on its surface and in its substance was excessively congested. In the centrum ovale, close to the right side of the corpus callosum and extending into it, was an extravasation of blood the size of a nut. The clot still retained the greater part of its colouring matter, but the structure around it was neither discoloured nor softened." (Loc. cit.)

The permanent effects of concussion are seen for the most part in the condition of the mind, which frequently remains enfeebled throughout the remainder of life, and especially in the impaired state of the memory, as before remarked. A degree of irritability, to which the patient was before a stranger, remains in some instances a lasting effect of the mischief to the brain. An amaurotic state of either or both eyes, and tinnitus aurium and deafness, and loss of the sense of smell, are amongst the most common of the permanent consequences of severe concussion; but it is most probable that these persistent signs of mischief depend on actual laceration of some part of the encephalon, and the latter may unquestionably be the result of fracture of the base of the skull implicating the nerves independently of the brain.

Prognosis.—The prognosis in simple concussion is favourable, death scarcely ever occurring without laceration or bruising of the substance of the brain or the effusion of blood upon its surface. The extent of injury does not generally bear a direct ratio to the violence of the blow or the height of the fall. Young subjects generally recover much more perfectly than old persons. These circumstances admit of ready explanation. If severe concussion accompany a fracture of the base of the skull, it is commonly fatal, although the amount of actual mischief to the brain, as shown by slight extravasation or contusion, is trifling. In forming an opinion as to the probable result, it is especially important to look to the state of the respiratory system and the condition of the sphincters; and if decidedly stertorous breathing, and not the mere mucous rattle which frequently appears even in the milder cases, exist, with a relaxation of the sphincters of the bladder and rectum, and if the pupil continue insensible to light, and especially if hemiplegia accompany these symptoms, an unfavourable termination may generally be anticipated. The supervention of hemiplegia and convulsions during prolonged concussion is regarded by all surgeons as a sign of the gravest import, as in all probability they are dependent on some sudden effusion upon the substance of the brain. But even with such a complication recovery sometimes takes place, of which the following is a remarkable instance:—A youth, eighteen years of age, a sailor, fell down a ship's hold the height of fourteen feet, his head coming in collision with some hard body. He was taken up insensible and brought into the London Hospital. He could not be roused when loudly spoken to, and was evidently unconscious of what was passing around him. On the following day he was so violent and restless as to require to be confined with the strait waistcoat. He was bled and purged and took mercury. On the next day he had several convulsive fits resembling epilepsy, the convulsions being universal; the pupils were dilated. He continued the subject of occasional convulsions until the thirteenth day, when they suddenly increased in frequency, succeeding each other with great rapidity; his left side became now decidedly paralytic, and he lay in a state of partial insensibility. The paralysis was particularly remarkable in the muscles of the face and arm. He continued still the employment of mercury, but in smaller doses, as his mouth was affected. Leeches and blisters were also employed, and on the sixteenth day the convulsions had left him and the paralysis began to decrease. He continued to improve, and eventually perfectly recovered.

If the patient survives the third or fourth day, unless the symptoms increase in intensity, a favourable issue may be expected, as it is probable that no serious organic lesion has occurred. A rapid sinking of the pulse, with a decided diminution in temperature, cannot but be regarded as most unfavourable symptoms. In ordinary cases a perfect restoration may with tolerable certainty be expected; nor can we adopt the opinion of Pott, who says that he never knew patients recover from the consequences of concussion without an imperfection in some sense or part of the body remaining.

Treatment.—After severe concussion the organic functions are more or less impaired for a length of time. This is shown by the feeble state of the circulation, general debility, and a tendency to constipation and diminution of sexual power. We attribute this in a very great measure to the effect upon the nerves distributed to the arterial system, which belonging to the sympathetic nerves are nevertheless obviously dependent in man and the higher animals on the integrity of the cerebro-spinal axis.

If the pathology of concussion, as deducible from the preceding observations, be correct, it follows that, in simple concussion, where no organic lesion of the cerebral fibres exists, and where the whole train of symptoms are referable to a sudden loss of nervous power, all that is necessary is to await the restoration of the cerebral functions. We know that this restoration will take place spontaneously and by the unaided efforts of nature. The surgeon has therefore little to do but to place the patient in circumstances favourable to this desirable end. The weak and faltering state of the pulse and the cold skin indicate a very depressed state of the circulation, a condition obviously depending on the feeble action of the heart resulting from the sudden deprivation of nervous power, and frequently require the exhibition of gentle stimulants, to be administered with the greatest caution; but on this point I quote the judicious remarks of Mr. Abernethy. He says:—

"With regard to the treatment of concussion, it would appear that in the first stage very little can be done. From a loose and, I think, fallacious analogy between the insensibility in fainting and that which occurs in concussion, the more powerful stimulants, such as wine, brandy, and volatile alkali, are commonly had recourse to as soon as the patient can be made to swallow. The same reasoning which led to the employment of these remedies in the first stage, in order to recall sensibility, has given a kind of sanction to their employment in the second.

"But here the practice becomes more evidently pernicious. The circumstance of the brain having so far recovered its powers as to carry on the animal functions in a degree sufficient to maintain life, is surely a strong argument that it will continue to do so without the aid of such means, which tend to exhaust parts already weakened by the violent action they induce. It seems probable that these stimulating liquors will aggravate that inflammation which must come on sooner or later. The access of it in the cases which I have related is sufficiently evident; and its cure is to be effected by the common methods."

In ordinary cases, therefore, for the first few hours let the patient be kept perfectly at rest in bed, with the head slightly raised. The slight warmth spontaneously generated, being retained by the blankets, is sufficient to act as a gentle stimulus to the capillaries, and through them to the heart, and the functions of the brain will be gradually restored. The pulse in the course of a few hours will be found to rise both in force and frequency, and the first indication of recovery will be the expression of wonder of the patient at what is taking place around him. Even the application of cold at the onset ought to be avoided, as it can do no good, and may tend to prolong the insensibility. If, however, after the pulse has risen and warmth has returned to the general surface, the insensibility is prolonged, the greatest circumspection should be used, as some doubts may arise as to whether the symptoms are not indicative of compression rather than of concussion of the brain. Very careful but very simple treatment is requisite. The hair is to be thinned, ice should be used to the head, and purges of calomel and croton oil combined should be administered; the pulse must be cautiously watched, and if a state of restless feverishness arises, as indicated by the increase in the power and frequency of the pulse and heat of skin, and especially if the patient frequently applies his hand to any particular part of the head, as if in pain, a few leeches are to be applied, or bleeding from the arm may be had recourse to in a full plethoric habit of body. Venesection in concussion is rarely employed to any extent in the present day; but, although in a great measure the practice is obsolete, it is not altogether to be disregarded, as a very important agent in the treatment to prevent inflammation of the brain or its membranes after concussion. A cautious exhibition of mercury in the form of calomel is advisable, even to the production of slight ptyalism, when insensibility is prolonged. It will be found most useful in relieving that congested state of the vessels of the brain so common after concussion. Even mercurial inunction may be used in extreme cases. During its exhibition the pulse must be watched with the greatest care, and if it flags strong broths, beef-tea, and even wine may be administered with advantage whilst the mercury is used.

We cannot speak too strongly against the use of emetics in concussion. The practice is to be condemned, as likely to lead to rupture of the cerebral vessels during the act of vomiting.

In persons of a nervous temperament, and especially if a depletory plan of treatment has been pursued to any extent, an irritable state of system becomes developed, which persists for a lengthened period after the signs of concussion have passed away. This state, more frequent in delicate females, is to be relieved by gentle purges and slight stimuli, with small doses of ammonia and camphor; and opium even may be most advantageously employed. The condition may be generally recognised by a pallid countenance, a blanched sclerotic with a wild expression of the eye, a weak irritable pulse, throbbing of the temporal arteries, a moist skin and furred tongue, restlessness, a disposition to faintness, and occasionally partial or complete amaurosis. I have seen this condition occasionally in persons habituated to the use of ardent spirits, in whom no depletion had been used in the treatment of concussion. Such are the cases, in fact, which would probably end in delirium tremens. A full dose of opium often allays the symptoms at once, and the patient from that moment makes a satisfactory recovery. The cautious use of opium in injuries of the head was recommended by Bromfield, and since his time has been advocated by Guthrie and most writers on this subject. As there is necessarily a tendency to inflammation of the brain and its membranes after severe concussion, the after-treatment is of the utmost consequence. In most cases all stimuli are to be avoided so long as any pain in the head remains and there is the slightest tendency to relapse into a state of insensibility. Country air and moderate exercise, tranquillity of mind, with a mildly nutritious diet, and careful attention to the bowels, will do more to complete the restoration of the patient than the use of medicine.

The paralysing influence of concussion is felt, as we have already shown, according to its degree, on the different nervous centres. Thus in man its first effect, in its simplest form, is upon the cerebrum, properly so called; and it is only in its highest degree that the other subordinate parts of the nervous system become affected, as is shown in the dilated condition of the pupil, in the stertorous breathing, and in loss of control over the sphincter ani. From these circumstances we draw the legitimate inference that the lesion in function of the organic system of nerves implies an extent of injury far higher than is indicated by the mere cessation of sense and the power of motion. These may be called subordinate parts of the nervous system. Let us not, however, be misunderstood upon this subject, for it is, of course, not disputed that they are the most essential, if we regard man as a mere animal. The term is only used as expressive of the idea of their inferiority as compared with the intellect of man.

The different forms of insanity, from simple dementia to violent mania, may be mentioned in the category of the occasional consequences of concussion. The condition may be temporary, or it may continue through life. Of the latter Guthrie (loc. cit.) mentions two instances: they were both followed by a fatal result. This obviously depends upon the extent of injury the brain has sustained, for it is evident that if severe organic lesion has happened, or effusion of blood has taken place into the arachnoid cavity to any great extent, permanent recovery cannot occur. Hewett (loc. cit.) gives a good illustration of this in the case of "a man, æt. fifty-three, who was admitted, under Mr. Cutler, into St. George's Hospital, twelve hours after having fallen down a flight of stairs when drunk. His case was thought to be one of severe concussion of the brain. He remained in a state of insensibility for two days, passing his water and his motions under him. But by the third day he was able to answer questions put to him, and henceforward he gradually improved until he became quite collected. His face was at one time drawn to the left side, and there was also ptosis of the right eyelid; but within a month these symptoms had passed away and he was allowed to get up and go about the ward. At times he was, however, flighty in his manner, with partial loss of memory. An attack of erysipelas carried him off just two months after the accident. The brain-substance was perfectly healthy, but within the cavity of the arachnoid there were the remains of an extensive extravasation of blood, which, membrane-like, was adherent to the parietal layer of the serous membrane corresponding to the upper surface of both hemispheres."

It is remarkable, but a few cases are on record of the fact, that a rather severe concussion of the brain has been followed by some benefit to the patient. Thus a restoration to reason, after *dementia*, occurred in a case mentioned by Desault. Mr. Liston (*Elements of Surgery*) mentions the case of an old nurse "who had sustained a fracture of the vertex, with slight depression of the broken part. Stupor, with other symptoms of concussion, was the immediate effect of the injury, but disappeared in a few days. Her hearing, which previous to the injury had long been so obtuse as to render it necessary for her to discontinue her employment, became so intensely acute that the most trifling noise became a source of pain. She gave immediate orders for the clock to be stopped, the ticking of which annoyed her greatly. In this case," says Liston, "there can be little doubt that restoration of a sense which had long remained dormant arose entirely from cerebral commotion, as no discharge of blood or other fluid occurred from the ears by which cerumen accumulated in these organs might have been displaced."

Mr. Hyslop (*MSS. on Injuries of the Head*, Library of the College of Surgeons) relates the case of a boy who had been deaf from infancy, and who completely and permanently obtained his hearing after a severe concussion of the brain. We forbear to speculate on the probable change which may have happened to the brain under such extraordinary circumstances as these just related; but they are by no means devoid of interest to the practical surgeon, as well as to the psychologist.]

Compression of the Brain.

[In severe cases of concussion of the brain slight effusions of blood take place frequently on the surface of this organ, or into its texture; and I have no doubt that when the symptoms of concussion continue for any length of time the veins of the brain are in a high state of congestion from the remora of the blood arising from a paralysed state of the capillaries, or that a slight effusion of blood has happened. But it cannot be said that cases of this description are cases of compression, as the characteristic signs of pressure are either absent or are so obscure as not to be recognised.

Compression of the brain may arise from the following causes:—First, depressed bone; secondly, effusion of blood; thirdly, suppuration on the dura mater; and fourthly, from the introduction of foreign bodies, as bullets, &c., which, lodging under the bones of the skull, occasionally give rise to pressure on the brain. These are all the result of accidental violence; but the brain may be compressed by abscess in its interior as well as by the growth of various tumors.

Depression of bone may happen in any part of the skull: the vault of the cranium is the most common seat of such depression; but pieces of the base may by extraordinary violence be forced in upon the brain and thus give rise to pressure. Such cases have been alluded to. We have seen the broken orbital plate of the frontal bone pressing upon the under surface of the anterior lobes. The inner table may press upon the brain, whilst the outer table is intact. A spiculum of bone connected with the inner table may become the cause of secondary pressure by lacerating the vessels of the surface of the cerebral hemispheres or one of the sinuses of the dura mater. It is absurd to suppose that the brain cannot be compressed. Of course the unyielding cranium cannot contain absolutely more than its original contents; but the contents of the skull are various, and as the brain is surrounded by fluid and contains much blood in its interior, the cerebral fibre, surrounded as it is by blood in its capillaries, must under pressure be deprived of its due supply of blood. The immediate and efficient causes of pressure upon the brain may be referred to one of five general heads:—First, to the unequal and unnatural compression of the cerebral fibre, by which the proper relation of its constituent molecules is changed; secondly, to the arrest of a due supply of oxygenated blood from the pressure on the arterial circle at the base; thirdly, to the necessary retardation of the flow of blood through the veins, and the consequent continual contact of dark venous blood with the delicate neurine; fourthly, to the presence of effused blood within the arachnoid cavity; and lastly, to injury of the medulla oblongata, the great centre of the respiratory system of nerves, whereby, the pneumogastric nerves being paralysed, the due oxygenation of the blood is seriously interrupted.

When the cranium is examined after death from pressure on the brain, whether from depressed bone or from effused blood, its contents will be found to have undergone the following changes:—The convolutions of the brain are flattened in the vicinity of the effusion; the cerebral substance is either blanched at this part or very much congested; the remaining portion of the organ is in a state of high congestion, the veins and sinuses being gorged with blood; and the arterial circle at the base is empty. The ventricles contain little or no fluid; indeed, the whole cerebro-spinal fluid appears to have been squeezed out of the cranium into the spinal canal. The effects of pressure on the brain may be observed during life when bone is removed by the trephine, for the up-heaving and subsiding of the brain, which are characteristic of its healthy function, have either entirely ceased, or are so indistinct as scarcely to be recognised. The consequences of pressure, if of moderate extent, and if it implicate only the white fibres of the brain, are perceived upon those parts which are in connection through the medium of the nerves with the part of the brain the seat of pressure, and hence the explanation of those partial paralyses which are of such frequent occurrence as the result of slight pressure; but if the effusion be extensive so as to interfere with the general circulation of the brain, and thus to place it in the condition that none but a dark venous blood comes in contact with its tissue, the effect becomes general, as is exemplified in the disturbance of the intellectual functions, coma, &c. But that the general effect is not always proportioned to the quantity of blood effused is well known. The seat of the effusion has a marked influence in this respect, effusions at the base being generally attended with much more formidable symptoms than those occurring in other parts of the brain; and when the brain itself is lacerated the contact of the effused blood with the delicate tissue of the brain gives rise to a train of most serious symptoms differing in some respects from those of pressure. Pressure from effused blood may arise from a rupture of one of the arteries of the dura mater, from the laceration of one of the sinuses, from an effusion beneath the arachnoid into the cells of the pia mater on the surface, or between the convolutions, or into the substance of the brain itself, or it may depend on effusion into the ventricles of the brain. When hæmorrhage results from rupture of one of the arteries of the dura mater, the blood is almost invariably found between the bone and this membrane; but if the dura mater is much lacerated it may escape into the arachnoid cavity and become diffused over the general surface of the brain. The blood which is poured out from the laceration of a sinus may escape by an external wound or through the ear, or it may pass into the arachnoid cavity; but it rarely gives rise to positive signs of pressure. When pressure arises from matter, the pus will be found either on the surface of the dura mater or in the arachnoid cavity, or in the substance of the brain in the form of abscess.

Effusion of blood as a cause of pressure may take place instantaneously on the receipt of the injury, as in the case of a ruptured sinus, or it may happen at a period more or less remote. The first may be denominated *primitive*, the second *consecutive*. Consecutive hæmorrhage may occur at a considerable interval from the time of the accident. Of this a good illustration is given by Sir Benjamin Brodie:—"A man thirty-five years of age, in the afternoon of the 8th of November, fell from a cart and struck his head against the pavement. He was afterwards taken to St. George's Hospital, talking and reeling like a drunken man. On the following day he complained of headache, but was otherwise well. He continued without any symptoms until about five in the morning of the 12th of November, when some of the patients in the same ward heard him talking incoherently. The man became insensible, his breathing stertorous, and pupils dilated. Blood was taken from the arm, but the symptoms were not relieved, and he died in about half an hour from the commencement of the attack. On examining the contents of the cranium after death, a thin layer of blood was found extravasated in the cells between the tunica arachnoides and pia mater, where those membranes cover the posterior part of the two hemispheres of the cerebrum. In the lower part of the right anterior lobe of the cerebrum the substance of the brain had been ruptured, and underneath this part, between the dura mater and the tunica arachnoides, there was a collection of about two ounces of blood. This last had all the appearance of a recent extravasation, and seemed to give a satisfactory explanation of the sudden alteration in the symptoms which immediately preceded the patient's dissolution."

Symptoms of Compression.—We now proceed to the consideration of the symptoms which indicate compression of the brain, and to point out the means of distinguishing it from concussion. In allusion to concussion it has been stated that its essence appears to consist in the momentary discharge of nervous power from the brain, characterised generally by a sudden deprivation, partial or complete, of sense and the power of motion; but that still the excito-motory functions of the nervous system continue in a state of activity, as is evinced by a continuation of the respiratory movements, &c., and the organic system of nerves continue their office, although perceptibly impaired in energy: this is shown by the continued though feeble action of the heart, &c. Whereas in compression, although to a certain extent some analogy may be found to the physiological effects of concussion, yet an essential difference exists between them. What then are the signs of compression? They may be easily comprehended by reference to an ordinary case. A person receives a blow upon the head by which a portion of the cranium is forced in upon the brain, and the first effect is a sudden deprivation of sense and the power of motion; in fact, he is stunned. An interval of longer or shorter duration elapses, when warmth returns to the surface of the body, and signs of returning sensibility begin to manifest themselves by pain in the head, as expressed by the patient continually raising his hand to the seat of depression. Restlessness and jactitation sometimes are present, or, as is more commonly the case, the patient lies partially comatose and stupid as if inebriated, and although capable of being roused when loudly called to, he returns an unwilling monosyllabic reply when a question is put to him. Paralysis, partial or complete, of some muscle or class of muscles is a very common attendant on compression. The breathing is slow, and in slight cases perfectly free slightly stertorous, the stertor being perceptible at each inspiration. The face is generally flushed. The pulse is slow, perhaps only forty (or even less) in the minute, and labouring. The eyelids are closed, and the irides are remarkably sluggish in their movements, and but feebly contract on the application of strong light transmitted through the pupil; the pupils are usually dilated. The temperature of the body is natural, or is sunk somewhat below the ordinary standard. Such are the symptoms indicating pressure upon the brain, at least in the less severe forms of the disease, and they resemble in some respects those of the second stage of concussion.

But to proceed with the signs of compression of a higher degree. The insensibility becomes absolute, as is exemplified by the loss of common sensation, by the total loss of hearing and sight, by the dilated state of the pupils, by the rolling upwards of the eyes, or by permanent strabismus. The muscular system generally is more deeply affected, and hemiplegia, at first partial, is now complete: in some cases the patient is paraplegic. No reflex action can be excited by tickling the skin of the limbs of the affected side. The sphincter ani relaxes and permits the involuntary discharge of the fæces, and the urine, at first retained, now runs off involuntarily. The temperature of the body subsides. The pulse becomes slower and weaker. The respiration is deeper, much more laborious, and loudly stertorous. The face is bloated, or, as the disease increases, livid and pale. The paralysed side of the face flaps to and fro at each respiratory effort; the patient foams at the mouth; and "the breath is emitted from the corner of the mouth like a whiff or puff of smoke." (*Guthrie.*) Slight muscular twitchings or even partial convulsions frequently occur in compression.

Towards the termination of the case the pulse increases in frequency, and occasionally becomes intermittent and exceedingly irregular; the respiratory movements are accelerated, and the temperature falls. I have purposely omitted to mention vomiting as a sign of pressure: it indicates, when present, a return of sensibility, as is beautifully illustrated by the observations of Sir Benjamin Brodie, who says that he has known the patient to become sick and vomit immediately after the depressed bone was elevated. This point has been curiously illustrated by an experiment of Majendie, who arrested vomiting by pressure on the medulla oblongata of an animal after it had been excited by emetics.

Such a combination of symptoms implies an immense amount of compression from which no recovery can be expected, and in many cases may be regarded as the joint effect of concussion, compression, and laceration of the brain.

Although the symptoms of concussion and compression present some analogy, which renders it difficult to make a distinction between them, yet, by a careful analysis, it will be found that they differ in many important respects.

Very great importance should be attached to the duration of concussion as a simple disease of the brain resulting from injury; for it is in those cases where insensibility continues for many days, that the difficulty and importance in distinguishing the symptoms are so palpable. Is it possible to fix a limit to the duration of concussion? Probably not: at least, we are quite sure from a considerable experience that the effects of simple concussion may continue for many days, and leave no trace of any permanent mischief behind.

It may be useful to add a brief comparison of the symptoms of concussion and compression. In concussion there is a sudden arrest of the functions of the brain, which, after a longer or shorter period, are gradually or suddenly restored; in compression, if from depressed bone, the sensorial functions are either wholly arrested or so far interfered with as to lead to some serious derangement, which continues until the depressed bone is elevated; if the compression arises from effused blood, this condition supervenes gradually, and continues until absorption takes place or the patient is relieved by operation. In concussion the temperature of the surface of the body sinks below its natural level; in compression it is generally natural. In concussion the pulse is quick, weak, irregular, and occasionally intermits; in compression it is slow and labouring, sometimes as low as forty or even thirty-six in a minute. In concussion the pupil of the eye is sometimes contracted, or if dilated, as is frequently the case, it contracts on the application of light; in compression it is dilated and immovably fixed. In concussion the breathing is natural and regular; in compression it is slow, labouring, and stertorous. In concussion the sphincters continue their proper office; in compression they are relaxed. In concussion there is an absence of hemiplegia, which exists in compression. In concussion a temporary paralysis of a single muscle or class of muscles, as the muscles of the face and the abducens oculi, occasionally exists; but persistent paralysis may be regarded as the result of pressure rather than of concussion. Finally, it may be assumed that whatever disorder of the cerebral faculties arises from injury of the head, it has generally a tendency to spontaneous cure in concussion; whilst in compression it persists until the cause of pressure is removed.

There are other symptoms of an equivocal character in compression requiring attention, and some further remarks on the *rationale symptomatum* may be here made: thus a fixed pain in the head may frequently be regarded as indicative of pressure on the brain, especially if accompanied by any other sign. Thus, in a case mentioned by Sir Benjamin Brodie, after an injury to the skull the only symptoms were a fixed pain in the head and a preternatural dilatation of the pupil of one eye: in this case a portion of the parietal bone was found depressed; the depressed bone was raised, and the pain ceased immediately. A case is related by Sir Astley Cooper which shows the importance of this symptom: a man suffered from extravasation of blood in the substance of the brain from an accident; he had recovered considerably, although pain in the head continued; he died three months afterwards, and on examination a coagulum of blood was found in the anterior lobe of the cerebrum. No distinction can be made of the kind or degree of insensibility in concussion and compression; where insensibility comes on gradually after the patient has recovered somewhat from the primary effects of concussion, it may reasonably be imputed to pressure from the pouring out of blood. A simple illustration of this may be given in a case related by Sir Benjamin Brodie: "A woman received a blow upon the head, after which she was able to walk home, complaining that her head was hurt, and that she had received her death-blow. In an hour after the accident she gradually became insensible. About fourteen hours afterwards, she was brought to St. George's Hospital labouring under symptoms precisely corresponding to those described by Mr. Abernethy as arising from concussion. These symptoms continued, and even rather abated than increased, until the third day, when an aggravation took place and she expired. On examination eight ounces of blood were found effused beneath the dura mater." An interesting example of a similar character occurred under our own observation, and doubtless parallel instances will suggest themselves to all surgeons of experience. A young man was knocked down whilst fighting and was stunned; he speedily recovered his senses, and was brought to the London Hospital complaining of pain in his head. As he walked along the ward he began to stagger, and with difficulty reached his bed; his breathing became stertorous, and he was evidently hemiplegic. A swelling was found in the temporal region of one side, and on dividing the skin a fracture was detected. The trephine was instantly applied, and a large coagulum was found on the surface of the dura mater. He recovered completely.

When insensibility depends on depressed bone, it is often extremely difficult to distinguish it from that which occurs in simple concussion. The diagnosis must be formed from its intensity and duration; but under any circumstances we may be deceived, for in severe cases of concussion this symptom may even co-exist with stertor and other signs of compression, and after a time they may all pass off and leave no ill effects behind. The trephine is therefore not to be hastily resorted to: the patient must be carefully watched, and if the symptoms gradually diminish in intensity it is better to wait, as there is great probability of their entire cessation under suitable treatment. If, on the contrary, insensibility continues, and if the breathing becomes more stertorous, and the pulse continues slow and labouring, and especially if paralysis is present, it may be regarded as an important and positive indication of pressure on the brain. Sometimes a sense of numbness in a particular part remains as the sole result of pressure after all other signs have disappeared. Insensibility, as shown in a total loss of the sense of sight or hearing, frequently depends on pressure, yet it is not an infallible sign, and therefore cannot be considered pathognomonic. We must rely generally, in the formation of our diagnosis, rather on a combination of symptoms than on any individual sign.

There is, perhaps, no symptom of pressure on the brain equal in importance to paralysis: it is certainly the most constant, and therefore the most to be depended upon. There is no doubt that even in the worst forms of the disease it may be altogether absent; nevertheless, whenever it continues after the effects of concussion may be said to have passed away, it may be regarded as an almost certain sign of pressure. In the common forms or milder degrees of pressure, the muscular system of animal life, as the voluntary muscles, is alone affected; whilst in the more severe forms of the disease the muscular system of organic life, and the sphincter muscles, which are under the influence of the excito-motory system of nerves, also become paralysed.

When hemiplegia results from pressure on the cerebrum, the voluntary muscles are affected on the side opposite to the seat of pressure. This is an axiom in surgical pathology. There can be no doubt on this subject: the fact is universal, and has been recognised since the days of Hippocrates. Valsalva remarks that in a large number of dissections, when one side of the body was paralysed, the injury constantly lay on the opposite side of the brain; and Morgagni and Lancisi had stated that "one might easily conjecture which side of the brain was injured, by observing on which side the patient was paralytic." (*Van Swieten.*) Sir Benjamin Brodie says that he has never met with any exception to this general rule; whilst, according to Dr J. Thomson (*Obs. in the Military Hosp. of Belgium*), the same rule usually applies, but in some cases he has seen paralysis confined to the upper, and in others to the lower extremity. The anatomical explanation of this phenomenon need not be particularly dwelt upon here; the physiological observations of Müller, founded on the experiments of numerous philosophers, may be consulted with great advantage, and the valuable collection of important conclusions deduced therefrom is of the highest interest.

Hemiplegia is certainly more frequently absent in cases where blood has pressed upon the brain after an accident, than where it has been effused in an apoplectic attack, and where the rupture of the vessel has happened in the cerebral substance. It is difficult to account for this, but it probably depends on the fact that in apoplexy the blood, being usually found in the white substance of the brain, more completely interferes with its conducting power, and the voluntary muscles in communication through the nerves with the part compressed become paralysed.

But there are undoubtedly many cases of severe injury to the cerebellum, where a large effusion of blood has been found, in which the hemiplegia corresponds with the side of the injury. Thus Morgagni has mentioned some cases which he says are invariably fatal, on which he remarks "that in some cases the paralysis was on the injured side, so that a doubt arose whether the cause of the hemiplegia may not generally be found to vary from that which happens in the cerebrum. Larrey also (*Clinique Chirurgicale*) admits the fact that in injuries of the cerebellum paralysis occurs on the same side, but speaks most positively as to the universality of the occurrence of paralysis on the opposite side of the body in effusion upon the cerebral hemispheres. It is difficult to explain these phenomena satisfactorily, for Flourens and Hertwig have shown experimentally that, in injuries of the cerebellum, loss of power always takes place on the opposite side, as is the case in injuries of the cerebrum. However, too much reliance must not be placed on experiments, however carefully conducted, in explanation of symptoms which are the result of accidental injuries.

The state of the pupil, in injuries of the brain, should be closely examined as affording a most important means of diagnosis. The iris is controlled in its action by nerves originating from two distinct sources: the fibres surrounding the pupil are under the influence of the third pair of nerves, whilst its radiating fibres are regulated by the filaments of the sympathetic. In simple concussion the pupil is generally contracted, whilst in compression it is generally dilated. As far as our own observations extend, this is the general rule, but it must be admitted there are many exceptions difficult to explain. Thus, in cases of severe concussion, we have often seen the pupil dilated on both sides; and in fatal compression both pupils have been found contracted to the utmost. Indeed, the difficulty of diagnosis in many cases may be well conceived by what Hennen remarked—namely, that in some cases the pupils were contracted, in others dilated, where the injury was nearly of a similar nature and degree; while sometimes in the same patient one pupil was dilated and the other much contracted. (*Hennen*, p. 300, 301.)

Sir Benjamin Brodie has seen the pupils dilate with the absence, and contract with the presence, of light, although the patient lay in a state of complete insensibility, and did not seem to be at all conscious of the impressions made on the retina. He admits, however, that this is a rare occurrence, and that, when the other symptoms of pressure are present, *the pupils are generally insensible and motionless, and mostly dilated*, though sometimes contracted. Every surgeon of experience must be aware of another circumstance mentioned by the same surgeon; namely, that it is not uncommon for the pupils to remain for a time in a state of dilatation, then to become suddenly contracted, and, after remaining so for a longer or shorter time, to become again dilated; these changes taking place independently of light and darkness. When the pupils have been dilated, Sir Benjamin Brodie has frequently known them to become contracted after the abstraction of blood; the dilatation returning as soon as the immediate effect of the bloodletting had ceased. He adverts to a curious case, reported by Dr. Hennen, in which blood was extravasated between the membranes of the brain, and in which the pupils sometimes dilated in an increased light, and contracted in a diminution of it. (See *Med. Chir. Trans.* vol. xiv. p. 352.) Another observation made by Sir Benjamin Brodie, is an occasional insensibility of one iris, dilatation of the pupil, and a ptosis, continuing after the subsidence of the general insensibility of the body, and even unattended with loss of vision. (Vol. cit. p. 354.)

Some further observations of Sir Benjamin Brodie show the difficulty which attaches to this subject. He says: "In a patient in St. George's Hospital, in whom there was an extravasation of blood on the upper part of the right hemisphere of the cerebrum, and no cause of pressure elsewhere, both pupils were insensible and motionless; but the right pupil was in a state of dilatation, and the left in a state of contraction. In another patient, in whom there was fracture and depression of the left parietal bone, the left pupil was permanently dilated, the right pupil being in its natural state. In a third case, in which there was a fracture and depression of the frontal bone, above the right supraciliary ridge, there was dilatation of the left pupil; and again in a fourth case, where there was a fracture with depression in the same situation as in the case last mentioned, and no cause of pressure elsewhere, both pupils were dilated and equally insensible, but immediately regained their sensibility and power of contraction on the depression being elevated."

In cases where one pupil is contracted and the other dilated, we have generally found that the dilated pupil corresponds to the side on which the greatest amount of mischief to the brain exists. (See *Med. Gazette*, June 30, 1838.) Whether this admits of explanation from the fact that the third nerve takes its origin from the brain prior to any decussation of the cerebral fibres, or whether it depends on injury to the third nerve itself at its origin or where it crosses the base of the skull, we do not know; but the examinations we have made of fractured skulls with cerebral compression, lead us to the impression that the cause is by no means uniform, although the effect is as stated. There is no doubt much difficulty in explaining the varied effects of injury of the brain on the cerebral nerves themselves, as most of them take their origin from the brain prior to the decussation of the cerebral fibres. Burdach found, in twenty-eight cases of cerebral lesion of one side, the muscles of the opposite side of the face were paralysed; in ten cases, those of the same side. Paralysis of the eyelid was found in six cases on the same side; in five, on the opposite. Paralysis of the muscles of the eyeball occurred in eight cases on the same side; in four, on the opposite. Paralysis of the iris occurred in five cases on the same side; in five, on the opposite. (*Müller's Physiology*, vol. i. p. 842.) The collection of numerous cases and their results by Burdach is exceedingly interesting as bearing on the subject of hemiplegia. Thus, in two hundred and sixty-eight cases of lesion of one side of the brain, ten presented paralysis on both sides of the body, and two hundred and fifty-eight hemiplegia, in only fifteen of which was the paralysis of the same side as the lesion. (*Müller*, loc. cit.) This quite confirms the result of the observations of all practical surgeons. Pressure on the brain not unfrequently produces amaurosis; and when this happens the loss of sight occurs as frequently on one side as the other. This is probably owing to the partial decussation of the fibres of the optic nerve at their union. The idea is strengthened by the fact that in animals where the decussation is more perfect the eye is always rendered amaurotic on the side opposite the seat of pressure.

The occasional occurrence of convulsions in compression has been observed from the time of Hippocrates, who remarks, "that if the wound be situated on the left side, convulsions will seize the right side of the body; or if the wound be on the right side of the head, the convulsion attacks the left side of the body." (*Hippocrates*, Syd. Soc. edition, p. 464.) Hildanus mentions two cases of convulsions accompanying paralysis where bone was pressing on the brain; in both, the convulsions and paralysis existed on different sides, the paralysis being on the opposite, and the convulsions occurring on the same side as the injury. (*Van Swieten.*) Similar observations have been made from time to time in cases of cerebral compression. Thus Mayo (*Outlines of Physiology*) relates the case of a man twenty-four years of age, who was admitted into the Middlesex Hospital in a fit. "He was drowsy, heavy, and stupid; the pulse was small and slow. The left arm and leg were powerless, and the face was drawn to the right side. When put to bed, he was seized with a rigor, and the right side of the body became convulsed; he was relieved at first by bleeding, but he died completely comatose. A large cavity filled with blood occupied the centre of the right hemisphere of the brain. There was a slight sanguineous effusion on the left hemisphere."

In the cases collected by Burdach, convulsions occurred in twenty-five cases on the same side of the body as the disease; in only three cases on the opposite side. In thirty-six cases of lesion of one corpus striatum, attended with paralysis of the opposite side of the body, convulsions occurred on the same side as the cerebral disease in six instances, and in no instance on the opposite side.

With regard to convulsions, it appears questionable whether they really are symptomatic of compression at all, or whether they are not attributable to cerebral irritation rather than to pressure. It has been stated that convulsions frequently attend concussion of the brain; but convulsions under such circumstances are general and not partial, and they pass away leaving no ill effects behind; whilst in extensive lacerations of the cerebral hemispheres convulsions are often the harbinger of death. There are two interesting cases related by Sir Benjamin Brodie, which are here briefly referred to, as showing the difficulty of this subject: in the first, convulsions arose from concussion; in the second, they appeared to depend on pressure from a small clot of blood on the dura mater. "A gentleman was thrown from his horse, and received a blow which caused the scalp to be separated to a considerable extent from the anterior part of the head, and occasioned a fracture of the frontal bone, but without depression. He was taken up in a state of insensibility. He was in this state a few minutes afterwards, when he was seized with violent convulsions, his limbs being moved in various directions, and with such force that it was with much difficulty that several persons could hold him. The convulsions continued for about half an hour, when they subsided, leaving him in a state of stupor. Blood was now taken from the arm, after which he began to regain his sensibility. On the following day his sensibility was completely restored, and he recovered without any unfavourable symptoms." The next case occurred under the care of Mr. Keate: "A man was admitted into St. George's Hospital, having fallen from the top of a coach and struck his head. He was stunned, and continued insensible after being brought to the hospital. At the end of two days, when he began to recover from his state of stupor, he was seized with violent convulsions, affecting not only the muscles of the limbs, but also those of the face. The first attack of convulsions continued about six minutes, but this was succeeded in the course of an hour and a quarter by four similar attacks, and in spite of a considerable quantity of blood taken from the arm. Mr. Keate discovered a fracture at the posterior part of the left parietal bone, extending into the lambdoidal suture, with slight depression. At this part Mr. Keate applied a saw, and removed the depressed portion of bone. A small coagulum of blood was found lying on the surface of the dura mater, and this having been exposed, there was no recurrence of the convulsions." The observations of Sir Benjamin Brodie, on these and other cases of like nature, are so appropriate that no apology is required for their introduction: "I have not observed convulsions take place where there are symptoms indicating the existence of considerable pressure on the brain. The pressure in these cases does not destroy the functions of the brain: it seems to act merely as a cause of irritation; and the operation of it may be compared to that of an exostosis, or other tumor, in producing fits of epilepsy."

Thomson, in a few cases which came under his notice, in which convulsions occurred, saw them cease immediately after the elevation of the bone.

Convulsions accompanying pressure may sometimes depend on the want of a due supply of blood to the brain from the impeded circulation through the circle of Willis, and would therefore come under the same category as those instances of epileptiform convulsions occurring after ligature of one or other of the carotid arteries. These attacks always happen on the corresponding side.

But whether convulsions depend on pressure or on cerebral irritation, the fact remains the same, namely, that if they accompany paralysis resulting from pressure, the paralysis occurs on the opposite side, and the convulsions on the same side as the injury. This is very difficult to account for. Can the same cause produce effects so different? Most probably not. We cannot help believing that in most cases there are two causes in operation as the result of the injury when such a combination of circumstances happens, and that these causes are found acting on opposite sides of the brain: possibly it may happen that where effusion has occurred on one side to such an extent as to induce paralysis of the opposite side of the body, some slight effusion has happened into the cineritious neurine of the other side, which induces convulsions; and that these convulsions would affect all the muscles belonging to the voluntary system of one side equally with the other, if the paralysed muscles were not incapable of being convulsed. The subject is involved in much intricacy, and I refer the reader to observations of Hakemeand and Flourens, which are detailed in the second volume of Müller's *Physiology*, p. 840, &c., translated by Baly.

The circulatory system is evidently affected more or less in compression of the brain, as is shown by the remarkable sinking of the pulse in frequency, whilst the heart retains its original power, as is exemplified by what is ordinarily termed a *slow labouring pulse;* this is regarded as almost characteristic of compression. It is true the pulse is sometimes intermittent under pressure on the brain, as Dr. J. Thomson remarks; but, nevertheless, most authorities, as Abernethy, Brodie, and Guthrie, consider the slow labouring pulse as the peculiar pulse of pressure from whatever cause. However, it frequently happens that in most extensive effusions of blood on the brain, especially just prior to death, the pulse is increased in frequency, and becomes intermittent. In children there is a diminished frequency in compression, as in the adult; but the pulse, under the age of ten years, rarely sinks below fifty.

The effect is very similar when all communication between the brain and spinal cord is destroyed by section under experiment, or by destruction of a portion of the spinal marrow from a fracture of the spine, if this occurs in the lower cervical or upper dorsal region. Whether the pressure arises from depressed bone or from effusion of blood upon the brain, the effect is similar. Brodie remarked in one instance that the pulse increased in frequency twenty beats in one minute as the pressure was removed by operation. In another case the pulse, before imperceptible, became distinct and beat with considerable strength as the bone was raised. If blood is abstracted from the arm in any large quantity, under pressure from extravasation, the pulse often begins to sink most rapidly; whilst in the struggling of the patient during the operation of trephining, it becomes at first remarkably accelerated, and then sinks as rapidly in power and frequency, so that it is often impossible to judge by the pulse of the effects of the operation. The pulse usually remains in the same state until the cause of pressure is removed, and the heart's action will often continue sluggish after many of the other signs of pressure have disappeared. The nerves of organic life are influenced indirectly in cerebral compression, and a constipated state of the bowels shows clearly that the muscular coat of the intestines throughout their whole course is destitute of a due supply of nervous influence.

Although the respiratory functions, both in their mechanical and chemical actions, proceed with great regularity in milder cases, yet in cases of greater severity it is not so; the stertorous breathing, the prolonged respiratory effort, the mucous rattle in the trachea and air cells, and the altered colour of the blood itself from want of due aëration and consequent oxygenation, show clearly how powerfully the whole respiratory system is affected by the paralysing influence of cerebral compression on the par vagum. When the arteries of the scalp are divided by accident or during the operation of trephining, the blood escapes of a dull venous hue, and it often changes to its proper arterial character as the pressure is removed.

Treatment.—If the symptoms of pressure are fairly attributable to the depressed bone, the trephine, Hey's saw, or the elevator must be employed. In a case of simple depression of recent occurrence, and where doubtful signs of pressure exist, it is prudent to adopt the advice of Pott, and wait some time to see whether the symptoms may not be attributable to concussion, in which case they gradually pass away. Hence it is far better to pause, as, under the employment of brisk mercurial purgatives, cold applications, and the occasional resort to bleeding from the arm or by leeches, the symptoms may all gradually disappear and leave no effect behind. If, on the contrary, the symptoms increase in intensity, the depressed bone should be immediately raised.

The distinction between compression from depressed bone and from hæmorrhage on the surface of the dura mater is not always apparent, although, as a general rule, it will be found that in the former case they appear at once, and continue without any decided increase in intensity until the bone is raised, whilst in the latter they come on gradually and afterwards increase rapidly in intensity; but there are many exceptions to this rule, and we have seen a fatal effusion upon the dura mater with only slight symptoms of insensibility, and these by no means increasing to the termination of the life of the patient.

Where any doubt exists as to the precise seat of the pressure, that unerring sign, hemiplegia, on the side opposite becomes a valuable diagnostic mark, and consequently suggests the proper line of practice to be pursued. It is quite evident from cases already related that the operation may in some cases be almost indefinitely postponed, and may be performed with every prospect of success at a period remote from the first indication of pressure.

After the bone is raised, the sensorial functions are either immediately restored, or the recovery takes place more gradually, but not the less permanently. The after-treatment consists in the use of mild antiphlogistic remedies with the greatest attention to quietude of mind and body.

Blood may be poured out, first, between the bone and dura mater; secondly, between the layers of this membrane and in the arachnoid cavity; thirdly, hæmorrhage may take place in the cellular tissue under the arachnoid; fourthly, in the substance of the hemispheres; and lastly, in the interior of the ventricles. It may occur on the surface of the hemispheres, between the hemispheres, or at the basis. It may be the result of a rupture of one of the arteries of the dura mater or of one of its sinuses, of the arteries of the brain itself, or of the veins upon the surface of the brain. In many severe injuries of the head, the effusion occurs from all sources simultaneously. The most remediable form of hæmorrhage is that depending on a rupture of one of the arteries of the dura mater, when the blood is collected between this membrane and the bone. When blood is poured into the arachnoid cavity from a wounded sinus, this membrane is necessarily lacerated. Rupture of the spinous artery is perhaps the most common cause of pressure from effused blood, and is generally dependent on a fracture traversing the groove of this vessel transversely or obliquely. When a rupture of the spinous artery happens it will be found generally that a large collection of blood occurs beneath the temporal aponeurosis. Abernethy, adopting the doctrine of Celsus, says, "If there is so much blood on the dura mater as materially to derange the functions of the brain, the bone to a certain extent will no longer receive blood from within, and, by the operation performed for its exposure, the pericranium must have been separated from its outside. I believe that a bone so circumstanced will not bleed; and I am at least certain it cannot with the same freedom and celerity as it does when the dura mater is connected with it internally." (*Abernethy's Surg. Works*, vol. ii. p. 47.)

Guided by the tumefaction of the scalp, the surgeon in such cases should cut down upon the bone, and, having ascertained the seat of fracture, proceed at once to the removal of the bone. The temporal aponeurosis may require division to obtain a fair exposure of the fracture or suspected wound of the spinous artery.]

The effused blood is frequently situated below the part on which the violence has operated; and hence, when such part is pointed out by a wound or discoloration of the scalp, or a fracture, and the symptoms of pressure are considerable, with paralysis on the opposite side of the body, I should have no hesitation about immediately trephining in the situation of the external injury. I have seen many cases in which such practice was justified by the result; and even when no extravasation exists, this plan will sometimes detect a depression of the inner table of the skull, and be the means of saving life, as happened in one very remarkable case which I trephined at Brussels after the battle of Waterloo. At the same time it would be wrong to hold out the expectation that, by acting on this principle, the surgeon will always find blood immediately under the part of the cranium which he perforates. With respect to a fracture also, as a guide to the place for the application of the trephine in cases of extravasation, Desault regards it as fallacious, dissections proving that numerous fractures of the skull are unattended with any effusion of blood immediately under them; and his experience taught him that the most frequent cases were those in which there was either extravasation without fracture, or a fracture with blood effused in a part of the head remote from the injury of the bone. (*Œuvres Chir.* t. ii. p. 130.) Even when blood is seen issuing from the fissure, he regards it as no proof of the dura mater being detached, as such blood may proceed from the vessels of the diploe. (p. 31.) But what is to be done when dangerous symptoms of pressure prevail, without any external mark to denote what part of the head has received the blow, or whether any at all? for a general concussion of the head may produce an effusion of blood within the cranium. Under these circumstances Pott was against the operation, and says that "the only chance of relief is from phlebotomy and an open belly, by which we may hope so to lessen the quantity of the circulating fluids as to assist nature in the dissipation or absorption of what has been extravasated. This is an effect which, although not highly improbable in itself, yet is not to be expected from a slight or trifling application of the means proposed. The use of them must be proportioned to the hazard of the case. Blood must be drawn off freely and repeatedly, and from different veins; the belly must be kept constantly open, the body quiet, and the strictest regularity of general regimen must be rigidly observed. By these means very alarming symptoms have now and then been removed, and people in seemingly very hazardous circumstances have been recovered." Desault also promulgated the same advice, and blamed the doctrine formerly in vogue, that it was better to apply the trephine many times uselessly than to let a single extravasation remain undetected; for he was firmly convinced that the trephine, when used on this principle, was a source of greater mischief than the effused blood itself. (*Œuvres Chir.* t. ii. p. 34.) The same doctrine is espoused by Sir Astley Cooper (*Lectures, &c.* vol. i. p. 288), and I believe by all the best modern surgeons.

[If the effusion is extensive it may be requisite to remove two or more portions of bone. In some cases where the injury depends on topical violence, and the bone is comminuted, and the necessity of trephining is necessarily obviated, the removal of the comminuted portions will suffice for the escape of the effused blood.

In the absence of any discoverable fracture, when a free incision has been made down to the bone, and severe symptoms of pressure continue, we may unhesitatingly adopt the advice given by Pott and Brodie, and proceed to the removal of the bone by the trephine. Brodie says: "Where no fracture is discoverable, yet if there is other evidence of the injury having fallen on that part of the cranium in which the middle meningeal artery is situated, the use of the trephine may be resorted to on speculation rather than that the patient should be left to die without an attempt being made for his preservation. I cannot indeed adduce any particular experience of my own in favour of what is here recommended; but I conceive that the instances which have been recorded, in which the middle meningeal artery has been ruptured without any fracture of the bone, and the known fact that there is sometimes a fracture of the inner table of the skull while there is none of the outer table, sufficiently justify such an experiment in desperate cases, or even in those in which there is much danger."

Mr. Cock (*Guy's Hospital Reports*, April 1842) details an interesting case illustrating the propriety of the treatment here advised. "A man fell from a height of seventeen feet and pitched upon his head. He was stunned by the fall, but was recovering from the shock at the time of his arrival at the hospital. He had lost a large quantity of blood. A severe scalp wound extended from the middle of the forehead along the vertex of the skull, and terminated to the left of the occipital tuberosity; the upper third of the left parietal bone was exposed; the occipito-frontalis tendon was torn up in patches, and in one or two spots the bone was denuded. No fracture could be detected. He was collapsed, but easily roused; had not vomited, and his pupils were obedient to light. He afterwards had a severe attack of hæmorrhage from the wounds of the scalp. This was arrested by pressure. He was then perfectly sensible. He got out of bed at four o'clock in the morning, nine hours after his admission, and passed his motions. When spoken to by the nurse, he answered incoherently. At eight o'clock the dresser found his respiration labouring, stertorous, and interrupted, with entire loss of consciousness, his pupils contracted and insensible. These symptoms continued to increase, and when I saw him about noon his case appeared to be nearly hopeless. His breathing was then in the highest degree stertorous, rapid, and laborious; pulse quick, weak, but rather sharp. No difference in the two eyes, the conjunctiva ecchymosed on each side. On pinching the left arm and leg they were freely and readily retracted; but not the slightest motion could be excited in either extremity on the right side. There appeared to be some paralysis of the muscles on the right side of the face." Mr. Cock, viewing the symptoms as the result of effusion of blood upon the dura mater, cut down over the anterior inferior angle of the left parietal bone, and exposed the cranium freely in that direction. Not the slightest indication of fracture could be discovered. He then removed a portion of the parietal bone above and behind the anterior inferior angle with a full-sized trephine. The moment the elevator had detached the bone, a gush of blood took place through the opening, and a clot was discovered beneath. "The interior of the cranium, as far as could be felt, presented no irregularity or trace of fracture. A small quantity of the coagulum was removed, and the wound was covered with lint dipped in water. The deep stertor of his breathing ceased almost on the instant that the bone was raised, and he was evidently relieved by the operation. Blood continued to ooze from the opening in the skull, but there did not appear to be any active hæmorrhage."

The case proceeded favourably up to the ninth or tenth day after the accident, when he began to get restless and uneasy, with a sloughy and offensive state of the wound; after which he became irritable, but still sensible, although relapsing into a rambling incoherent state, with occasional exacerbations. His unfavourable symptoms increased. His pulse became sharp, quick, and irritable. He was with difficulty roused from his low muttering state. There were incessant twitching motions of the right arm and leg, and right side of the face. "On examining the trephine wound, I found that the dura mater had risen into the opening of the bone, so as completely to shut out all communication with the interior. The pulsation of the brain was evident, but the membrane was dry and covered with an inspissated secretion round the circumference of the aperture in the bone. After the application of a poultice, a free discharge of ill-conditioned pus, mixed with decomposing coagulum, took place from between the dura mater and the cranium, after which his unfavourable symptoms subsided." He eventually got perfectly well.

If the blood is found fluid on the removal of the bone, it escapes immediately, and the symptoms are at once relieved; but if it is coagulated some time elapses ere any effectual relief can be anticipated. The resistance to the motions of the brain being thus taken off, the natural pulsations are gradually restored, and the brain will again receive its due supply of blood from the arterial circle at its base. The evident heaving of the brain on the removal of the bone is an important salutary indication, and it ought not to be overlooked. But we are not to suppose that all mischief has ceased when the pulsations of the brain are restored; for there are few instances where, be the mischief ever so extensive, some slight movement of the brain is not perceptible: but the converse is undoubtedly true, and the absence of any motion in the brain is a very serious sign, and indicates a high degree of mischief, and a greater extent of effusion than can be exposed and relieved by the trephine.

Pressure from effused blood occasionally admits of temporary relief by the free abstraction of blood; but the surgeon will in all probability be much disappointed to find a speedy recurrence of all the dangerous signs of pressure, and should waste no more time in the use of general measures, but proceed at once to the application of the trephine, provided clear indications of the seat and cause of the pressure are present. The tenacity with which the coagulum adheres to the surface of the dura mater renders the attempt to cleanse this membrane by forcible scraping highly injurious; but if the effusion is very recent and the coagulum but loosely adherent, it may be very carefully sponged away, so as to afford an exit to any subsequent effusion. Mr. Guthrie makes especial allusion, in speaking of the probability of recovery after the trephine in hæmorrhage from the spinous artery, to the speedy restoration of the brain to its natural level, and asserts "that, in all cases where recovery took place, the brain had not lost its resiliency, and had been seen to regain its natural level on the removal of the depressing cause." (Loc. cit.)

Effusion of blood into the arachnoid cavity, from a rupture or laceration of one of the sinuses of the dura mater or any other cause, is generally fatal, especially if accompanied with laceration of the brain. But the symptoms are usually not so well marked as where the pressure arises from hæmorrhage upon the dura mater after rupture of the spinous artery, a circumstance probably depending in the former case on the facility with which the blood is diffused over the general surface of the brain. Before the trephine is applied, it is impossible to diagnose this condition. It is highly probable that small effusions of blood into the arachnoid cavity are absorbed, and it is well known that a very extensive layer of blood may remain in the same cavity for a long time without giving rise to positive signs of pressure. (See a detail of experiments by Serres and Malgaigne, *Brit. and For. Quarterly Review*, October 1840.)

When blood is poured out into the arachnoid and the trephine is applied, the dura mater is found to be pushed up through the opening made, and presents a bluish aspect; the cerebral impulse is scarcely perceptible, or altogether absent. Under such circumstances the surgeon is justified in puncturing the membrane with a lancet, which affords the only chance of relief. A very small puncture is sufficient, as the blood remains in a perfectly fluid state. We shall quote two instances, one from the eighth volume of the *Medical and Physical Journal*, and the other on the authority of Sir B. Brodie, showing remarkable success following this plan of treatment.

"The late Mr. Chevalier was called to a child a year and a half old, who had received a severe blow on its head. The child lay in a state of insensibility, and was affected with convulsions. There was no wound of the scalp, but on attentive examination of the head the fontanel appeared to be somewhat elevated. Mr. Chevalier was led therefore to make a crucial incision of the scalp, by dissecting up the corners of which he exposed the fontanel. He then made an angular incision of the right side, and raised the membrane forming it so as to expose the surface of the dura mater, beneath which the purple colour of extravasated blood was plainly to be seen. A puncture being made carefully with a lancet, the blood issued at first with considerable force to the distance of a foot. Three or four ounces of blood escaped. The symptoms were immediately relieved, and the child recovered without any further unfavourable symptoms."

The next case occurred in the practice of Mr. Ogle:—"A woman fell from the street, head foremost, to the bottom of a cellar, and was taken up in a state of insensibility. Mr. Ogle found her lying as if in a fit of apoplexy. He ordered her head to be shaved, and on examining it afterwards discovered no wound of the scalp, but observed that she flinched very much when pressure was made on the spot near the anterior and superior angle of one of the parietal bones. Having made an incision at this part he could perceive no appearance of fracture. Nevertheless, as the woman was manifestly in danger, he thought it expedient to remove a portion of bone with the trephine. Immediately on the bone being removed, the dura mater, of a dark colour, rose into the opening nearly as high as the external surface of the skull. Convinced, from its appearance and from the feeling of tension communicated to the fingers, that a fluid was interposed between it and the brain, and that that fluid was blood, Mr. Ogle ventured to puncture the dura mater with the point of a lancet. The puncture was instantly followed by a stream or jet of blood, which spirted out to the height of some feet. Immediately on the blood being discharged the woman, who till that moment had continued totally insensible, opened her eyes. From this time she recovered without any untoward symptom. It was supposed that about three-quarters of an ounce of blood escaped."

Some precaution is requisite in making an opening through the dura mater, for where there is much distension of the veins on the surface of the brain, a preternaturally blue appearance is given to the dura mater, which we have seen mistaken for effused blood; the operation, however, is the only means likely to be successful for the relief of the brain under circumstances of such pressing emergency. The diagnosis of effusions of blood between the bone and the dura mater, and into the arachnoid cavity, is obscure; any deductions, therefore, from practical observation cannot but be interesting. Hence we extract the following remarks of Mr. Cock from the paper before mentioned. He says: "I have observed that in every case of this kind (viz. where the effusion is external to the dura mater) the pure symptoms of compression are more distinctly and strongly marked than where they are occasioned by depressed bone or effusion of blood in any other situation. There is a death-like quietude of the limbs; the face is devoid of expression or muscular motion; the powers of the patient seem concentrated to produce the laborious heavings of the chest; whilst the lips and cheeks are mechanically puffed out as the air is expelled at each expiration. These signs, together with the deep loud tone of the stertor, are, we think, very characteristic. The pupil also, on the same side as the extravasation, will generally be found dilated. These peculiarities may probably be attributed to the clot of blood being to a certain degree circumscribed in extent, to its great depth, and the pressure which it consequently exerts on the opposite surface of the brain, which becomes deeply impressed by it; whereas, when blood is effused into the arachnoid cavity, it is generally less in quantity, and spreads over a much wider surface, producing more general and less local pressure."

As to the general treatment to be pursued where there is no indication to lead to the application of the trephine and puncture of the dura mater, it must obviously be conducted on strictly antiphlogistic principles, and may be comprised under the heads of free abstraction of blood generally and locally, cold applications to the head, the employment of mercury to affect the gums, and brisk purging, with due attention to the state of the bladder, position of the head, &c. &c.

In treating of exfoliation of bone, suppuration, which not unfrequently occurs during this process and becomes a very formidable cause of pressure upon the brain, has been already alluded to. The seat of the suppuration may be either between the dura mater and the bone, or in the arachnoid cavity, or in the substance of the brain itself. The train of symptoms which usher in these formidable affections have been mentioned in the description of inflammation of the dura mater during exfoliation; but we again allude to them under the head of pressure. Of course, in suppuration upon the brain, the symptoms never make their appearance until some time has elapsed after the accident, and they are ushered in with rigors, convulsions, frequently vomiting of bilious matter, and the general signs of what has been termed bilious fever; the countenance becomes sallow, the pulse is accelerated, and the wound takes on the unhealthy aspect already described. After this the brain begins to suffer from the pressure of the effused fluid; this is manifested by hemiplegia, by loss of consciousness, coma more or less complete, stertorous breathing, and retention of urine and incontinence of fæces; the skin is hot, the pupils, at first contracted, afterwards become dilated, and the general febrile excitement tends to modify, if not to mask, the signs of pressure.

In the treatment of compression from purulent deposit within the skull, after the full employment of the ordinary antiphlogistic measures, the operation of the trephine to give exit to the fluid must be had recourse to; and if the matter be confined to the exterior of the dura mater, a favourable result may be anticipated.

When pressure arises from abscess it is preceded by inflammation of the brain.

Traumatic inflammation of this organ is usually attended by fever, accompanied by deep-seated pain in the head extending from the seat of injury towards the forehead; there is extreme irritability, often followed by drowsiness and stupor. The countenance is flushed, the conjunctiva is injected; and the carotid arteries throb with unusual force, nausea or vomiting indicates the irritability of the stomach; the intellectual functions are materially disturbed, and the patient is restless, anxious, and often delirious; during his delirium, which assumes a low muttering character, he holds imaginary conversation with some friend on the subject of his customary avocations. There are marked exacerbations at night, which are calmed in the early morning. The symptoms increase in intensity; he is now furiously delirious, or he assumes a gaiety, or even a degree of comicality, quite unusual with him; his skin is hot, and excessive thirst indicates the exalted sensibility of his stomach. Extreme restlessness, with frequent jactitation, followed by a sense of weight and numbness, is often succeeded by subsultus tendinum. The bowels are costive, and the urine is scanty and high-coloured, and is often retained. In advanced stages of the disease the patient loses the power of articulation; he becomes completely prostrated, and his delirium gives way to profound stupor; he still occasionally directs his hand to his head, as it were, instinctively, and carries it gently over his face. Cold shiverings of variable duration occur. These are followed by rigid spasms of the head and neck, or of one extremity. Paralysis of the face, and loss of power over one or both limbs, clearly indicate now that suppuration has occurred, or that effusion has taken place into the arachnoid cavity, or that disorganisation of the brain has happened. The surface of the body is bedewed with cold sweat; the power of deglutition is gone, and the sinking pulse indicates approaching death.

Such is the course of an attack of acute inflammation of the brain after concussion or other injury to the head. But the disease often assumes a more chronic form: thus slight indisposition, or general *malaise*, accompanied by pain in the head, ushers in the attack; the pain is of a dull, deep character, and is attended by great lassitude and irritability. The eyes are intolerant of light, and sound is painful to the ear. As the disease proceeds, the intellect becomes disturbed, the locomotive powers are enfeebled, and the patient assumes an unsteadiness in his gait, although he is not quite paralysed. To this, however, hemiplegia often succeeds; and if this is accompanied by decided attacks of shivering, it becomes a clear indication of the formation of matter in the brain. The pulse, in this subacute or chronic form, is slightly accelerated, but is soft and compressible, and the tongue is at first white, but, as the disease advances, becomes covered with a brownish crust.

Under suitable treatment, inflammation of the brain may be arrested and completely cured. The treatment may be summed up under the following heads, namely, free venesection, leeches, drastic purges, and mercury carefully administered so as to induce a slight salivation. Ice should be applied to the head, and low diet succeeded by moderate support enjoined; but as the disease advances the patient is to be sustained by more generous diet and gentle stimuli, as ammonia and wine. In decidedly chronic inflammation, there is nothing equal in efficacy to a prolonged and mild course of mercury, with small doses of iodide of potassium. The disease terminates often in gangrene and suppuration, or in both combined. We have frequently seen gangrene of the cineritious substance in purulent infiltrations into the arachnoid cavity; it sometimes extends into the medullary substance: the part assumes a leaden or greenish aspect, and the fœtor is most disgusting. There are no means of distinguishing this condition during life.

When matter forms in the substance of the brain it may be infiltrated into the general tissue of the organ, or mixed with clots of blood as a consequence of laceration, or it may be contained in a distinctly circumscribed cyst, as in a common abscess; the cerebral tissue is frequently softened around the abscess, and small bloody points of extravasation indicate the bruised state of the brain; the convolutions covering the abscess are generally flattened. The matter itself ordinarily assumes a greenish hue, is exceedingly fœtid, and is often mixed with portions of cerebral substance in a state of gangrene. The diagnosis of abscess in the brain after injury is often extremely obscure, but may generally be correctly formed by careful attention to the symptoms accompanying and succeeding an attack of inflammation: thus, if the usual signs of inflammation have been followed by distinct attacks of shivering fits at intervals of longer or shorter duration, and if these are succeeded by stupor, convulsions, and decided hemiplegia, the inference that suppuration has occurred may be fairly drawn.

Suppuration of the brain may take place at almost any period after the accident, and extensive suppuration may occur without any rigors and without any appreciable paralysis: in this respect it can scarcely be said to cause pressure. This renders the diagnosis difficult. In cases of this description, after a long-continued attack of subacute inflammation, a low typhoid state may continue, and after death a large abscess may be found occupying almost an entire hemisphere. Gamma mentions a case of abscess in the right hemisphere; the disease lasted thirty-three days, and was unattended by either convulsions or paralysis. Suppuration may occur and terminate rapidly after an acute attack of inflammation. The following is an instance of this. A young man who had received an injury to his head, from which he was recovering, was permitted to get up; he indulged in copious draughts of beer, and was immediately seized with rigors and all the signs of inflammation of the brain. He died within twenty-four hours of the attack. The anterior lobes of both hemispheres were in a state of suppuration; there was an extensive fracture through the orbital plates of the frontal bone, and it is not unlikely the brain may have been damaged at the time of the accident.

With regard to the situation of abscess in the brain there is frequently much uncertainty; most commonly the matter is found close to the original seat of injury, but in some cases it is much deeper than this, and it is occasionally found diametrically opposite to the part on which the blow was inflicted. These circumstances, added to the obscurity frequently attending their formation, enhance materially the difficulty of diagnosing cerebral abscesses. As the signs of abscess, therefore, are by no means unerring, it would be rash to institute an exploring operation except in unequivocal cases, especially as the matter may be accumulated at a very considerable distance from the surface of the brain. (*Quesnay, Mémoire de l'Académie de Chir.* v. ii. p. 145.)

The prognosis of cerebral abscesses the result of injury must, from the nature of the organ affected, be exceedingly unfavourable, and when they happen from internal causes they are almost of necessity fatal. The cases, however, recorded by Petit, Louis, Quesnay, and others, offer abundant evidence that if a free outlet is given to the matter by the removal of bone, there may be ground for expecting a favourable termination.

In some instances abscesses have been known to burst into the lateral ventricles, and under such circumstances death occurs at once. An instance of this has been already mentioned; and in the *Journal de Médecine* for 1830 Lallemand, Lerminier, and others record instances which illustrate the same point.

The tendency of matter in the brain is generally towards the surface as in other parts of the body (this is often witnessed after the removal of bone by the trephine): the unyielding dura mater preventing its escape is therefore pushed up through the opening in the bone; the arachnoid cavity is shut out by a barrier of lymph, and if the dura mater is not punctured it becomes sloughy in appearance, and the matter escapes by small openings in the membrane. The surgeon should anticipate or at any rate favour the efforts of nature, and by a free incision permit the ready exit of the matter. Unfortunately cerebral abscesses frequently co-exist with suppuration in the arachnoid cavity and purulent deposits in other parts of the body, so that but little success attends their treatment. Quesnay relates an instance in which Petit relieved a case of cerebral abscess by freely puncturing the dura mater after trephining. The treatment was eventually successful, although the symptoms did not immediately subside, owing to the confinement of matter, which afterwards escaped. Two very similar cases occurred to Roux. (*Archives Générales*, vol. xxiv. p. 81.) In the first the ordinary signs of suppuration of the brain had existed, and the trephine had been applied over a diseased piece of bone; the dura mater was punctured, but no matter appeared: Roux was dissuaded from puncturing the brain. After death a large abscess was discovered in the hemisphere. In the second case there had been a fistulous opening in the skull in the centre of the left parietal bone, by which a large quantity of sanies continued to escape; whenever this was stopped the patient was seized with coma, but when the discharge recurred his symptoms were immediately relieved. M. Roux removed a piece of bone with the trephine, and detected a fistulous orifice in the dura mater. He increased the opening in the membrane, and immediately a large quantity of matter escaped. As the abscess discharged its contents, the brain appeared depressed at this point; but in a few days the space became filled up, and the discharge gradually decreased in quantity. No hernia cerebri occurred, and the patient was eventually cured.

But the abscess does not always reach the surface, and the surgeon may hesitate before he punctures the brain itself to give exit to matter, which after all may be deep in the substance of the organ, and even in the opposite hemisphere: the urgency of the symptoms must be held as affording a justification for puncturing the brain in cases of doubt. Quesnay relates an interesting case of this description which occurred to De la Peyronie. A child had met with an injury to the head requiring the trepan; a considerable quantity of blood escaped which had been effused on the surface of the dura mater; the membrane was healthy, and the case was proceeding favourably until the twenty-eighth day, when convulsions and partial paralysis of the right side supervened, accompanied by stupor and loss of consciousness. The surgeon suspecting abscess made an opening in the dura mater, but discovered nothing beneath the membrane. The symptoms increasing, he was disposed to puncture the brain, but his opinion was overruled. The child died in a fit of convulsions, and on opening the head he discovered an abscess in the substance of the brain about three or four lines from the surface.

A remarkable instance is recorded by Dupuytren (*Lancette Française*, Oct. 14, 1830) of abscess in the brain consequent on a wound of the skull by the point of a knife received some years before. A sudden attack of stupor induced the friends to bring the patient to the Hôtel-Dieu. Dupuytren incised the cicatrix and removed the point of the knife; after this the trephine was applied, but without any good effect. Dupuytren opened the dura mater, and plunged a lancet into the hemisphere to the depth of an inch, and in this manner evacuated a large quantity of matter. He was led to this somewhat bold procedure in consequence of the persistence of hemiplegia on the opposite side of the body. In the evening the symptoms subsided, the patient's speech and intelligence returned, and he eventually recovered.

The advice given by Velpeau in doubtful cases is judicious, and may be followed with advantage, namely, to wait where no matter is found after the trephine has been used, if the symptoms are not very urgent; the cyst then distended with pus, and freed from all compression, would be pushed towards the opening by the expansion of the brain. The abscess could then be easily opened, and some advantage would be gained by the opportunity thus afforded for adhesions to form between the opposed arachnoid surfaces, by which the tendency to meningitis would be obviated. (*Velpeau, De l'Opération du Trépan*, p. 87.)]

CONTUSION OF THE BRAIN.

[In all severe cases of concussion it is very probable that the brain is bruised, but it is very questionable whether this condition can be recognised during life as a distinct affection. So far as our own experience extends, we confess our inability to determine this point. Many cases of concussion occur in which insensibility is prolonged, and in which slow but imperfect recovery takes place; and in such cases a suspicion arises that the brain is more or less bruised, but the positive proof is wanting, and the question must still remain undecided, whether the condition is attributable to simple concussion, or to bruise of the cerebral substance, or to slight pressure.

M. Sanson paid great attention to this subject at the Hôtel-Dieu, and his views are ably set forth by M. Boinet in the *Archives Générales de Médecine* for May 1837. That the brain occasionally suffers bruise without fracture of the skull, is admitted by all surgeons, and the extent varies according to the severity of the injury. In some cases the effects of the bruise are confined to the subarachnoid cellular tissue and the pia mater; in others the cineritious substance is the seat of injury, whilst the bruise may extend or even be confined altogether to the white fibrous portion of the brain: in either of these cases the appearance of the bruise, if confined to a single spot, becomes gradually less evident towards the circumference of the bruised part. In some cases minute spots of extravasated blood are found disseminated in various parts of the brain, whilst in others the cineritious and medullary substances are wholly broken up.

Mr. Hewett states, in reference to the situation of the bruise, "that out of thirty-six cases of bruised brain, accompanying fractures extending from various parts of the vault into the base of the skull, the upper surface of the hemispheres was bruised in five cases only." He further states, "The base of the brain is the part most frequently injured; but, even here, the various regions differ widely in this respect. The posterior lobes are rarely injured, the anterior ones frequently, and the middle lobes the most frequently of all. Out of the thirty-six cases I have mentioned, the posterior lobes were bruised in four instances only, the anterior lobes in eighteen, and the middle lobes in twenty-five. In twelve of these cases the anterior and middle lobes were bruised at one and the same time." There is some difference on this point in the result of the examinations of M. Fano, who found the anterior lobes more frequently bruised than any other part of the brain; but he only gives the analysis of eight cases. (*Hewett's Lectures*, op. cit.)

The explanation of this circumstance offered by Sir Benjamin Brodie, in his paper in the *Med. Chir. Transactions*, vol. xiv. p. 324, is quite satisfactory. "A blow on the head may cause a rupture of the tender substance of the cerebrum or cerebellum, and hæmorrhage into the cavity of the dura mater. These cases generally afford examples of the *contre-coup*. The rupture of the brain rarely takes place at the exact spot on which the blow is inflicted; and the great irregularities which exist on the inner surface of the base of the cranium sufficiently explain why the inferior is more liable to be ruptured than the superior surface of the brain." It must be remembered, nevertheless, that all the cases referred to are cases attended with a fatal result, and it is possible that, if an analysis of others terminating favourably could be formed, some modification of the opinion might be necessary.

Symptoms of Contusion. — According to M. Boinet, after the signs of concussion have passed off, the patient remains to a certain extent devoid of consciousness, his breathing being slow but regular, and not stertorous; his extremities, which have not entirely lost their sensibility, are violently or sometimes feebly contracted; he either refuses to answer all questions, or his answers are given without reference to the questions put to him; he is in a constant state of agitation, and his movements are of an epileptic character. In some cases the pupils are dilated, in others contracted: a discordance of the pupils is occasionally observed. There is no involuntary discharge of urine or fæces. M. Boinet considers these signs, in the absence of stertor, as diagnostic of contusion of the brain, and he especially dwells upon the epileptic contraction and constant agitation, as characteristic of the disease. These signs come on either at a short interval of time from, or immediately after, the accident, and are liable to be mixed with those of concussion, or, in the event of a large effusion of blood, with compression. If the extravasation be of great extent, the symptoms of contusion are then masked by those of pressure; but where only slight effusion of blood takes place, the symptoms of contusion, notwithstanding, will still manifest themselves in the constant jactitation of the patient, and an evident disposition to evade any questions put to him.

In some cases of contusion consciousness remains, but the patient is unable to express himself in answer to questions he fully understands, and he therefore makes use of signs and gestures to render himself intelligible. In others there is a difficulty of enunciating a proper name or any particular word, and an incapacity to complete a sentence already begun except by paraphrases. Of this we shall adduce an example from Sanson.

"A carpenter of the name of Martin, aged thirty-two, was brought to the Hôtel-Dieu, in consequence of a fall upon the head from the height of twenty or twenty-four feet. Blood flowed from his ears and nose. On his admission his limbs were contracted, and he was in a constant state of agitation, turning himself in all directions; he retained his consciousness, but would only answer questions in interrupted phrases; he had lost the recollection of substantive words; and when asked of what trade he was, he could not pronounce the word 'carpenter,' but when this word was mentioned with four or five others, he fully comprehended what was said, and with a motion of his head expressed the affirmative when the right trade was mentioned, though he could not pronounce the word.

"On the second day after his admission, the left side of his face, which corresponded to the side of his head injured, became paralysed, together with the superior extremity of the same side; he lost the power of speech; his agitation and the epileptic movements increased. He died seven days after his admission, never having lost his consciousness or sensibility.

"On examination after death, a contusion of the middle lobe of the right side of the brain was found, with a superficial effusion of blood over the bruised part."

These signs are supposed to indicate the most severe form of contusion, but they are modified in milder cases. Thus a continued pain in the head may be the only symptom present, and hence, in injuries of the head, the surgeon cannot be too much on his guard during the continuance of a constant localised pain in the head. If the effect of contusion in these cases is confined to a slight extravasation of blood into the cellular structure of the pia mater, the blood may be absorbed without any permanent detriment to the functions of the brain; but, if the cerebral neurine is damaged, the pain usually goes on increasing in violence; a sensation of weight over the region of the forehead comes on, accompanied with dizziness, and restlessness with jactitation takes place; the pulse, at first slow, becomes hard and frequent, the skin hot and dry, and the countenance flushed and excited; nausea and vomiting, succeeded by shivering, convulsions, and delirium, at once indicate a fatal attack of meningitis or phrenitis, and not unfrequently are the certain harbingers of suppuration of the brain.

Treatment.—Two points are especially indicated here, namely, to prevent inflammation, and to obtain the re-absorption of the effused blood. To effect these two desirable objects, strictly antiphlogistic treatment is requisite. A free general and local abstraction of blood, the application of ice to the head, drastic purges and enemata, blisters to the nape of the neck, are to be employed with energy, and the exhibition of mercury so as to affect the gums should on no account be omitted.

The *prognosis* in severe cases must be very unfavourable; but who can tell how many cases of simple bruise of the brain may have recovered? If the contusion be of limited extent, the brain may recover itself, as after a slight apoplectic effusion. It is very probable the cure may not be complete, and some imperfection of the intellectual faculties may remain, of which some instances have come under our notice, but the ordinary functions of life may remain unimpaired. We abstain from the enumeration of cases of recovery after contusion of the brain, because the diagnosis is not sufficiently clear to justify a positive opinion on the subject; but we suspect that a great many cases are clearly of this nature, where loss of memory of names or places, with loss of the power of speech, and other signs continue, which are believed to be the consequence of pressure. It will be sufficient to relate a single case, on the authority of Hennen, in which no doubt can be entertained that the surface of the brain had suffered severe contusion, and in which recovery took place.

"A Captain B—— was wounded in the head by a musket-ball at the battle of Waterloo. On approaching the waggon in which he was laid, I was attracted to that part of it where he was stretched, by a low protracted moan, as of a person in pain, but very weak. On calling him by name he sat up, caught me by the hand, and, pointing to a wound in the head, burst into tears. His countenance was pale and glassy, and his mouth somewhat distorted; his eye languid and suffused with blood; his pulse about ninety, soft and compressible. He had been bled previously. His pulse in the night had risen to about a hundred, was hard and bounding, and he was bled in consequence. A cruciform enlargement of the wound gave a view of an extensive fracture of the left parietal bone. On my visit I found him with a pale countenance expressive of great pain, referable more to mental than bodily suffering; mouth distorted; eye sunk but its pupil dilatable; the power of articulating any distinct sound lost, but the desire obviously strong; pulse eighty, soft; tongue clean; bowels open; urine copious; the liver itself very prominent, and painful on pressure.

"On examining the wound of the head I found an extensive radiating fracture occupying almost the whole of the left parietal bone; at the centre there was a piece of bone, beat in through the membranes of the brain, and bedded in its substance, but considerably more towards the frontal region than the occipital. The unequal pressure I found to proceed from a musket-ball which was wedged in between the displaced pieces of bone and the portion which though cracked preserved its situation. The separated piece was obviously much more extensive on its internal face than its outer, and could only be removed with the trephine. The leaden wedge and several splinters which jammed it in were easily removed; and on making one perforation with a large-sized trephine I removed the depressed portion of bone, which was forced into the brain nearly an inch and a half from the surface of the scalp. No relief followed the operation. He was bled during the night; his breathing became decidedly stertorous. He lay coiled up in the bottom of his bed, the right arm stretched out and occasionally convulsed. On addressing him he made an effort to rouse himself, but almost immediately relapsed into his former state. A spontaneous bilious diarrhœa took place, and he became more sensible. He made an attempt to articulate, and pronounced audibly the letter *t*. The next morning, the fifth from the receipt of the wound, he was amazingly altered for the better; the diarrhœa continued, and his efforts to speak were continual. On the sixth day he uttered audibly, though with much labour, the monosyllable 'ther,' to which, in the course of the day, he added 'o,' and for the next three days, whenever addressed, he slowly, distinctly, and in a most pathetic tone, repeated the words 'o-ther,' 'o-ther,' as if to prove his powers of pronunciation. His general appearance amended considerably. I therefore resolved to write to his family, and before doing so I printed in large characters on a sheet of paper the following words:—'Shall I write to your mother?'—that being the wish he so long and ardently had laboured to utter. It is impossible to describe the illumination of his countenance on reading these talismanic words; he grasped and pressed my hands with warmth, burst into tears, and gave every demonstration of having gained the boon which he had endeavoured to solicit.

"From this period his mental faculties gradually developed themselves; he regained a consciousness of the circumstances immediately preceding his wound, and, in succession, of those of a more remote period. The power of speech was the last which he perfectly regained, and for which he usually substituted his thoughts and wishes in writing. He returned to England nearly recovered on the 103rd day from the wound."

It may be truly said in reference to this case that the brain, independent of the contusion to which it must have been subject, had suffered some degree of laceration from the introduction of the spicula of bone removed by the trephine; but I notice it here as presenting one of the most marked symptoms of contusion, namely, the complete inability to speak, and this evidently not as the result of a want of consciousness, but in all probability depending on the inability to give utterance to distinctly articulate sounds and to effect their ordinate arrangement.

The observations just made refer more particularly to supposed contusions of the cerebrum, as the part necessarily more frequently injured. The cerebellum and other parts of the encephalon are nevertheless occasionally the seat of contusion and laceration; but it is impossible in severe injuries of these parts of the nervous system to form an accurate diagnosis of them. Some curious circumstances in relation to injuries in the region of the cerebellum now and then force themselves on our observation, which it becomes a matter of considerable interest to inquire into, as they are supposed to throw light upon the functions of this organ. We allude to the supposed influence of such injuries upon the generative system of the male subject.

Whether the physiological inference be legitimately deducible from such cases or not, we are not prepared to say; but the evidence on record is sufficient to justify an inquiry into the effects of contusions of the cerebellum upon the organs of generation.

Some cases are here quoted from Larrey. "A soldier of the army of Egypt, eighteen years of age, received a blow upon the nape of the neck, accompanied with considerable contusion and ecchymosis in the occipital region. Inflammation of the surrounding tissues and of the cerebellum set in. An abscess formed near the occiput. The symptoms were very severe, but yielded to antiphlogistic treatment. In three months he was able to join his regiment, and he returned to France. Some years afterwards he presented himself at the hospital of Groscaillou: he was now thirty-two years old, but he had every appearance of a young conscript; he was thin and meagre, his countenance pale and wrinkled, his eyes sunk, lips pale, his hair scanty and bristling, especially about the occipital region, where he felt a constant pain and coldness; but his intellectual faculties had remained uninfluenced. He was beardless, and his voice was feminine. He had so much of the female character about him that some doubts existed as to his sex; but upon examination his genital organs were found reduced to the size of an infant's three months old; his penis, which was only five or six lines in length, was incapable of erection, and his testicles were no larger than small beans. He attributed this change in his condition to the injury, since which his beard had gradually disappeared, and previous to which he had enjoyed the usual sexual faculties of his age."

The next instance of a similar affection of the generative system occurred to an officer of the horse artillery who was struck by a musket-ball which traversed the extensor muscles of the head, and glancing over the occipital fossæ, which were remarkably prominent, completely denuded them of their aponeurotic connections. After the wound was dressed he suffered severe pains in the occiput, with a sense of weight in the head, with numbness and stiffness of the lower extremities. His sight and hearing failed him so that he was scarcely able to distinguish large objects and to appreciate the most acute sounds. His testicles became atrophied, and his penis diminished in the same ratio and remained incapable of erection. The wound was healed by the fiftieth day.

The third patient that came under the notice of Larrey with injury to the cerebellum was a cavalry soldier of a robust constitution and much addicted to women. He received a sabre wound in the occipital region, which divided the skin and the convex portion of the occipital bone, so as to expose the dura mater, which was also wounded. The right lobe of the cerebellum was seen through the opening of the membrane. The slightest touch of this organ gave rise to vertigo, syncope, and convulsions, but excited no pain. A continual escape of fluid from the inner surface of the dura mater prevented the union of the wound. Very soon after the accident he lost both sight and hearing on the side corresponding to the wound, and he complained of acute pain in the course of the dorsal region of the spine, with a sense of pricking in the testicles, which diminished in volume with great rapidity, so that in fifteen days the right testicle was reduced to the size of a garden bean, and he lost all desire for the other sex. His wound was proceeding favourably, but the functions alluded to appeared entirely lost; symptoms of inflammation, however, came on, and continued to increase notwithstanding the adoption of strict antiphlogistic means. The pains in the head and down the spine were most severe; he lay on the side of the injury coiled upon himself. The slightest motion excited convulsions, and when raised to expel the contents of his bowels he fell into a frightful state of syncope. He died thirty-nine days after the accident, having been seized with opisthotonos. On examination after death a large portion of the occipital bone had been destroyed; the opening through the dura mater corresponded to the centre of the right lobe of the cerebellum, which was depressed and of a yellowish colour, without suppuration or extravasation. The medulla oblongata and spinalis were white in colour and of a firmer consistence than natural, and reduced one-fourth of their natural size.

Larrey also mentions two other instances of atrophy of the organs of generation as the result of abscess in the cerebellum; and he sums up the following observations on injuries of this portion of the encephalon:—1st. That in injuries of the cerebellum the intellectual faculties and senses, except sight and hearing, suffer no derangement. 2ndly. That the locomotive organs, with one exception, have not been found affected, and that, in the exceptional case, the arm of the side corresponding to the injury was affected. 3rdly. That lesions of the cerebellum have a decided tendency to diminish the power of the generative system, and to induce atrophy of the organs of generation. And, lastly, that accidents of this description are not of necessity fatal, as has been usually said to be the case. The physiological inferences drawn by Larrey from these facts appear to be so far fairly sustained, and they are corroborated by the observations of others.

The following case was seen by many surgeons of the metropolis a few years since:—A man who had been a soldier during the civil war in Spain received a blow from a cannon-ball in the occipital region whilst in the trenches, and, after recovery from the effects of the injury, his testicles began gradually to diminish in size and firmness, and he began to assume in a great measure the characters of the opposite sex. His beard nearly disappeared, his voice altered, and large mammæ began to develope themselves, so that when seen they had the appearance and feel of the breasts of an adult virgin; he observed no diminution in his powers of locomotion, his testicles were pendulous and flabby, and he had lost all desire for the other sex.

Mr. Guthrie has met with more than one instance where the cerebellum has been bared by sabre-cuts without any immediate ill consequence.]

Laceration of the Brain.

[The delicate nature of the cerebral tissue naturally predisposes it to laceration; and in fatal cases of injury to the skull it is common to find the brain broken up in various parts. This occurs frequently without fracture, although it is more common in extensive fractures. Laceration often results from the forcible driving in of spicula of bone, and from foreign bodies, as bullets and other projectiles. The seat of laceration, like that of contusion, varies, and, as has been frequently mentioned in this article, is often at a spot diametrically opposite to that on which the original blow was inflicted. In the post-mortem examinations of fifty-three cases at the London Hospital, the brain was found to have been lacerated in thirty-two near the seat of fracture; in eleven at a point diametrically opposite; and in ten it occurred in both situations. The fact is of the highest practical import in reference to the application of the trephine, especially as laceration is often accompanied by pressure from the blood effused from the divided vessels.

The *symptoms* of laceration of the brain are by no means accurately defined; they are frequently obscured by those of concussion and pressure. It sometimes happens that the ordinary symptoms of concussion are present at first, when suddenly, after a brief interval, furious delirium with convulsions point out to us fatal laceration. When this occurs, it is most probable that the ruptured vessels, which had previously been closed by coagula, have become suddenly opened, and the effusion of blood upon the delicate neurine gives rise to symptoms of laceration: in some cases this happens after a long period of comparative repose, and probably depends on inflammation of the brain.

Laceration is ordinarily indicated by the following symptoms: epileptiform convulsions to a greater or less extent, loss of consciousness and furious delirium, stertorous breathing, great acceleration of the pulse, insensibility of the pupils, which are sometimes widely dilated, sometimes contracted, and occasionally discordant; the skin, at first cold, soon becomes warm; paralysis often succeeds the convulsions; there is retention, sometimes incontinence, of urine, and involuntary discharge of fæces; these are succeeded by profound coma, or the patient dies in a violent paroxysm of convulsions. We have known the symptoms assume a distinctly remittent character, of which the following case affords an illustration: it appears inexplicable. A man thirty-five years of age, whilst unloading a waggon of coals, fell from a height of about two feet, with a sack of coals upon his back. He was found to be quite insensible. He was immediately brought to the London Hospital; on his way thither he vomited several times. About an hour after the accident he was in a state of partial collapse, with cold skin, &c., and seemed disposed to sleep; but when roused his answers were rational, his pupils acting, though tardily. In this state he continued till the afternoon, when his pulse had become more natural and his body quite warm. He had had leeches applied to the head, and a purgative was administered. He was suddenly seized with a fit presenting all the characters of epilepsy; he became totally insensible; the convulsions were violent, his pupils were contracted, and his breathing was loud and stertorous. The violence of the fit, which was twice repeated during the night, rendered it necessary to confine him in the bed. Between the fits he was quite sensible when roused, but immediately relapsed into the same sleepy state. In the morning, his bowels not having acted, two drops of croton oil were given, immediately after which he vomited; some cathartic mixture was given, which operated violently. During the whole of the following day he remained in a stupefied state, but was conscious when spoken to; his pulse was eighty, weak, and irritable. In the evening he was attacked with a violently convulsive fit; throughout the night he slept well, and was quiet, and his bowels were moved several times. On the morning of the third day he appeared weaker; his drowsiness had increased, his pulse was labouring and only fifty-four in the minute, his head was hot, but his extremities were cold. Soon after this the nurse of the ward thought he was dying; his muscles were in a state of great rigidity, his pupils became immovable and his breathing loud and stertorous, pulse almost imperceptible: this condition lasted for a quarter of an hour, when his body was covered with a profuse sweat, and he said he felt better. He was ordered a blister to the back of the neck, and sinapisms to the calves of his legs; and mercury was administered. In the evening he had another fit of an epileptic character, and afterwards relapsed into the same unconscious state. Once or twice during the night he got up in bed and sang a song correctly through, when he again lay down and slept soundly. On the fourth day he was considerably worse; pulse labouring, his answers incoherent; he rose in the bed several times, sang a song, and lay down as quietly as before. He had no fit during the day; he became quite insensible at night. On the fifth day he continued much in the same state, quite insensible, his pupils acting tardily; during the night he talked incoherently, and on the morning of the sixth day he had a slight convulsive fit and died.

On examination after death a fracture was found at the lower part of the right parietal bone. There was a small quantity of blood effused over the whole surface of the brain, which appeared bruised. The left lateral ventricle contained a large coagulum of blood, which was evidently effused from the rupture of a large vessel in the anterior lobe of the brain; this was extensively lacerated, and the walls of the ventricle were here broken into.

The obscurity of the symptoms of laceration is exemplified in the following case:—A middle-aged man was brought into the London Hospital in consequence of a blow over the left temple from the fall of a heavy weight. He was stunned by the blow, and was in a state of insensibility on admission; in this state he continued to his death, which occurred six days after admission. There was an appearance of contusion in the left temporal region, with slight ecchymosis of both eyelids. He was quite senseless, but not paralytic in either extremity. His pulse was slow, the irides immovable; grinding of the teeth and slight jactitation were present; there was no stertor; when pressure was made over the temporal region, he evinced the faintest signs of sensibility. His urine and fæces passed involuntarily. It became a question as to the propriety of applying the trephine; but, in the absence of hemiplegia, the case was regarded as one of concussion with laceration rather than of compression. The operation was therefore not performed. On examination after death, no hæmorrhage was found above or beneath the dura mater. The surface of the cerebrum was generally contused. The corpus callosum, septum lucidum, and fornix were completely broken up.

By active treatment, especially by the free abstraction of blood, the symptoms are often mitigated, but as, in the generality of cases, no permanent relief can be afforded, the symptoms increase in intensity until death closes the scene; this more generally occurs very soon after the accident, or life may be prolonged for four or five days.

The most fatal forms of laceration are those occurring at the base of the brain, or from the introduction of blunt-pointed instruments through the cranial bones, and where no exit is afforded for the escape of the broken-up brain; nevertheless, fractures of the base, accompanied by the discharge of cerebral matter through the ear, occasionally recover, and in lacerations of the surface of the brain, if the bone is extensively comminuted, and if the damaged brain can be readily squeezed through the opening, recovery may occur. In such cases, therefore, it is most desirable to remove any comminuted or angular portions of the bone, so that, as the blood is poured into the cerebral substance, or as it becomes swollen from inflammation, it may readily escape through the opening, and pressure may thus be obviated.

In thus presenting the symptoms of laceration of the brain, we cannot but admit that they are not individually to be received as characteristic; and the sign most to be depended upon, namely, convulsions, frequently exists in simple concussion, and is often absent when the brain is lacerated. Mr. Banner, in a paper published in the *Provincial Medical and Surgical Transactions*, 1841, has detailed seven cases of lacerated brain, in five of which convulsions were present, and in two nothing of the sort was remarked, and in these latter cases death took place soon after their admission; from which the conclusion is reasonable, that an absolute and entire paralysis of the white or conducting fibres of the cerebral tissue took place, so that the irritating effects of the laceration could not be propagated to the motor nerves. In some cases, certainly of rare occurrence, symptoms are at first absent altogether, but they speedily set in.

Mr. W. Sharp, of Bradford, in a work published some years ago, has given a remarkable instance of this in a man "who was driving a heavily laden cart: he was knocked down, and apparently the wheel of his own cart passed over his head, producing an extensive compound fracture over the left eye. When seen a few hours after the accident, several portions of brain were lying on his cheek, and others were matted with his hair. Yet this poor man had got up by himself, had driven his cart, when almost dark, nearly a quarter of a mile to its station, had emptied it of its materials, and had taken others into it instead; he had afterwards driven it home some hundred yards to his own house, and had gone into his house for the key of the stable, before he became sick. He was then helped into bed, and remained there till I saw him. Before I saw him, he had one or two violent convulsions, and became extremely restless. The injury done to the brain was frightful. I removed the splintered bones, and placed a little dry lint over the wound, and he became much more tranquil. The next day I was not without hope of his recovery, but the day following the convulsions returned, and he shortly afterwards expired."

The *prognosis* is necessarily unfavourable, especially if the mischief is at the base of the brain, and if the cerebellum is lacerated. Morgagni alludes to two instances only on record of recovery after violent wounds of the cerebellum. Guthrie says: "The result of my experience is that brain is more rarely lost with impunity from the fore part of the head than from the middle part; and that a fracture of the skull, with even the lodgment of a foreign body and a portion of the bone in the brain, may be sometimes borne without any great inconvenience in the back part." (Op. cit.) But even in the worst cases we ought not to despair of a favourable issue, provided a free exit can be given to the damaged brain.

The general *treatment* of lacerations of the brain must be strictly anti-inflammatory until suppuration is established or hernia cerebri occurs, when due constitutional support should be given. But the local treatment is a matter of the highest importance to attend to. All comminuted bone must be sedulously removed, and the trephine or Hey's saw must be employed to remove spicula and angular projections of bone, which are likely to impede the exit of the broken-up brain or become the occasion of irritation. All foreign bodies should be carefully removed, if this can be accomplished without violence or the risk of increasing the injury by pushing them further into the brain. More especially this should be at once, and at all hazard accomplished, if convulsions or other cerebral disturbance arise.

To show the importance of the removal of foreign bodies from the brain as speedily as possible, the following case is quoted from the *Edinburgh Medical and Surgical Journal*:—"A farmer was wounded in the head by the breech-pin of his gun, which was blown out in the discharge of his piece. It was driven through his hat, and, piercing the os frontis, entered the brain about an inch and a half above the edge of the orbit, carrying before it a circular piece of the hat and several splintered pieces of bone. He was knocked down and stunned by the blow, but he soon recovered sufficiently to walk, with little assistance, to the nearest residence. He was afterwards conveyed home a distance of two miles. When first seen by the surgeon, the breech-pin had been withdrawn from the skull by the removal of the hat; and as there appeared to be no bleeding, a piece of sticking-plaster was laid over the wound to exclude the air. In ten minutes he was seized with a distinctly marked fit of epilepsy, which ceased immediately on the removal of the plaster, under which a little oozing of blood had taken place, the slight pressure of which had disturbed the functions of the brain. The fractured pieces of the bone were removed, and at the depth of about an inch in the brain a hard substance was felt at the end of the probe, which on extraction proved to be a circular piece of hat, of the shape and size of the breech-pin. Several angular pieces of bone were then carefully removed, together with pieces of brain into which they were imbedded. Under the use of repeated bleedings, with other antiphlogistic treatment, he recovered; but had afterwards two or three epileptic attacks, to which he had not before been subject."

It appears very extraordinary that there should be any difference of opinion as to the propriety of an immediate removal of pieces of bone and foreign bodies from the brain. It is a subject, however, with regard to which it is useless to enter into any lengthened controversy; it will be sufficient to quote the opinions of two surgeons of somewhat opposite notions on this important subject, leaving the reader to draw his own inference on the arguments advanced. Mr. Colles, a surgeon of unquestionably high authority, says: "In very small depressed fractures, such as may deserve the name of punctures of the bone, where a depressed bit of bone is sunk into the brain, it will perhaps be prudent to postpone the operation for a few days; for if the operation be performed immediately on the receipt of injury, and if we attempt to seize the depressed fragment, the first touch of the forceps sinks it more deeply into the brain. Portions of the brain, from the softness of its texture, rise up and conceal the bone both from our sight and touch; whereas, if we defer the operation for a few days, we give time for the adhesive inflammation to take place. This circumscribes the depressed piece, hardens this spot of the brain, and thus enables us more easily and certainly to lay hold of the fragment of bone." Mr. Guthrie says on this point: "It is necessary to recollect that the brain appears to be insensible, or nearly so, when first exposed; and it has rarely occurred to me to see a serious convulsion, or anything beyond vomiting, take place on the removal of a piece of bone from the brain; nor do I suspect any difficulty will be found in removing such small fragments as can be seen, with a pair of forceps duly adapted for the purpose. It is impossible to say at what period the brain becomes irritable, and no longer admits of being touched without convulsive movements ensuing. But whenever this state of irritation has commenced, and its existence is proclaimed by the excitement which takes place on touching the fragment of bone, the surgeon should at once desist from all attempts to remove the foreign body. The brain, under ordinary circumstances, is, I conceive, much more likely to recover from an injury, all foreign or irritating matters being removed, than when also suffering from their presence. Should I be mistaken upon this point, the opinion generally entertained of the propriety of removing extraneous bodies from wounds generally must, I imagine, be erroneous."

All that is requisite, after the removal of foreign bodies, &c., is to apply the lightest dressing, as a small piece of moistened lint, to the surface, and carefully to abstain from inducing pressure by a too accurate adjustment of the wounded scalp by adhesive plaster and bandages, a practice which is certain to be followed by convulsions, &c. Abscesses will occasionally form in the cerebral tissue, and these are usually preceded by shivering and other signs of suppuration, and are accompanied by epileptiform convulsions, which cease on the discharge of the matter. As a matter of curiosity it may be observed that in two instances of extensively lacerated brain we have been under the necessity of applying a ligature to arrest active hæmorrhage from a wounded artery.

The variety of cases mentioned by the older writers in surgery, and referred to by Quesnay and others, as also those which are described by modern authorities in military and naval service, whilst they all tend to demonstrate the complete curability of extensive lacerations of the brain, may be passed over without comment, as the principles they elucidate are now sufficiently well understood, and as it is quite clear that the brain, itself the seat of all sensibility, is capable of supporting injury and recovering from the effects of mischief which, in some other organs, would of necessity compromise life. Whether, after losses of cerebral tissue, the functions of the organ, as evinced in the higher intellectual faculties, as judgment, memory, &c., are ever completely restored to their pristine state of perfection, is a problem hitherto not completely solved; and its solution will probably never be attained. Haller mentions many cases which had come under his own observation, and instances on the authority of others, where patients had retained complete possession of their intellectual faculties after the loss of a large quantity of brain. (*Elementa Physiologiæ*.)]

HERNIA, OR FUNGUS CEREBRI.

[When the natural support of the brain is lost by the removal of bone by the trephine, or as a result of extensive comminution, an organised growth frequently protrudes through the opening from the substance of the brain. The same also happens occasionally when the bone is destroyed by caries. The disease is termed hernia or fungus cerebri.

The term *hernia cerebri* has been employed synonymously with encephalocele, as expressive of the protrusion of a portion of the brain and its membranes through an opening in the cranium from some imperfection in the cranial walls. To remove all ambiguity on this point, it would be better to discard the term *hernia* altogether, and to employ the expression *fungus cerebri* to designate the condition now under consideration. By this we understand a growth arising from the brain, and intimately connected with this organ, consequent on a loss, by accident or disease, of the natural support which the brain derives from its membranes and the bone. Mr. Stanley has written an able article on this subject in the 8th vol. of the *Med. Chir. Transactions*, which will be referred to in the following description.

The disease commonly makes its appearance in the following manner:—In a few days after the removal of a portion of the skull, the dura mater, if entire, is observed to be forced up in a gradual manner through the opening, until it rises above the surface of the bone. It now becomes remarkably tense, and puts on a dark bluish aspect as if its blood-vessels were much congested; dark spots here and there make their appearance, indicative of partial gangrene like that resulting from strangulation. In Van Swieten's commentaries this state of the dura mater is correctly explained as the consequence "of the urging of the membrane against the edge of the hard bone; the free course of the blood through its vessels is thereby impeded, whence inflammation and all its consequences may follow, especially a suppuration and gangrene." The gangrenous spots of the dura mater subsequently give way, and small portions of brain gradually ooze through the openings; these continue to enlarge, and a protruded mass of cerebral substance fills up the opening in the bone. If the dura mater has been lacerated the tension of the membrane is taken off at the commencement of the disease, and the fungus makes its appearance much more quickly; but, having reached the level of the outer part of the skull, it advances in a similar manner as in the former case. The tumor is at first covered with the pia mater unless the brain is lacerated, but as the disease advances this gradually gives way, and the fungus extends itself in various directions. Sometimes it presents an oval shape; in others, like a mushroom, it encroaches to a great extent upon the surface of the skull, especially if pressure is employed to restrain it. Its extent is almost unlimited. Mr. Stanley mentions a case occurring in the Lock Hospital, in which the tumor reached six and a half inches in one direction and five and a half in another, and its greatest elevation reached two inches above the opening in the frontal bone. When the fungus first appears it is brainlike in its character, but it is frequently found mixed with clots of blood. Sometimes its surface is covered with a layer of coagulated blood. If handled much it bleeds freely, but if left untouched it rarely bleeds. The character of the tumor changes as the disease advances, and if a section of it be made it is found to have lost its original brainlike appearance, or but very slight traces of cerebral matter are observed in it. If the finger is carefully carried round the root of the tumor, it is felt begirt by the dura mater and the edge of the opening in the bone, which is frequently found quite dead. Sloughs not uncommonly are seen upon the surface of the tumor, and it discharges a fluid of a remarkably fœtid odour. It is impossible to say to what extent the disease may proceed; the only limit to its extension appears to be its tendency to slough, as if its vessels were unable to maintain its vitality beyond a certain point. Pressure, when firmly applied, occasions a sloughing of the mass, and when the sloughs have separated healthy florid granulations shoot up and supply their place. In a case quoted from the *Medical Commentaries* by Mr. Stanley, the protruded mass gradually dropped off in large pieces, and the patient eventually got well, the only application being dressings of dry lint. At the beginning of the disease, when the mass just fills up the opening of the skull, or is raised a little above it, pulsation is perceptible, and the tumor is raised when forcible expiration is performed, as in the act of coughing; but this ceases after the tumor has advanced over the surface of the cranium. During the progress of the disease a large quantity of discharge is poured out from the tumor, sometimes serous and fœtid, at others distinctly purulent, and frequently after an attack of coma a free discharge of fluid occurs by which the symptoms are relieved. The progress of the tumor, if not restrained, continues uninterruptedly until sloughing occurs, or the patient is exhausted by irritation or by the discharge, or dies comatose. If, on the contrary, the case proceeds spontaneously to a favourable termination, sloughs form upon the surface of the tumor and gradually drop off, giving place to healthy granulations, which coalesce with those of the scalp, and complete cicatrisation takes place; or, if the tumor is sliced off and pressure applied, it ceases to be reproduced, and the surface assumes a healthy granulating aspect and cicatrises, or the tumor gradually recedes into the skull. The disease makes its appearance within ten or fourteen days after the accident which led to the removal of the bone. From the commencement and during the progress of hernia cerebri, an irregular train of symptoms of general indisposition together with great cerebral disturbance occurs. From an apparently convalescent state after the removal of a piece of bone, irritative fever comes on, succeeded occasionally by stupor, a tendency to coma, and hemiplegia, with low muttering delirium. But, prior to the appearance of any protrusion, great general constitutional irritation is often observed, and, the instant the dura mater gives way, a remarkable amelioration, or even a complete cessation, takes place.

An illustration of this fact is given by Mr. Stanley, which we shall briefly relate. "A boy, ten years old, received a kick from a horse on the left side of the head, which produced a fracture of the skull, the bone being bare and depressed fully the thickness of the skull itself. Symptoms of pressure existed, and an irregular triangular piece of bone was removed with the trephine. The dura mater was covered with a coagulum extending considerably beyond the area of the fracture. The wound was dressed with adhesive plaster, and in the evening his pulse was more regular, but the other symptoms were not relieved. Next day he was restless and impatient, instantly falling into a comatose state, and as suddenly starting out of it; his respiration and pulse were a little relieved, but still irregular. On the fourth day there appeared paralysis of the right side of the face. The wound was daily dressed, his bowels were relieved by clysters, but he continued in the same stupid state till the eighth day from the operation. He could not be roused by his attendants, but on any loud noise would screech wildly and attempt to jump out of bed, falling again suddenly into stupor and muttering delirium. On the eighth day he passed his urine involuntarily. In the evening he was much better, having slept quietly for some hours; he had asked for bread and eaten it freely, talked about circumstances which had occurred previously to the accident, had had a copious motion, and was perfectly quiet and easy. His pulse became fuller, slower, and more quiet; his skin improved, his features were more full, but the paralytic condition, though less perceptible, still remained. The next morning the dura mater was observed ruptured and turned back by the protruding brain, which was about the size of the end of a hen's egg. It was of natural colour and perfectly healthy. He was now quite sensible; the pulse was soft, full, and regular; in fact, he was now in a very satisfactory condition. He eventually got perfectly well."

With the advance of the tumor and the increase of the discharge the constitutional symptoms increase, and hectic fever with profuse perspirations gradually reduce the powers of the patient; the delirium continues, and he dies exhausted. Such is the result of cases of fungus cerebri in general; in some, however, during its progress a sudden discharge of serum or pus is attended with an improvement in the condition of the patient whilst in other cases the duration of the disease is protracted for an indefinite period, and the patient may even be cut off by some other affection; but this is by no means common. Inflammation with suppuration in the general arachnoid cavity, extending over both hemispheres or limited to one side, is sometimes the immediate cause of death. A total absence of any general symptoms is occasionally remarked, notwithstanding the rapid advance of the fungus, until some topical application is made to arrest its growth, when hemiplegia and stupor give evidence that the brain is influenced by the pressure, and if this be remitted the functions of the organ are restored. In such cases the organic functions proceed with tolerable regularity, the appetite continues good, and the bowels regular, and the intellect is unimpaired.

Morbid Anatomy.—The extreme rapidity of growth in hernia cerebri at once suggests to us the idea of its high organisation; and its abundant vascular supply is apparent from the quickness with which it is reproduced after excision, and in the almost absolute impossibility to restrain it by the application of pressure or by escharotics. All this is easily explained from its connection with the encephalon, one of the most highly organised tissues in the body.

It is usually believed that the fungoid growth is true cerebral matter; at least this may be fairly inferred from the writings of Lawrence, Hennen, Roux, Stanley, &c., and that the mass, at the commencement, consists of either cineritious or medullary matter, or a mixture of both, as in some cases the distinctive characters of these two substances can be recognised when careful examination is made of a recent section of the tumor. The first protrusions are said to be made up of true cerebral matter, mixed frequently with clots of blood; but when the growth has continued for any time the mass appears to have undergone considerable solidification, and to have become converted into a product approximating in character to fungus in any other part, containing, however, traces of a substance like brain interspersed with a fibro-cellular tissue; its supply of blood is entirely derived from the blood-vessels of the brain.

To ascertain the true nature and source of the disease, the examination ought to be extended below the depth of the tumor and its apparent origin, and in many instances there will be found at the root of the tumor clots of effused blood, or an abscess, or a large quantity of serum in the corresponding lateral ventricle; in other cases softening of the subjacent brain will be discovered. Blood-vessels can generally be distinctly seen passing into the tumor along the peduncle which traverses the opening in the bone. In one case detailed by Mr. Mallett (*Transactions of Prov. Med. and Surg. Assoc.*, 1839) a serous cyst lined by a delicate glistening membrane was found in the centre of the tumor.

Dr. Thompson, in reference to the morbid anatomy of fungus cerebri, says: "I am inclined to believe that they are the consequence of a contusion of the substance of the brain and its membranes, which gives rise to the formation of a new organised substance differing in its texture from brain, and are not, as some late writers would endeavour to persuade us, simple protrusions of the brain resulting from the removal of the natural resistance which is made to them by the dura mater and cranium."

We have recently witnessed the development of a cyst containing two or three drachms of serum and a small quantity of pus in a case of fungus cerebri which had completely cicatrised. Some symptoms of constitutional irritation preceded a remarkable enlargement of the tumor, which became excessively tense. It was necessary to puncture the tumor, which presented evident fluctuation, and the patient was relieved for the time, but he eventually died.

In other cases the mass will be found made up almost entirely of coagulated blood effused from the substance of the brain beneath the pia mater, which, in a case related by Abernethy, attained the size of a hen's egg, and came evidently from the brain an inch beneath its surface, and when cut into resembled a clot of blood.

Pathology.—The disease cannot occur without the destruction or loss of a portion of the natural support of the brain; and hence this has been considered as the most common cause of the disease. But the inference is not necessarily just, for if such were the case, the protrusion, as Mr. Stanley remarks, ought invariably to follow an opening in the skull; but this is by no means the case. It is, however, somewhat remarkable that the disease did generally happen in cases where the trephine had been applied at St. Bartholomew's Hospital. But it must be remembered that in most of these cases the brain has suffered an amount of injury causing symptoms of pressure, and thus demanding the removal of the bone.

Without denying that the simple removal of the bone is the occasional cause of fungus cerebri, we nevertheless do not consider it as resulting solely from want of due support. We should rather attribute it, when arising without any mischief to the brain itself, to the irritation, first to the dura mater, and afterwards to the brain, from the constant impulsion of these highly organised structures against the sharp edge of the bone. The older surgeons were alive to this source of irritation, and directed that after the use of the trephine the edge of the inner table of the skull should be rounded off.

Velpeau has fully entered into the consideration of this point in his able memoir *Sur l'Opération du Trépan*, and judiciously remarks that the disease is due to the expansion and swelling of the brain under states of excitement. He says that it occurs less frequently when the trephine has been applied over a coagulum, as then the expansibility of the organ has been injured by the pressure. He considers the probability of the occurrence of this disease after trephining to be in the inverse ratio of the dimensions of the aperture in the skull, and that the brain is much more likely to remain *in situ* where the opening of the cranium is extensive, than where a single perforation has been made. He draws from this an important practical deduction, to which we shall revert in speaking of the treatment of the disease. Flourens, in his memoir on the trephine, remarks that hernia cerebri frequently succeeds the removal of bone, and that the largest protrusions take place when the brain itself is wounded, and that, if the dura mater be uninjured, the protrusion is of much less extent. This is amply corroborated by every day's experience. He attributes the disease to the expansion of the brain from the impulsion of the arteries at the base, the natural limit to its expansion being lost by the removal of the bone.

Mr. Abernethy explains the origin of herniæ cerebri thus: "Their formation seems to proceed from an injury done to a part of the brain by concussion or contusion, which has terminated in a diseased state of the vessels similar to what occurs in apoplexy. The morbid state increasing, one or more vessels give way, and an effusion of blood into the substance of the brain ensues, which, if the skull were entire, would probably occasion apoplexy, but, where there is a deficiency of bone that allows it to expand, presses the surface of the brain and its membranes through the vacant space." And Mr. Stanley says with great justice, "There must be an increase in the volume of the contained parts, produced either by a general distension of the blood-vessels of the brain, or by the addition of some new matter, as water or pus." It is, however, evident from numerous well-authenticated cases, that the disease does not depend merely on an over-distended state of the cerebral blood-vessels, such as occurs in inflammation, for it makes its appearance generally after the subsidence of the inflammatory symptoms, and frequently when everything is apparently progressing favourably. The mode of formation described by Abernethy is well illustrated in those cases in which effused blood makes up the greater part of the tumor, which presents externally an appearance that a coagulum would do; but it will not apply to very many cases, which obviously depend on one of three causes, namely, a diseased condition of the brain itself, or the formation of abscess at the base of the tumor, by which the cranial contents are increased, or some special cause of irritation, as a foreign body lodged in the substance of the brain. In these latter cases the tumor is brainlike at the beginning, but speedily assumes the appearance of simple fungus. By overstretching, the pia mater and arachnoid gradually yield, the tendency of the tumor being of course in that direction where there is least resistance; and masses of cineritious and medullary neurine, still maintaining their vitality and connection with the parts beneath, gradually ooze out until the tumor attains a considerable size. If the parietes of the skull were not deficient, the patient must necessarily succumb to the pressure arising from the effusion.

That foreign bodies in the brain, as in other highly organised parts, may become the immediate cause of the disease in question, can admit of no dispute; indeed, I am inclined to class under this head effusions of blood into the cerebral tissue, and to explain the formation of hernia cerebri, when arising from this cause, as resulting as much from the irritation of the clot, as from the mechanical distension of the brain. Are we not justified also in arranging abscesses at the base of the tumor under the class of irritants of the brain?

From the perusal of a few cases, a brief abstract of which is subjoined, it will be seen that the source of the disease existed in the greater number beneath the root of the fungus, and that an altered state of the brain from suppuration or some other lesion, in many, must have preceded its formation, whilst in others we cannot fail to recognise a coagulum as its special cause; and, lastly, the existence of foreign bodies in the substance of the brain, or near its surface, may without hesitation be pronounced the most remediable cause of the affection, as on their removal the tendency to fungate has immediately ceased. In the examination after death of the first case mentioned by Mr. Stanley, it is said, "The exposed surface of the brain from which the portion had been cut off, exhibited a softened and broken-down texture, a state of disorganisation which extended deep into its substance. Several small effusions of blood were met with both between the membranes and in the substance of the brain."

In the second fatal case, it is remarked, "The greater part of the substance of the brain was much changed from its healthy condition, and especially in the right hemisphere (*that is, on the side corresponding to the fungus*). All the medullary structure intervening between the base of the protruded part and the anterior cornu of the right lateral ventricle had entirely lost its natural structure, and had become soft and pulpy, so as to convey the idea of rottenness." And in the dissection of the case quoted by the same author from Mr. Pearson, surgeon to the Lock Hospital, and which happened after the exfoliation of bone from caries consequent upon syphilis, it is said, "The tumor was evidently continuous with the anterior lobe of the right hemisphere of the brain. An abscess was found in the anterior lobe of the right hemisphere, containing between two and three ounces of pus. The cavity extended from the anterior part of the corpus striatum to the base of the tumor. On dividing the diseased mass, it exhibited no distinct organisation, but was a pulpy substance of a grey colour, connected by shreds of the pia mater." In this case symptoms of pressure preceded the appearance of hernia cerebri. In a dissection by Hennen, it is observed, "that the right hemisphere of the cerebrum was reduced to a sort of bloody pulp, rendering it impossible to trace its organisation."

In a case mentioned by Abernethy, "the hernia cerebri was evidently formed of congealed blood, deposited in the medullary part of the cerebrum; the containing cavity being about an inch in diameter, and its parietes appearing to be the substance of the brain condensed by pressure. The ventricles were full of bloody serum." Mr. Hill (see *Cases in Surgery*, p. 89) details a very interesting illustration of hernia cerebri as the result of abscess; the case eventually recovered, but Hill says, "To prevent a repetition of bad symptoms, I was obliged to shave away the tumor, and to push a lancet into its root, as often as the stupor and other symptoms showed that matter was lodged there, by which he was uniformly relieved." A similar instance is recorded by Scultetus (*Armament. Chirurg.* obs. 19).

In the *London Medical Journal*, vol. x. p. 277, two cases are mentioned in which repeated attempts were made to prevent the growth of the tumor by pressure: one died at the end of a month, and the other after six months. "In both there was found a large cavity, which had been formed by the accumulation of a fluid that could not escape on account of the aperture being closed up by the fungus."

In the *London Medical and Surgical Journal* for 1831 a case is related by Dr. Tuthill of a man who had hernia cerebri succeeding a depressed compound fracture of the left parietal bone. The trephine was applied, and splinters of bone were removed from the brain. After a violent attack of inflammation, hernia cerebri made its appearance. It was excised by ligature, but it was reproduced; five or six ounces of brain were removed without any derangement to its functions. The man continued able to raise himself up and to feed himself, portions of brain being removed daily. Compression of the tumor was employed, which immediately produced paralysis of the opposite side of the body: this continued until the pressure was remitted. He became afterwards violently convulsed, the pupils were discordant, and he died about three weeks from the attack. On opening the skull the brain on the injured side was softened and infiltrated with pus; and an enormous abscess was found occupying the whole middle lobe, communicating with the ventricle, which was filled with pus.

In the *Transactions of a Society for Improving Medical and Surgical Knowledge*, 1807, p. 94, Sir E. Home relates two cases of fungus cerebri accompanied by abscess. In cases which have come under our own notice we have frequently remarked large abscesses at the root of the tumor; and in patients dying at the first commencement of the fungus we have often found small abscesses at its root, or have seen abscesses opened in slicing off the fungus. Hill also, in his work, p. 135, records a case in which "a part of the brain was dissolved into pus about two inches round."

Mr. Syme, of Edinburgh, has published a case of hernia cerebri occurring after a gunshot wound. The trephine was applied an inch and a half above and behind the right ear in consequence of depressed bone. On the eighth day a "soft round swelling as large as a nutmeg presented itself at the opening of the skull; a bandage and compress were applied to prevent its increase. On the 9th another protrusion presented itself at the side of that just mentioned." A portion weighing 110 grains was sliced off. The patient died on the seventeenth day after the accident. "The head was examined after death, when the dura mater, at the seat of injury, was seen perforated, sloughy and discoloured; at the *same part an abscess as large as a walnut existed in the substance of the brain*, which was otherwise healthy." (*Med. Chir. Review*, April 1841.)

But to show that the disease occasionally results from the irritation of dead bone as well as from foreign bodies, I shall briefly advert to a few instances published by Mr. Mallet in the *Transactions of the Prov. Med. and Surg. Association*, 1839. In the first case the hernia disappeared after various small portions of the inner table of the bone had exfoliated. In another instance, after an injury to the brain from the falling of a lump of coal upon the head, "in eight days a slight elevation or growth from the brain appeared, which continued about a week, *when a small piece of coal was discharged about the size of a pea.* The rising then gradually disappeared by the sole application of lint wetted with very dilute nitric acid."

In the next case, after fracture of the os frontis, and the removal of the broken and loose portions, "in about a week hernia cerebri made its appearance, which, in spite of pressure and various local applications, gradually increased till it had gained the size of a large duck's egg. It then remained stationary for about a fortnight, when I determined to remove it with the knife. The operation was performed in a few seconds, and apparently without the patient being sensible of pain. The wound was then accurately examined, and *I found a spiculum of bone projecting from the inner table of the skull.* It was removed, and the wound was completely cicatrised in about six weeks."

In the last case mentioned, "when the knife was about half way through the tumor, something presented a slight resistance to its progress, which afterwards proved to be a loose portion of bone."

Mr. Mallet says, "It will be seen that four of the five cases just mentioned were affected with hernia cerebri, and that in each of these four cases a foreign body was found acting as a constant source of irritation; and knowing how generally the occurrence of irritating bodies found in other parts is followed by fungous growths, partaking more or less of the nature of the part from which they proceed, I think it extremely probable that without some irritating cause we should not have hernia cerebri."

In the *Memoirs of the Academy of Surgery* (see selections from, published by the Sydenham Society) Louis relates the case of a man who suffered from fungus cerebri after a laceration of the brain by the splinter of a shell. The surgeon removed the fungus and with care extracted all the splinters of bone. In this case the cure was protracted until the thirteenth month after the accident. See also a case by Guthrie. (Op. cit. p. 142, note.)

We could multiply cases of this description to show that the cause of the fungus must be sought for below the surface whence the tumor appears to spring, and that the removal of the bony support must be regarded rather as a necessary condition than as a cause of the disease, as no protrusion can occur while the bone remains entire. It is illogical to consider the removal of the bone an exciting cause, except in those cases in which the fungus can be traced to the irritation of dead bone at the circumference of the opening through which the tumor protrudes. Drs. Lawrie and King, of Glasgow, have published in the *Edinburgh and London Journal* for 1844 a great number of cases in many of which large abscesses were found near the root of the tumor, and they make the following remarks on the cases in reference to the cause of such protrusions: "It has been objected that there must be in such cases some other power in operation besides the cause of protrusion above given; otherwise the brain would have expanded itself laterally, and filled the vacant space before it protruded externally. To us there appears to be no such necessity, seeing that all protrusions have a tendency to project towards a point rather than to spread themselves indefinitely laterally."

In respect to the situation of these protrusions the same surgeons observe: "The cases before us would lead us to believe that the part of the head injured has some influence in favouring the cerebral protrusion. Of fourteen cases, the injury in seven was situated partly or entirely over the frontal bone, in six over the parietals, and in one over the temporal; from which facts we might be led to infer that hernia cerebri much more frequently follows injuries and operations on the superior and anterior part of the head, than on the lateral and posterior regions. It must, however, be recollected that injuries requiring operation occur more frequently over the former than the latter regions: thus, of the forty cases operated on, and in which no cerebral protrusion took place, the injury was wholly or partly over the parietal bone in twenty-four cases, over the frontal in thirteen, over the occipital in five, and over the temporal in one. Sir Philip Crampton has recorded a case in the *Dublin Medical Journal* where the protrusion took place through the occipital bone, and Dr. Thomson in his reports mentions another."

Of the fatality attending the disease the Glasgow surgeons remark, "that of fourteen cases twelve died and two recovered. Of three cases detailed by Mr. Stanley, two died and one recovered. Mr. Hill relates three cases, all of which recovered; Mr. Mallet four, which were also successful." In regard to age they say, "There is some ground for the belief that hernia cerebri occurs more frequently in children and in young persons than in patients more advanced in life. Of the thirteen cases, ten were below 30 (8 the youngest, and 27 the eldest), three were 40 or above it (40 the youngest and 46 the eldest). Mr. Stanley's cases were of the respective ages of 11, 12, and 13. Mr. Hill's were 6, 11, and a young woman whose age is not given. Sir Philip Crampton's patient was 23. Will the greater activity of the cerebral circulation in early life account for this?"

Diagnosis.—The history of the disease when it is the result of accident, and the fact that it can only occur when the natural support of the brain is lost, will readily distinguish it from those comparatively rare carcinomatous affections originating in the cranial bones or the membranes of the brain. And where the hernia is the result of the irritation of a portion of diseased bone upon the dura mater, as in the case quoted from Mr. Pearson, and succeeds the removal of the bone, it will require but little observation to form a correct diagnosis between it and the *fungous tumor of the dura mater*, which, as it advances in growth, always gives rise to destruction of the bones of the skull. Before hernia cerebri has made its appearance under the circumstances just mentioned, the dura mater, on the removal of the carious bone, will be found either healthy or merely altered in colour, and pushed up into the aperture of the skull, and its subsequent sloughing to give way to the protrusion of the fungating brain will at once lead to the idea that the disease is in the brain itself, and has not commenced in the dura mater. In the fungoid disease of the dura mater the thinning of the bone takes place from below, and long before the giving way of the scalp the bone becomes gradually shelled by the pressure, and the scalp is pushed up; and crepitation, like that which the crumpling of parchment gives, is usually experienced. In caries, on the contrary, suppuration at an early period takes place beneath the scalp, and if a probe be passed down to the bone it is found dead. Should the bone be removed, the state of the membrane beneath indicates its freedom from fungoid disease. In the absence of any history of the disease, the nature of the fungating mass, as shown by the microscope, will afford a tolerably fair criterion of its origin. In hernia cerebri the mixture of true cineritious and medullary matter is commonly at first recognised. In fungoid disease of the dura mater the mass is more fleshlike, although in appearance cerebriform and lobulated; but no distinction of the two substances can be recognised. In the latter, bleeding is a very common concomitant; in the former, although now and then occurring, yet it is not common, unless the tumor be handled. The blood in hernia cerebri coagulates and forms a crust upon the surface, and is of a venous character. In fungoid disease of the dura mater it is discharged apparently from minute capillary vessels. In the former sloughy masses occasionally drop off, giving place to healthy fleshy granulations; in the latter the disease advances without sloughing. Hernia cerebri, if the cause be removed, as after the removal of a foreign body, undergoes spontaneous cure, whilst the fungoid disease of the dura mater advances to the inevitable destruction of the patient.

The only other disease at all likely to be confounded with the affection now under consideration is carcinoma of the brain itself, provided it makes its way through the parietes of the cranium. The history of the progress of tumors of this description, which is very like that of the same disease of the dura mater, and their character after protrusion, would readily lead to a correct diagnosis. They are exceedingly rare.

Treatment.—If it be true that the protrusion of the brain occurs generally after the subsidence of the inflammation, active antiphlogistic measures are inapplicable with a view to cut short the progress of the disease, when once the hernia has made its transit through the opening in the skull. But as, just prior to its appearance externally, it not unfrequently happens that signs of cerebral irritation, and even of pressure, are present, the surgeon should not withhold the employment of the ordinary means of relief; and, therefore, if the strength of the patient be not exhausted, a free abstraction of blood may be had recourse to, with a brisk purge and the exhibition of mercury, &c. But when the hernia is fairly established, a mildly antiphlogistic treatment only should be adopted, such as the employment of mercurial purges and saline medicines, and the application of cold to the head. This must be followed by such support and stimuli as the exhausting nature of the disease demands. Morphia may be given with advantage.

The results of the dissections we have already briefly given prove that deep-seated or diffused abscess, with a general breaking up of the cerebral tissue to a greater or less extent, is frequently found at the root of the tumor; and with this general destruction of parts recovery must be incompatible. But in cases where the abcess remains circumscribed, a free exit to the discharge by an opening, as in one instance referred to, affords the only fair prospect of relief. But we unfortunately have no characteristic symptoms during life by which such a condition can be positively asserted, unless the signs of pressure be so regarded; otherwise we should be fully justified in adopting the plan of treatment pursued by Mr. Hill, "who," to requote his own words, "after having shaved off the tumor, plunged a lancet into its root, as often as the stupor and other symptoms showed that matter was lodged there, by which he was uniformly relieved." To ascertain the condition of parts beneath the fungus, and especially to detect the existence of a circumscribed abscess, is clearly so important that I think the surgeon would be fully warranted in exploring the root of the fungus by a grooved needle, provided symptoms of pressure, although obscure, and the continued indisposition of the patient were on the increase. We venture to offer this suggestion from deductions drawn from the facts here recorded. The employment of the same means would also be decidedly applicable to those cases in which foreign bodies are suspected.

The local means usually had recourse to for the cure of fungus cerebri consist in the application of pressure to arrest its growth, and the removal by incision of that which has already protruded; or the two means are frequently used, and very judiciously, in combination: the fungus being cut off, pressure is applied to its root to prevent any further growth. Experience fully justifies the employment of these means, and the free removal of the protruding mass affords additional evidence of the fact that the human brain, the centre and seat of sensation, is a part of no high sensibility, and may be handled with impunity as roughly as any viscus in the body.

We shall enter a little into detail in the consideration of the methods of cure just referred to, beginning with the employment of pressure with a view to prevent or check the growth of the tumor. If the opinion be correct that hernia cerebri is not caused by the mere want of support from the removal of bone by the trephine or by exfoliation, and especially if, as we suppose, the cause of the disease exists generally in the brain itself, it follows of necessity that the indiscriminate employment of pressure at the onset, that is, when the diseased mass is just making its appearance through the opening of the skull, is highly injudicious, and ought not to be had recourse to, as it then increases the inconvenience which the escape of the diseased brain is calculated to remove. Witness in proof of this assertion the following quotation from a case mentioned by Mr. Stanley. (Loc. cit. p. 42.) "The wound was dressed as usual with adhesive plaster, the strips being made to cross each other over the protruded portion of brain previously covered by the flaps of scalp. I observed, however, that when the strips were applied so tight as to compress the brain to a certain degree, the boy became restless and stupid until they were removed or had slipped." The perusal of other cases also, in which a similar plan of treatment has been employed, induces us to condemn the use of pressure on the first appearance of the fungus, except under the closest inspection, for two reasons: namely, because the escape of the diseased brain will in itself afford relief, and ought not therefore to be interfered with; and secondly, because it is quite clear from very little observation, that pressure will not prevent the extension of the tumor, and that if the fungus is by force arrested in one direction, it will make its way in another.

It has been advised, and the proposal is worthy of great attention, to afford mechanical support to the brain and dura mater after the removal of bone with the trephine, with the object of preventing hernial protrusions of the brain: therefore, when the scalp has been carefully adjusted, a soft compress should be carefully applied in all cases where no blood is effused upon the surface of the dura mater, and where there is every reason for the belief that the brain is healthy beneath. But pressure is to be deprecated where the dura mate is lacerated, and where the brain is necessarily contused.

Where the hernia cerebri has made considerable progress and has encroached extensively in a mushroom-like form on the cranial parietes, pressure may be used with advantage to an extent sufficient to cause sloughing of the mass; by this a very considerable source of irritation may be got rid of at once. But this must be at once remitted if symptoms of compression or cerebral irritation come on during its employment. The use of pressure should not be altogether condemned, but much reliance should not be placed upon it, independent of general treatment, as a remedy for hernia cerebri; and we certainly should never advocate its use with the intention of restoring the protruded brain to its original position in the skull.

The shaving off of the tumor on a level with the opening of the skull is a bold, rapid, and decisive practice; it has been frequently employed with no inconsiderable success; and if pressure is useful, it can, after the ablation of the tumor with the knife, be used with much greater prospect of benefit. Another advantage gained by the incision through the root of the tumor is the exposure of any foreign body which may exist, as a spiculum of bone, or any other irritant; and moreover it affords a ready opportunity for any explorative puncture which may be deemed from the urgency of the symptoms advisable. Let the surgeon, therefore, freely slice off the whole mass, and then carefully apply pressure with compresses wet with simple water or with any weak astringent, as a solution of alum, or dilute nitric acid. The practice seems hazardous, but experience justifies its employment. But little pain is usually felt on cutting through the tumor, and the flow of blood, which is sometimes considerable, may be generally stopped by pressure. The speedy reappearance of the fungus will often demand a repetition of the operation; and if all the diseased parts of the brain are thus removed, the surgeon will find ultimately a healthy granulating surface supersede the tendency to fungate, and a cure will be effected. The ligature has been used to effect the same object as the knife.

The tendency to spontaneous cure may be sometimes remarked in cases apparently of the most formidable description; for after the growth of the tumor to an almost unlimited extent, its surface begins to separate into large masses, and sloughs are formed by which the whole of the tumor is gradually thrown off, and distinct and healthy fleshy granulations, springing up at the root of the fungus, gradually coalesce with those of the adjacent scalp; when under proper management complete cicatrisation speedily ensues, and the cure is perfected. All that is required during this healthy restorative action, is to give moderate support with strips of wet lint, with the occasional use of solid nitrate of silver. From observing the fact that hernia cerebri occurs more commonly after lacerations of the brain, when a comparatively small opening has been made by the trephine, Velpeau advises that the surgeon should not limit himself to the removal of a single piece of bone, but, to prevent the occurrence of so intractable a disease, should boldly remove the bone to such an extent as to give an opportunity to a more general expansion of the brain at the seat of injury, by which the disposition to fungate would be obviated; and he suggests a similar mode of treatment after the protrusion of the tumor. He says, "Il suit de là que la meilleure manière de prévenir ou de faire disparaître un pareil accident, n'est pas d'exciser l'exubérance cérébrale à mesure qu'elle fait saillie, ni de la comprimer; mais bien de chercher à obtenir une ouverture plus grande que moindre, et de combattre l'irritation ou l'afflux des liquides dans le crâne par tous les moyens possibles."

Flourens also, in his memoir on the trephine (*Archives Générales*, t. xxv.), advises the enlargement of the opening of the cranium, by which he supposes all the symptoms would disappear. And, upon this point, we may refer to the observations of Mr. Abernethy on the treatment of that form of fungus cerebri which arises from effusion of blood into the substance of the brain. After advising that the tumor should be pared off with a knife, he says: "But if the tumor continues to increase, and if the patient suffers a train of bad symptoms, apparently arising from irritation and pressure made on the brain, some further attempt to relieve him seems to be required. Under these circumstances we have reason to suspect that the coagulum, from want of room to protrude, is enlarged internally, or that by plugging up the orifice in the bone it prevents the escape of some fluid collected within the cranium. The obvious mode of relief here appears to be to enlarge the opening in the bone in proportion to the extent and increase of the tumor. Many surgeons have objected to the removal of much of the cranium lest protrusions of this kind should ensue; but it is evident that these tumors arise from an injury and consequent disease of a part of the brain, the event of which must be more fatal if the bone were entire. A large removal of bone was formerly a frequent event, but a protrusion of this kind very seldom took place." The object is to allow a free escape of the effused blood, so as to obviate the effects of pressure upon the brain, and to arrest the further effusion by the exposure of the bleeding surface. We have great confidence in this mode of practice. As to the application of styptics and escharotics for the suppression of hæmorrhage or the removal of fungus cerebri, we have not much confidence in their employment. The depth to which their influence extends cannot be limited in a manner which is desirable. It is possible, as Mr. Abernethy says, that being dissolved in the discharge they may insinuate themselves between the tumor and edges of the skull, so as to get into contact with the sensible parts within. The occasional use of the nitrate of silver is free from the objections mentioned, and as an auxiliary means may be advantageously employed, if used with proper precautions; but we should not rely upon it alone. After the slicing off of the tumor very dilute nitric acid has been employed, and without any injurious effect; but it is doubtful whether any decided advantage has been gained by it. We should restrict our local means of treatment therefore to the use of the most simple dressings, of which none is better than lint moistened with warm water; and, if pressure be advisable, a pledget of the same, with strips of unirritating adhesive plaster, affords the safest and best possible application.

It fortunately happens occasionally, in very unpromising cases, that under a very mild treatment the tendency to protrude altogether ceases, and the protruded brain either recedes within the cavity of the skull or disappears by gradual shrinking. Under these circumstances the lost brain must be supplied by some other constituent, and from the dissection of a case recently under our own immediate care we suspect that a large collection of fluid in the lateral ventricle of the corresponding hemiphere supplies the place of the lost cerebral matter.]

John Adams.

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HEMERALOPIA [(from ἡμέρα day, and ὤψ the eye) *visus diurnus*, or *night-blindness*. Much confusion has arisen in consequence of some writers, ancient as well as modern, having employed this term to signify the opposite condition.]

According to M. Dujardin, it is derived from ἡμέρα, the day, ἀλαὸς, blind, and ὢψ, the eye, and its right signification is therefore inferred to be *diurna cæcitudo*, or *day-blindness*. (See *Journal de Méd.* t. xix. p. 348.) In the same sense, Dr. Hillary (*Obs. on the Diseases of Barbadoes*, p. 298, edit. 2), and Heberden (*Med. Trans.* vol. 1, art. 5) have employed the term. Scarpa, on the other hand, with the generality of modern writers, considers hemeralopia as an affection, in which the patient sees very well in the day, but not after sunset; and it is in this sense that the word is used in the present article, in opposition to the *nyctalopia* of the ancients, or *night-blindness*.

According to Sauvages, hemeralopia (in his nomenclature called *amblyopia crepuscularis*) was in some degree epidemic in the neighbourhood of Montpellier, in villages in damp situations, adjoining rivers, and it particularly affected the soldiers, who slept in the open damp air. They were cured, he says, by blistering, together with emetics and cathartics, and other evacuants. (*Nosol. Method.* class vi. gen. 3, spec. 1.)

The abolition of eyesight by night (observes Mr. Bampfield) has occurred in all ages, and is a common disease of seamen in the East and West Indies, Mediterranean, and in all hot and tropical countries and latitudes, and affects more or less the natives likewise of those regions of the globe. It also occurs frequently among soldiers in the East and West Indies; but, he has been informed, that it is by no means so prevalent amongst them as sailors. It is not an uncommon complaint of the Lascars, employed in the East India Company's ships, trading between India and Europe. It has very rarely indeed affected the officers of her Majesty's, or of the East India Company's ships. Celsus has remarked, that women and virgins, whose menstrual returns are regular, are exempt from this disease (lib. vi. cap. 6); and it may be observed, that the inhabitants of cold latitudes are less subject to hemeralopia in their own climate, than the natives of tropical countries are in theirs; but, more so, when they visit the tropics. (*Med. Chir. Trans.* vol. v. p. 38.)

"*Hemeralopia*, or *nocturnal blindness* (says Scarpa), is properly nothing but a kind of imperfect periodical amaurosis, most commonly sympathetic with the stomach. Its paroxysms come on towards the evening, and disappear in the morning. The disease is endemic in some countries, and epidemic, at certain seasons of the year, in others.

"At sunset, objects appear, to persons affected with the complaint, as if covered with an ash-coloured veil, which gradually changes into a dense cloud, which intervenes between the eyes and surrounding objects. Patients with hemeralopia have the pupil, both in the day and night-time, more dilated, and less movable, than it usually is in healthy eyes. The majority of them, however, have the pupil more or less movable in the day time, and always expanded and motionless at night. When brought into a room faintly lighted by a candle, where all the bystanders can see tolerably well, they cannot discern at all, or in a very feeble manner, scarcely any one object: or they only find themselves able to distinguish light from darkness: and at moonlight their sight is still worse. At daybreak they recover their sight, which continues perfect all the rest of the day, till sunset." (Cap. xix. p. 322, ed. 8vo.)

Mr. Bampfield represents the disease as always affecting both eyes. "In general (says this gentleman), the nocturnal blindness is at first partial, the patient is enabled to see objects a short time after sunset, and perhaps will be able to see a little by clear moonlight. At this period of the complaint, he is capable of seeing distinctly by bright candlelight. The nocturnal sight, however, becomes daily more impaired and imperfect, and, after a few days, the patient is unable to discriminate the largest objects after sunset, or by moonlight, &c.; and, finally, after a longer lapse of time, he cannot perceive any object distinctly by the brightest candlelight. If the patient is permitted to remain in this state of disease, the sight will become weak by daylight, the rays of the sun will be too powerful to be endured, whether they are direct or reflected; lippitude is sometimes induced; myopism, or shortness of sight, succeeds; and, in progress of time, vision becomes so impaired and imperfect, that apprehensions of a total loss of sight are entertained; and this dreadful consequence has been known to ensue, where the complaint has been totally neglected, or left to nature, or where ineffectual remedies have been employed." (*Bontius*, p. 73.)

"It has been remarked by some, that the patients are capable of seeing distinctly, at all periods of the complaint, with the aid of a strong artificial light; but, in *bad* cases of hemeralopia, in my practice, the patients positively denied the existence of the sense of distinct sight by very clear candlelight." (*Bampfield in Medico-Chir. Trans.* vol. v. p. 39, 40.)

The duration of the disease, when left to itself, is generally from two weeks to three or six months. Experience has not proved that the disposition to the complaint depends upon any particular colour of the iris, as several writers have conjectured; nor upon the largeness of the eyes, as alleged by Hippocrates. (Lib. vi. sec. 7.)

In idiopathic cases, the health does not in general suffer, and, except in the worst stage, the eye is not altered in appearance. But, in cases of long duration, the pupil, according to Mr. Bampfield, "is often contracted, and the eyes and actions of the patient evince marks of painful irritation, if the eyes are exposed to a vivid light; or if he looks upward. But, if they meet the direct rays of the sun, which in the tropics are always powerful, or a strong glaring reflection of them, pain and temporary blindness are induced, from which the patient recovers, by closing his eyelids for a time to exclude the rays of light, and retiring to the shade. The pupil of the eye is considerably dilated, both by day and night, in the proportion of about one case in twelve, and at night the pupil is often dilated, and does not perform its expansions and contractions, when exposed to the moon or artificial light. The cases, attended with dilated pupil, were generally those of long duration, &c.

"Europeans, who have been once affected with hemeralopia, in tropical climates, are particularly liable to a recurrence of this disease, as long as they remain in them." (*Bampfield*, op. cit. p. 42, 43.)

In two examples, described by Dr. Andrew Smith, the pupils were observed to contract and dilate regularly in the day time, according to the quantity of light; but, after sunset, they seemed a little more dilated than natural, and contracted but sluggishly upon exposure to light, while the eyes themselves seemed devoid of their usual energy and vivacity. (See *Edin. Med. and Surgical Jour.* No. 74, p. 22.)

The proximate causes of hemeralopia are not well ascertained. Sleeping with the face exposed to the brilliancy of daylight, the vivid reflection of the sun's rays from the sandy shores of hot countries, and bright moonlight, have been enumerated as exciting causes. Dr. Pye regards the disorder as intermittent. (*Med. Obs. and Inquiries*, vol. i. art. 13.) But, as Mr. Bampfield properly observes, though the complaint is certainly periodical, there is nothing in its character tending to prove, that it is influenced by the same causes as intermittent fever. The latter gentleman conjectures, "that too much light suddenly transmitted to the retina, or for a long period acting on it, may afterwards render it unsusceptible of being stimulated to action, by the weaker or smaller quantities of light transmitted to it by night." (P. 44.) The same sentiment is adopted by Dr. Smith. (*Edin. Med. Journ.* No. 74, p. 23.) Amongst other objections to this explanation, however, it might be remarked, that the patients do not always see, though the light be good; and Mr. Bampfield's own "patients positively denied the existence of distinct sight by very clear candlelight." Besides, if the disease were entirely caused by the sudden or long operation of vivid light, one would conclude, that all persons subjected to that cause ought to have the effect produced, which is far from being the case.

When the tongue is white, and the patient has headache and bilious complaints, M. Lassus thinks the cause of the disease is in the stomach and primæ viæ. The same author likewise states that hemeralopia attacks debilitated persons, subject to catarrhal affections, residing in damp situations, and living on indigestible food. From the combination of such causes (says he) the disorder was epidemic in the vicinity of Montpellier (*Sauvage, Nosolog. Méthod.* t. ii. p. 732); at Belle-Isle sur Mer (*Recueil d'Observ. de Médecine des Hôpitaux Militaires, par Richard*, t. ii. p. 573); and hence it is endemic in watery situations, where the nights are cold and damp. They who expose themselves to this humidity (says M. Lassus), or who navigate along the eastern coasts of Africa, who traverse the Mozambique channel, or sail along the coasts of Malabar and Coromandel, are sometimes attacked by it. (See *Pathologie Chir.* t. ii. p. 542, 543.) Hemeralopia sometimes occurs as a symptom of the scurvy. This fact was noticed by Mr. Telford, in Sir G. Blane's Treatise on Diseases of Seamen, and it is likewise confirmed by Mr. Bampfield, who remarks, that hemeralopia should be referred to the same causes as scurvy, "when the subject of it has for a long period subsisted on a salted diet at sea, &c., and if any other scorbutic symptom be present, such as spongy gums, ecchymoses, saline smell of the secretions, ulcers, with liver-like fungus, &c." (*Medico-Chir. Trans.* vol. v. p. 45.)

[Mr. Wharton Jones has met with two cases apparently arising from exposure of the eyes to the vapour of naphtha. The following is one of these cases:—A lad, aged 17, has been working for a fortnight with shell-lac, naphtha, and gutta-percha. Since then, he finds that his sight, which is perfectly good during the day, regularly becomes dim at night. (*Ophthalmic Medicine and Surgery*, ed. 2, p. 347.)]

In July and August, 1834, hemeralopia was epidemic in two battalions of the 19th Prussian regiment of the line, 138 soldiers having been attacked by it, while quartered at Ehrenbreitstein and Pfaffendorf. Those who suffered were unable to find their muskets, if they put them out of their hands at night, and they experienced such difficulty in discerning at that time, even near objects, that they were afraid of quitting the sentry-box, lest they should not find it again. Surgeon-general Hübner attributed the origin of the disorder to the following causes:—1. The great heat of the summer. 2. The fatigue of the men in the frequent ascent of the steep heights of Ehrenbreitstein and Pfaffendorf. 3. The frequency of their exercise and parade on an unshaded and dazzling sandy soil, where also they were exposed to the reflection of the sun from the Rhine. 4. The extreme darkness of their rooms, which rendered their eyes too sensible to bear the open daylight without ill consequences. (See *Med. Zeitung*, and *Dubl. Journ. of Med. Science*, vol. viii. p. 123.)

This disease (according to Scarpa) may commonly be completely cured, and oftentimes in a very short time by employing emetics, aperient powders, and pills, and a blister on the nape of the neck; and topically, the vapours of ammonia; followed, towards the end of the treatment, by bark, conjoined with valerian. In cases in which the disease has been preceded by plethora, and suppressed perspiration, bleeding and sudorifics are also indicated. (Cap. xix. p. 322, 333.)

One hundred cases of idiopathic, and two hundred of symptomatic or scorbutic hemeralopia, occurred in the practice of Mr. Bampfield, in different parts of the globe, but chiefly in the East Indies. All these cases perfectly recovered, and hence we may infer, that, under proper treatment, a favourable prognosis may always be given.

In a few instances, however, night blindness is congenital and constitutional, and altogether beyond the reach of any curative measure. It is said sometimes to be hereditary; and the writer of the article *Nyctalopia*, in Dr. Rees's Cyclopædia, was acquainted with an instance, in which it occurred to two children of the same family. A congenital case which had continued many years without change, and independently of any disease, is related by Dr. Parham. (See *Med. Obs. and Inquiries*, vol. i. p. 122, note.)

The treatment which Mr. Bampfield adopted, was simple. "A succession of blisters to the temples (says he), of the size of a crown, or half-crown piece, applied tolerably close to the external canthus of the eye, has succeeded in every case of idiopathic hemeralopia which I have seen, &c. The first application of blisters commonly enables the patient to see dimly by candlelight, or perceive objects without the power of discriminating what they are. In some slight cases, which admitted of easy cure, the first application succeeded perfectly. The second application of blisters commonly enables the patient to see by candlelight distinctly, perhaps by bright moonlight, and even half an hour after sunset, or the sight is restored for short periods during the night, and is again abolished. The second application very often effects a perfect recovery. The third, fourth, or fifth applications in succession generally produce a complete recovery, where the first or second have failed; but some rare instances of very obstinate hemeralopia have required even ten successive blisters to each temple; or, instead of using them in succession, a perpetual vesicatory has been formed on each temple, and maintained until a cure has been accomplished; an event, which has generally followed in a fortnight." (*Bampfield in Medico-Chir. Trans.* vol. v. p. 47, 48.) In some cases, shades over the eyes were worn during the treatment, and a certain time after the cure. The patients were also often directed to bathe their eyes with cold water, two or three times a day.

The epidemic hemeralopia amongst the Prussian soldiers at Ehrenbreitstein was cured by change of quarters, removing the exciting causes, already specified, and having recourse to cold lotions.

Mr. Bampfield knew of some instances, in which electricity was successfully employed, as a topical stimulus to the eye. He also informs us, that a spontaneous cure sometimes followed the eruption of boils on the head or face, or the formation of abscesses on these parts, or in the ears.

Although blisters will generally effect a cure, there were particular cases in which Mr. Bampfield administered cathartics, such as calomel and the neutral salts. In these examples, the patient had bilious complaints, indicated by a yellow state of the tongue and skin, headache, and pain about the præcordia; or symptoms of indigestion; white tongue, loss of appetite, pain and flatulence of the stomach, &c. With blisters and aperient medicines Mr. Lawrence sometimes combines cupping on the temples, or nape of the neck. (On *Dis. of the Eye*, p. 570.)

The patients, treated by Dr. Smith, were put into a ward moderately lighted, and their bowels emptied by a gentle cathartic. A blister was then applied to each temple, and kept open with savin cerate. A little of a solution of the oxymuriate of mercury, in the proportion of two grains to an ounce of water, was dropped into the eyes twice a day. The purgatives were repeated on the third day, and the quantity of light to which the patients were exposed was afterwards gradually increased. (See *Edin. Med. Journ.* No. 74, p. 24.)

In scorbutic hemeralopia, blisters are to be deferred until the state of the constitution has been amended, by giving lemon and lime juice, and fresh animal and vegetable food; because hemeralopia often gradually ceases as the scurvy is cured; and before this last event, the blister might produce a scorbutic ulcer. Mr. Bampfield estimates, that about one-third of the cases of scorbutic hemeralopia resist the efficacy of the antiscorbutic regimen and medicines; and consequently must ultimately be treated as idiopathic cases.

The frequent recurrence of this disease, during the patient's continuance in a tropical or hot climate, naturally suggests the propriety of recommending him to return to his native climate, by which change the tendency to a relapse is in general completely removed. (*Bampfield, in Medico-Chir. Trans.* vol. v. p. 53.)

Consult Celsus de Re Médica, cap. 6, lib. 6. Galeni Op. Lib. de Oculis, pars iv. cap. 11, 22. Ætii Sermo Septimus, cap. 48, &c. Paul. Æginæ, lib. iii. cap. 48. *Actuarius*, De Method. Med. lib. iv. cap. 11. *Rhases*, De Ægritud. Ocul. cap. 4. *Avicenna*, lib. iii. fen. 3, tractat. 4. Fabricii Hildani centur. i. obs. 24.; centur. v. obs. 13. *Platner*, Praxis Med. *C. A. Bergen*, et *J. C. Weise*, De Nyctalopia seu Cæcitate Nocturna; *Haller*, Disp. ad Morb. &c. 359. Journal de Médecine et de Chirurgie, an 1756, t. iv. Medical Observations and Inquiries, vol. i. Recueil d'Observations de Médecine des Hôpitaux Militaires, par *Richard*, t. ii. *Duport*, Mémoire sur la Goutte Sereine Nocturne épidémique, ou Nyctalopie. Observations on Tropical Nyctalopia, by *Mr. J. Forbes*, in Edinb. Medical and Surgical Journal, No. xxviii. p. 417, et seq. *Richter's* Anfangsgründe der Wundarzneykunst, b. iii. p. 483, et seq. *Schmucker's* Chirurgische Schriften, band. 2. Saggio di Osservazioni e d'Esperienze sulle Principali Malattie degli Occhi di *Antonio Scarpa*, p. 322, et seq. edit. 8vo. Venezia, 2081. *Lassus*, Pathologie Chirurgicale, t. ii. p. 539, edit. 2. *Rees's* Cyclopædia, art. Nyctalopia. A Practical Essay on Hemeralopia, or Night-blindness, commonly called Nyctalopia, by *R. W. Bampfield*, in Medico-Chirurgical Trans. vol. v. p. 32, et seq. *A. Simpson* on Hemeralopia, 8vo. Glasgow, 1819. *C. H. Weller*, Manual of the Dis. of the Eye, transl. by *D. Monteath*, vol. ii. p. 142, 8vo. Glasgow, 1821. *Good's* Study of Medicine, vol. iv. p. 203, edit. 3, 1829. *W. Lawrence* on Dis. of the Eye, p. 568, 8vo. Lond. 1833. *Dr. A. Smith*, in Edinb. Med. and Surgical Journ. No. lxxiv. *W. Mackenzie* on Dis. of the Eye, p. 880, ed. 2, 8vo. Lond. 1835. *Robert Middlemore*, on Dis. of the Eye, vol. ii. p. 225, 8vo. Lond. 1835. *H. E. C. Richter*, Scriptores Ophthalmologici Minores, vol. iii. Dublin Journ. of Med. Science, vol. viii. p. 123, 8vo. 1835.

HEMIOPIA (from ἥμισυς, half, and ὤψ, the eye.) A certain disorder of the eye, in which the patient cannot see the whole of any object which he is looking at, but only a part of it. Sometimes he see the middle, but not the circumference; sometimes the circumference, but not the centre; while, on other occasions, it is only the upper or lower half which is discerned. Sometimes objects are seen thus imperfectly, whether distant or near; sometimes only when they are near, and not at a great distance.

The causes of hemiopia are divided by Richter into four kinds.

To the first belong opacities of the cornea and crystalline lens, especially such as destroy the transparency of only a certain portion of these parts. The cure of this species of hemiopia depends upon the removal of the partial opacity from which it originates. (See CATARACT, and CORNEA, *Opacities of.*)

Under certain circumstances, persons, whose upper eyelids cannot be properly raised, are affected with hemiopia. They can only discern the lower half of an object, which is near and of large size, unless they go farther from it, draw their heads backward, or turn their eyes downward.

The pupil, in particular instances, becomes drawn away from the middle of the iris, or there may be a separation of the iris from the margin of the cornea by external violence, or other causes.

Each of these occurrences may cause hemiopia of an incurable kind.

The foregoing species of hemiopia are merely effects of other diseases. The fourth and last kind is the most important, being generally regarded as an independent disorder. Sometimes it appears to be the effect of a sudden and transient irritation, producing a morbid sensibility in the optic nerve.

The causes of this sort of case, if we can credit Richter, are mostly seated in the abdominal viscera. When the affection is more durable, forming what has been termed *amaurosis dimidiata*, the same treatment is indicated as in *amaurosis;* in which, indeed, it often terminates. (*Richter, Anfangsgr. der Wundarzn.* b. iii. kap. 17.)

Dr. Wollaston, who experienced two attacks of hemiopia, and wrote a paper on the semidecussation of the optic nerves, concluded that the disorder might depend upon injury of one of the thalami, occasioning insensibility of the right or left halves of the retinæ, according to the nervous filaments implicated. (See *Phil. Trans.* for 1824, p. 224.)

Dr. Mackenzie, however, in reasoning on Dr. Wollaston's theory, thinks that by far the greater mass of facts in pathological anatomy, touching this question, go to prove, that injuries and diseases affecting one side of the brain, instead of hemiopia in both eyes, produce *amaurosis* only in the opposite eye. (Vide *Mackenzie on Dis. of the Eye*, ed. 4, p. 1001, where other arguments against the hypothesis of Dr. Wollaston may also be met with.)

HERNIA (from ἔρνος, a branch, from its protruding forward). A protrusion of any viscus from its proper cavity is called a hernia; and the term, of course, comprises that very frequent case in which a tumor is formed by the protrusion of some of the viscera of the abdomen out of that cavity into a kind of sac composed of a portion of peritoneum which is pushed before them. With respect to abdominal herniæ, however, some cases will not be embraced by this definition, either because the parts are not protruded at all, or because they have no hernial sac. Yet it is only in rare cases that the sac is wanting; as, for example, when the hernia has been produced by the operation of great violence, or has been preceded by a wound of the abdominal parietes. A hernial sac is sometimes burst by a blow. " When this happens (as Sir Astley Cooper has observed) its contents escape out of the sac, and become placed under the contiguous skin, so that the viscera require to be returned into the sac before they can pass into the abdomen." He attended a case of inguinal hernia in which these circumstances were exemplified. (*On Abdominal Hernia*, ed. 2. by *C. Aston Key*, part i.) Some viscera, which occasionally protrude, are not entirely surrounded by the peritoneum, as the bladder and cæcum; under these circumstances, when the viscera are considerably displaced, and if the parts destitute of peritoneal covering present themselves at any of the natural outlets and protrude, a hernia without a sac will result. These herniæ without a sac, if they continue to protrude, draw after them the portion of peritoneum connected with them, which forms a sac into which other bowels may fall, so that the surgeon when operating may first come upon the bowel without opening a hernial sac, then higher up he may find a sac containing other viscera. Lastly, there may be no sac, when a hernia arises from malformation of the muscles, attended with abdominal openings in them; for these are not always closed by peritoneum. (*Sir Astley Cooper*, op. cit.)

" The brilliant progress which surgery has made in modern times (says Scarpa) is, properly speaking, only the result of pathological anatomy; that is to say, of exact comparisons of the natural state of our organs with their different diseases, which may depend upon an alteration of texture, a derangement of functions, a solution of continuity, or a change of situation.

" There are, indeed, a certain number of surgical operations, for the prompt and safe execution of which mere anatomical knowledge will suffice; but, in many others, the surgeon cannot promise himself success, even though he be well acquainted with anatomy, unless he has particularly studied the numerous changes of position and alterations of texture of which the parts upon which he is about to operate are susceptible. If he has not the requisite information upon all these points, false appearances may deceive his judgment, and make him commit mistakes, sometimes of a very serious and irreparable kind.

" In order to have a convincing proof of this truth, it will be sufficient to take a view of the different species of herniæ, and their numerous complications. Assuredly, no anatomist would believe that the cæcum, naturally fixed in the right iliac fossa, and the urinary bladder, situated at the bottom of the pelvis, could undergo, without being torn, so considerable a displacement as to protrude through the abdominal ring, and descend even into the scrotum; that the same intestine, the cæcum, could pass from the right iliac region to the umbilicus, protrude at this opening, and form an umbilical hernia; that the right colon could have been found protruded from the abdomen at the left abdominal ring, and the left colon through the right one; that the liver, spleen, and ovary could sometimes form the contents of umbilical, inguinal, and femoral herniæ; that the cæcum could engage itself within the colon, and even protrude at the anus; that the stomach could be forced through the diaphragm, and form a hernia within the chest; that the omentum, or intestine, or both these parts together, could sometimes escape from the belly through the foramen ovale, or sacro-ischiatic notch of the pelvis." (See *Scarpa, Traité des Hernies, Préf.*)

The parts of the body where herniæ most frequently make their appearance, are the groin, the scrotum, the labia pudendi, the navel, and the upper and fore part of the thigh: they may occur at any point of the anterior part of the abdomen; and, in less common instances, at the foramen ovale, in the perinæum, in the vagina, at the ischiatic notch, &c.

The parts which, by being thrust forth from the cavity in which they ought naturally to remain, mostly produce herniæ, are either a portion of the omentum, or a part of the intestinal canal, or both together. But the stomach, the liver, spleen, uterus, ovaries, bladder, &c. have been known to form the contents of some hernial tumors. Indeed, as Sir Astley Cooper remarks, there is no part of the abdomen at which a hernia may not occur, excepting where it is bounded by bone; and, if the muscles be imperfectly formed, even the kidney may protrude in the loins. The small intestine is more frequently protruded than the large, and the ileum more frequently than the jejunum, in consequence of its greater proximity to the ring and crural arch. A part only of the diameter of the tube is sometimes included in a hernia: any larger quantity may descend, from a single fold to the whole movable portion of the canal. (See *Lawrence, On Ruptures*, p. 5, ed. 4.) The viscera more frequently met with than any others, in a hernia, are the omentum and the ileum; the next in frequency is the colon; then the cæcum; and, lastly, the jejunum. Sometimes the appendix cæci is the only part found in the hernial sac. (*Sir Astley Cooper on Abdominal Hernia*, ed. 2.) A hernia is referred to by Mr. Crosse, which consisted solely of the appendix vermiformis; this was enlarged to four times its natural size, and produced most of the usual symptoms of strangulation, so that the operation was required. (See *Trans. of Provincial Assoc.* vol. v.)

From these two circumstances of situation and contents are derived most of the different appellations by which herniæ are distinguished. If a portion of intestine alone form the contents of the tumor, the case is called *enterocele;* if a piece of omentum only, *epiplocele;* and if both intestine and omentum contribute to the formation of the tumor, it is called an *entero-epiplocele.* When the contents of a hernia protrude at the external abdominal ring, the case receives the name of *inguinal hernia*, of which there are two varieties called *oblique* and *direct.* If the protrusion only passes as low as the groin, it is called a *bubonocele;* but, if the parts descend into the scrotum, it is called an *oscheocele* or *scrotal hernia;* if into the labium, it is called a *labial hernia.* The term bubonocle, however, has been frequently used to signify an incomplete oblique inguinal hernia, that is to say, one which is still in the inguinal canal, and has not yet protruded through the external abdominal ring. Other varieties of oblique inguinal hernia are the *congenital*, and the *encysted*, the nature of which will be explained in a subsequent part of this article. The *crural* or *femoral hernia* is the name given to that which takes place below Poupart's ligament. When the bowels protrude at the navel, the case is named an *exomphalos* or *umbilical hernia.* There are also obturator, ischiatic, vaginal, perinæal, and diaphragmatic herniæ; and *ventral* is the epithet given to the swelling when it occurs at any other promiscuous part of the wall of the abdomen.

When the protruded bowels lie quietly in the sac, and admit of being readily put back into the abdomen, the case is termed a *reducible hernia;* and when they suffer no constriction, yet cannot be put back, owing to adhesions, or their large size in relation to the aperture through which they have to pass, the hernia is termed *irreducible.* An *incarcerated or a strangulated hernia* signifies one which not only cannot be easily reduced, or cannot be reduced without an operation, but suffers constriction, so that, if a piece of intestine be protruded, the pressure to which it is subjected stops the passage of its contents towards the anus, or even interrupts the circulation of the blood in the protruded part, excites inflammation of the bowel, or causes its death, and brings on a train of alarming, and often fatal, consequences.

The causes of herniæ are either *predisposing* or *exciting.* Amongst the former, writers mention a preternaturally large size of the openings, at which the bowels are liable to protrude; a weakness and relaxation of the margins of these apertures; extraordinary laxity of the peritoneum; an unusually long mesentery or omentum, &c. With regard to the abdominal ring, the transverse tendinous fibres (*inter-columnar fibres*) which naturally cross and strengthen its upper and outer part, are much weaker in some subjects than others. Some of the alleged predisposing causes may justly excite scepticism; but several circumstances prove that a natural deficiency of resistance in any part of the parietes of the abdomen, promotes the occurrence of hernia. Hence, persons who have had the peritoneum wounded, are very liable to the present disease. Men are much more liable than women to inguinal hernia, evidently from the larger size of the inguinal canal; while in women, as there is a larger space for the protrusion of the viscera below Poupart's ligament, they are more exposed than men to femoral hernia. The distension of the abdomen in pregnancy also gives a disposition to crural and umbilical hernia.

With regard to the *exciting* causes, our knowledge is involved in less doubt. The grand cause of this kind is the powerful action of the abdominal muscles and diaphragm on the viscera. In feats of agility, such as jumping, &c. the pressure which the contents of the abdomen must often encounter, sufficiently accounts for their protruding at any part where the abdominal parietes do not make adequate resistance. The same consideration explains why herniæ very often take place in lifting and carrying heavy weights, running, vomiting, straining at stool, parturition, coughing, sneezing, &c. and in people who inhabit mountainous countries. In individuals who have long laboured under bad strictures, the habitual efforts of the abdominal muscles to make the urine pass, often bring on the formation of hernia. In Sir A. Cooper's splendid work is the representation of a case of this kind, in which several herniæ were produced.

The diminution of the capacity of the abdomen, by the action of the abdominal muscles and diaphragm, in many occasional exertions, must take place in everybody, by reason of the common habits and necessities of life. But, as only a certain number of persons meet with the disease, it is fair to infer that either the exciting causes must operate with greater force in them than in the generality of people, or else that their abdominal parietes have not been capable of the ordinary degree of resistance. Many patients, who meet with herniæ in making violent efforts and exertions, may be in the former circumstance; while others, whose viscera protrude from such trivial things as coughing, sneezing, crying, &c. must be considered as being under the influence of some predisposing cause. "Herniæ which originate in predisposition generally come on gradually, and almost imperceptibly; while those which are produced by bodily exertions are formed suddenly, and by the immediate action of the exciting cause. The occurrence of the complaint (in inguinal hernia) is often indicated in the first instance by a fulness, combined with a sense of weakness, about the abdominal ring. The swelling is increased by any action of the respiratory muscles, and disappears on pressure, and in the recumbent position of the body. It gradually finds its way through the tendon of the external oblique muscle into the groin, and afterwards into the scrotum. When a hernia takes place suddenly, it is generally attended with a sensation of something giving way at the part, and with pain." (*Lawrence on Ruptures*, p. 42, ed. 4.)

Upon the subject of the immediate cause of herniæ, it is observed by Scarpa that several distinguished surgeons, as, for instance, Warton (*Adenograph.* cap. 11), Benevoli (*Dissertazioni Chir.* 1), Rossius (*Acta Nat. Cur.* t. ii. obs. 178), Brendel (*De Herniarum Natalibus*), and Morgagni (*De Sed. et Caus. Morb.* epist. 43, art. 13), consider a relaxation and elongation of the mesentery as the principal cause of herniæ in general, and of inguinal hernia in particular. Hence, say they, the whole mass of intestines, or only a portion of an intestine, descends against the inner orifice of the inguinal ring, presses against this opening, and gradually makes its way out of the abdomen. In examining this pathological point without prejudice, it is incontestable, says Scarpa, that an intestine cannot be moved beyond its natural limits, unless that part of the mesentery which retains and fixes the bowel in its proper place be at the same time elongated. But it does not follow from this that a relaxation of the mesentery must precede the displacement of the intestine. It appears to Scarpa much more probable that these two events are simultaneous, and depend upon one and the same cause.

"In the healthy state, the abdomen, considered altogether, is submitted to two opposite forces which reciprocally balance each other. One is the pressure of the viscera against the abdominal parietes, the other is the reaction of these same parietes upon the viscera which they contain. If these two forces were in perfect equilibrium in all individuals, and under all the circumstances of life, we should not be in the least subject to herniæ. If, when the equilibrium has been broken, every point of the parietes of the belly were to yield equally to the impulse of the viscera, an increase of the volume of the whole abdomen would be the consequence, but a true hernia would never happen. The cavity of the abdomen is always completely full. The containing and contained parts react upon, and reciprocally compress, one another. It is by the effect of this moderate, but equal and unremitting pressure, that all the viscera mutually support each other. Without it, the ligaments of the liver, those of the spleen, and the various membranous bands of the intestines in general, would only be feeble means for fixing such parts in their respective situations. But there are certain points of the abdominal parietes which naturally present much less resistance than others, and which react with much less power against the pressure made from within outwards by the abdominal viscera. Such is, particularly, the part which extends from the pubes to the anterior superior spinous process of the ilium. This relative weakness of some points of the abdominal parietes is very marked in certain individuals, in consequence of a defect of organisation. It may also be increased by internal or external causes, which are as various as they are numerous. When, in one of these cases, the pressure made by the viscera is unusually increased, as happens in a violent effort, a defect in the equilibrium between the two forces above mentioned is occasioned; that is to say, the reaction of the abdominal parietes is no longer proportioned, at least at certain points, to the force of the impulse of the viscera. The conjoined powers of the abdominal muscles, diaphragm, and levator ani, are then directed and concentrated against the most feeble point of the abdomen, towards which they propel the nearest viscus, or that which, from its movableness, is the most liable to displacement. If such viscus should happen to be the noose of an intestine, it is evident that the power which tends to make it protrude from the belly must at the same time act upon the corresponding portion of the mesentery; and the intestine, in passing through the parietes of the abdomen, drags the mesentery after it, and makes this membrane yield and become elongated. When the displaced viscera meet with little resistance on the part of the parietes of the abdomen, the hernia is quickly formed, and the elongation of the mesentery occurs with equal celerity. We have an example of this in inguinal congenital hernia: in this case the intestine is precipitated into a sac previously prepared for its reception. On the contrary, in the ordinary inguinal hernia, a totally different disposition of the parts renders the progress of the disease much slower. In most instances, the hernia is not formed immediately the equilibrium between the impulse of the viscera and the reaction of the abdominal parietes is broken; but in the groin a slight elevation is first observed in the direction from the anterior superior spinous process of the ilium towards the inguinal ring. Some time afterwards, when the intestine has made its appearance on the outside of the ring, the enlargement of the hernia, and the elongation of the mesentery, make much more rapid though always simultaneous progress.

"Numerous practical observations (says Scarpa) concur in proving that we must not search for the immediate cause of herniæ in the relaxation of the mesentery, but rather in a want of equilibrium between the pressure of the viscera and the resistance of one or several points of the abdominal parietes. Indeed, herniæ are seen occurring from the slightest causes in infants in whom the neck of the tunica vaginalis is not speedily obliterated, and in individuals who, from being fat, have, all on a sudden, become extremely thin. Such women as have had children are more subject to the disease than others. Persons also of both sexes, who carry considerable burdens, or who play upon wind instruments, or who have suffered a forcible contusion of the abdomen, are particularly exposed to the disorder, even though there be not the least reason for suspecting in them a relaxation of the mesentery. Vaginal herniæ, which arise after difficult labours, afford another proof of the same truth. Their cause is owing to a laxity and weakness of the parietes of the vagina, which, not being capable of making any further resistance to the pressure of the viscera situated in the cavity of the pelvis, at length suffer these parts to protrude.

"With respect to the second proposition, that during the formation of a hernia the combined force of all the abdominal muscles is, as it were, directed and concentrated against the most feeble point of the parietes, we see a proof of it in a fact that occurs to our observation every day. In order to convince ourselves of this, we need only notice what happens in individuals afflicted with herniæ. If they cough, or sneeze, or make the slightest effort, they instantly find the size of the swelling increased, and hasten to support the part with their hand. During the slightest efforts, which render the herniæ larger, it is also indisputable that the mesentery is elongated in the same proportion as the intestine protrudes. All the viscera have such a tendency to be displaced, and carried towards the weakest point of the parietes of the abdomen, that even those which are naturally the most distant from it, and are the most firmly fixed by the folds of the mesentery, may, in their turn, descend into the hernia. Anatomical knowledge alone would never have led us to entertain a suspicion of the possibility of these occurrences. Sandifort and Paletta have found, in an umbilical hernia, the cæcum, with a portion of the ileum and colon. (*Obs. Pathol.* cap. iv., and *Nova Gubernaculi Testis Descriptio.*) Mauchart, Camper, and Bose have met with the cæcum in an inguinal hernia of the left side. (*De Hern. Incarc. in Halleri Disput. Chirurg.* t. iii.; *Demonstrat. Anat. Patholog.* lib. ii. p. 18; *et Animadvers. de Hern. Inguin.* p. 5.) Lassus has seen the left colon protrude at the right inguinal ring. (*Méd. Opératoire,* t. i. p. 173.) If it be proved by all these facts that such viscera as are the most closely united to the great sac of the peritoneum and neighbouring parts, are nevertheless liable to form herniæ, and if such displacements cannot happen without a considerable elongation of the membranous bands fixing these bowels in their natural situation, how can we refuse to admit that a noose of intestine, pushed by degrees through the inguinal ring, drags along with it the corresponding portion of the mesentery? In order to explain this event there is no necessity for supposing a partial relaxation of the mesentery." (*Traité Pratique des Hernies, par A. Scarpa, trad.* p. 37—43.)

The same causes which first produced the complaint, or others of an analogous nature, are constantly tending to promote its increase. The tumor becomes larger, in proportion as the pressure against the hernial sac is stronger and more frequent. Hence the great size which it often attains in persons constantly pursuing laborious occupations. Its increase will also be in proportion to the less considerable resistance of the parts in which it is situated. Hence the magnitude of scrotal and umbilical ruptures, and the generally small size of a femoral hernia. The size of a hernia is likewise in part dependent upon the largeness and weakness of the opening through which the protrusion happens. Hence inguinal ruptures are usually much larger than those called femoral or crural. The looseness of the cellular connection of the peritoneum is another cause of the disposition of a hernia to attain a considerable magnitude; while the shortness and closeness of the same uniting medium operate, in particular cases, as a check to the enlargement of the tumor, as is exemplified in herniæ of the linea alba, which are generally small. When the sac, after it has passed the parietes of the abdomen, is situated among cellular or adipose substance, it expands equally in all directions, and forms a nearly spherical tumor, being, however, generally rather flattened, as in umbilical and crural herniæ. If it protrude through a canal it is nearly cylindrical, as in incipient inguinal herniæ, and even in those which have passed the ring and are still confined by the sheath of the spermatic cord. The fundus of the sac enlarges as it descends into the scrotum, and thus, in almost all scrotal cases, the swelling becomes pyriform. Irregularities of shape often take place from the extension of the membrane in directions presenting the least resistance. At the first moment of the occurrence of a hernia of sudden formation, the protruded peritoneum is unconnected to the parts amongst which it lies; but adhesions take place so quickly that the sac is found universally connected to the contiguous parts, even in a rupture of two or three days' standing. These adhesions prevent the return of the sac into the abdomen when the contents of the swelling are replaced. The peritoneum which immediately surrounds the protruded viscera generally retains the same thin and delicate structure which characterises that membrane in its natural situation. It is covered by other investments, varying in thickness and structure, according to the part in which the swelling is formed, and the size and duration of the tumor, &c. (See *Lawrence, On Ruptures,* p. 18, &c. ed. 4.)

Many interesting circumstances in relation to hernial sacs have been satisfactorily explained by Sir Astley Cooper and M. Cloquet; and some of them are noticed in Mr. Lawrence's work. "If the causes which have produced the hernia continue to operate, and further descent of the peritoneum be prevented by its strong adhesion to the tendinous opening, the sac becomes thin by distension. It may give way partially by a kind of laceration, and thus become irregular in figure, presenting an appearance of small cysts or secondary cavities. On the contrary, when the neck does not adhere so strongly, and the mouth of the sac forms a thickened ring, the renewed action of pressure may make the ring descend, and a fresh one will form at the new mouth of the sac. This process may be again repeated; and thus the sac presents one or more constrictions, by which the protruded parts may be compressed, and even strangulated. Inguinal and scrotal ruptures are almost the only cases in which this occurrence can take place. When a hernia passes through a canal, a thickened ring may be formed at both orifices of the canal. If a hernial sac has been formed, and its mouth become thickened, a new protrusion may take place by the side of it: this may occur again; and thus we may have sacs composed of two lateral cavities, or consisting of two or more secondary openings into one principal protrusion; or the original serous cavity may be contracted, and form a small appendix to the subsequent protrusion." (See *Lawrence, On Ruptures,* p. 26; and *J. Cloquet, Recherches sur les Causes, &c. des Hernies.*)

According to Sir Astley Cooper, however, the peritoneum, in forming a common hernial sac, "is not dragged from its natural situation, but becomes elongated by gradual distension; and it is usually not only lengthened, but slightly thickened; for a long-continued pressure of moderate force will produce an elongation and thickening of fibre, though a greater degree will bring about an entire absorption of parts." So far, however, as this distinguished surgeon has been able to ascertain by dissection, the seemingly great thickness of the hernial sac, and its apparent divisibility into several layers in old herniæ, are owing to the state of the coverings of the sac, the sac itself being generally but little thicker than the peritoneum.

Several hernial sacs are sometimes found in the same patient; and Sir Astley Cooper has recorded an instance in which this occasioned a difficulty in determining which protrusion was to be the subject of operation.

Herniæ are more frequent on the right than on the left side of the body. This fact, as Mr. Lawrence has remarked, does not depend on any disparity in size between the apertures of the two sides, but must be referred to the employment of the right side in those offices of life which require the most powerful exertion. (*On Ruptures,* p. 33, ed. 4.) This subject has been particularly considered by Cloquet. (See *Recherches sur les Causes et l'Anatomie des Hernies Abdominales,* p. 10, &c. 4to. Paris, 1819.)

The general symptoms of a hernia which is reducible and free from strangulation are an indolent tumor at some point of the abdomen, most frequently descending out of the abdominal ring, or from just below Poupart's ligament, or else out of the navel; but occasionally from various other situations, as will be presently explained. The swelling often originates suddenly, except in the circumstances above related, and it is subject to a change of size, being smaller when the patient lies down on his back, and larger when he stands up or holds his breath. It frequently diminishes when pressed, and grows large again when the pressure is removed. Its size and tension often increase after a meal, or when the patient is flatulent. In consequence of the unnatural situation of the bowels, many patients with hernia are occasionally troubled with colic, constipation, and vomiting. Sometimes, however, the functions of the viscera seem to suffer little or no interruption.

Sometimes the contained parts may be known by the symptoms. But, as Mr. Lawrence justly remarks, this discrimination is often difficult, and even impossible, when the hernia is old, large, and very tense; for, in cases of this description, the viscera experience considerable changes in their figure and state, while the thickened hernial sac prevents an accurate examination by the hand. (*On Ruptures*, p. 46, ed. 5.)

If the case be an *enterocele*, and the portion of intestine be small, the tumor is small in proportion; but though small, if the bowel be distended with wind, inflamed, or have any degree of stricture made on it, it will be tense, resist the impression of the finger, and give pain upon being handled. On the contrary, if there be no stricture, and the intestine suffer no degree of inflammation, let the prolapsed piece be of what length it may, and the tumor of whatever size, the tension will be little, and no pain will attend the handling of it; upon the patient's coughing, it will feel as if it were blown into; and in general it will be found very easily returnable. (*Pott.*) A gurgling noise is often made when the bowel is ascending. An enterocele is also generally characterised by the uniformity of its surface and its elasticity.

If the hernia be an *epiplocele* or one of the omental kind, the tumor has a more flabby and a more unequal feel; it is in general perfectly indolent, is more inelastic, and (if in the scrotum) is more oblong and less round, than the swelling occasioned in the same situation by an intestinal hernia; and if the quantity be large, and the patient adult, it is in some measure distinguishable by its greater weight. In very young subjects, the contents of a hernia are generally intestine, and but seldom omentum. (*Sir A. Cooper, Lectures*, vol. iii. p. 8.)

If the case be an *entero-epiplocele*, that is, one consisting of both intestine and omentum, the characteristic marks will be less clear than in either of the simple cases; but as the smooth slippery surface of the intestine generally makes its reduction easier than that of the omentum, we may infer, with Mr. Lawrence, "that if a portion of the contents slip up quickly and with noise, leaving behind something which is less easily reduced, the case is probably an entero-epiplocele." (Op. cit. ed. 4, p. 47.)

On the subject of prognosis, the age and constitution of the subject, the date of the disease, its being free or not free from stricture or inflammation, the symptoms which attend it, and the probability or improbability of its being returnable, necessarily produce much variety. If the subject be an infant, the case is not often attended with much difficulty or hazard, the reduction being easy as well as the descent; and though, from neglect or inattention, the bowel may fall down again, yet it is easily replaced, and mischief seldom produced. Mr. Pott says seldom, because he has seen an infant, one year old, die of a strangulated hernia, which had not been down two days, with all the symptoms of mortfied intestine. (For other examples of strangulated hernia in very young infants, refer to *Gooch's Chir. Works*, vol. ii. p. 33; *Lawrence On Ruptures*, p. 77, edit. 4; *Edinb. Med. and Surgical Journal*, vol. iii. p. 470, &c.) "If the patient be adult, and in the vigour of life, the consequences of neglect, or of maltreatment, are more to be feared than at any other time, for reasons too obvious to need relating. The great and principal mischief to be apprehended in an intestinal hernia, is an inflammation of the gut, and an obstruction to the passage of the aliment and fæces through it, which inflammation and obstruction are generally produced by a stricture made on the intestine. In very old people the symptoms do not usually make such rapid progress, both on account of the laxity of their frame and their more languid circulation, and also because their ruptures are most frequently of ancient date, and the passage a good deal dilated; but then, on the other hand, it should also be remembered that they are by no means exempt from inflammatory symptoms; and that if such should come on, the infirmity of old age is no favourable circumstance in the treatment which may become necessary." (*Pott.*)

If the disease be recent, and the patient young, immediate reduction and constant care to prevent another protrusion, are the only means whereby it is possible to obtain a perfect cure.

If the case be an epiplocele, that has formed gradually, it seldom occasions any bad symptoms, though its weight will sometimes render it very troublesome. But if it be produced suddenly, by effort or violence, that is, if a considerable piece of the omentum slip down at once, it will sometimes prove painful and cause very disagreeable complaints; the connection between the omentum, stomach, colon, &c. being such as to render the sudden descent of a large piece of the first sometimes productive of nausea, vomiting, and colic. When the piece of omentum is engaged in such a degree of stricture as to prevent the circulation of blood through it, it will sometimes, by becoming gangrenous, be the occasion of very bad symptoms, and even of death, as all surgeons of experience have seen. But even though the portion of the omentum should remain uninjured in the scrotum, yet, as Pott correctly relates, it renders the patient constantly liable to hazard from another quarter; it makes it every moment possible for a piece of intestine to slip into the same sac, and thereby add to the case all the trouble and all the danger arising from an intestinal rupture. It is by no means an uncommon thing for a piece of gut to be added to a rupture which had for many years been merely omental, and for that piece to be strangulated and require immediate help.

"An old omental hernia is often rendered not reducible, more by an alteration made in the state of the prolapsed piece than by its quantity. It is very common for that part of the omentum which passes through the neck of the sac to be compressed into a hard, smooth body, and lose all appearance of caul, while what is below in the scrotum is loose and expanded, and enjoys its natural texture. In this case, reduction is often impossible, from the mere figure of the part; and I have so often seen this, both in the living and the dead, that I am satisfied that, for one omental rupture rendered irreducible by adhesions, many more become so from the cause above mentioned." (*Pott.*)

Upon the whole, this author infers that an intestinal rupture is subject to worse symptoms, and a greater degree of hazard, than an omental one, though the latter is by no means so void of either as it was formerly supposed to be; that bad symptoms are more likely to attend a recent rupture than one of ancient date; that the descent of a very small piece of intestine is more hazardous than that of a larger; and that the hernia which consists of gut only is in general attended with worse circumstances than that which is made up of both gut and omentum. (See also *Lawrence, On Ruptures*, p. 75, 76, ed. 4.)

Mr. Hey coincides with Pott in thinking the prognosis more unfavourable when the tumor is small. "I think it is not a bad general rule, that the smaller the hernia the less hope there is of reducing it by the taxis. Long-continued efforts to reduce a prolapsed intestine are most likely to succeed in old and large hernias when no adhesions have taken place." (*Pract. Observ. in Surgery*, p. 203.)

It is correctly remarked by Mr. Lawrence that "the danger is greatest when a rupture is incarcerated (strangulated) at the moment of its formation. Herniæ which arise spontaneously, and merely from predisposing weakness, seldom become strangulated; the stricture, in such cases, is never close, nor are the symptoms violent, because the parts concerned are weak and relaxed. The opening through which the parts protrude is narrower in some situations than in others. The progress of the case will therefore be more rapid, and the danger of the patient more urgent. The aperture is generally very small in femoral hernia. This kind of rupture in men, and the bubonocele in women, have a particularly narrow entrance. On the same grounds, femoral, inguinal, and umbilical ruptures are more dangerous than the ventral, perineal, or vaginal kinds." (*On Ruptures*, p. 75, ed. 4.)

Treatment of a Hernia capable of easy and immediate Reduction, and not attended with any troublesome or bad Symptoms.

Here the first indication is to reduce the protruded viscera without delay, and to prevent them from descending again by the application of a suitable truss. As soon as the parts are returned the truss should be immediately put on, and worn without remission, care being taken, especially if the patient be an infant, to keep the parts upon which it presses regularly washed, to prevent galling. The truss ought to fit properly, for one "which does not press enough is worse than none at all, as it occasions loss of time, and deceives the patient or his friends; and one which presses too much, or on an improper part, gives pain and trouble, by producing an inflammation and swelling of the spermatic cord, and sometimes of the testicle.

"In adults whose ruptures are of long standing, and accustomed to frequent descent, the hernial sac is generally firm and thick, and the aperture in the tendon of the abdominal muscle large. The freedom and ease with which the parts return into the belly when the patient is in a supine posture, and the little pain which attends a rupture of this kind, often render the persons who labour under it careless; but all so circumstanced should be informed that they are in constant danger of such alteration in their complaint as may put them into great hazard, and perhaps destroy them. The passage from the belly being open, the quantity of intestine in the hernial sac is always liable to be increased, and, when down, to be bound by a stricture. An inflammation of that portion of the gut which is down, or such obstruction in it as may distend and enlarge it, may at all times produce such complaints as may put the life of the patient in imminent danger; and therefore, notwithstanding this kind of hernia may have been borne for a great length of time without having proved either troublesome or hazardous, yet, as it is always possible to become so, and that very suddenly, it can never be prudent or safe to neglect it.

"Even though the rupture should be of the omental kind (which, considered abstractedly, is not subject to that degree or kind of danger to which the intestinal is liable), yet it may be secondarily, or by accident, the cause of all the same mischief; for while it keeps the mouth of the hernial sac open, it renders the descent of a piece of intestine always possible, and consequently always likely to produce the mischief which may proceed from thence."

Mr. Pott comments upon the importance of having the parts completely reduced before the truss is applied, and upon the danger that may be incurred by laying such instrument aside after it has been worn some time, since the partial closure of the passage, whereby the descent of the bowel is rendered less easy, will also make the reduction more difficult, if a piece should happen to slip down; and hence he insists that a truss "should be long and unremittingly worn by all those whose time of life makes the expectations of a perfect cure reasonable, many of the ruptures of adults depending upon the negligent manner in which children at school are suffered to wear their trusses." (See Truss.)

Besides the danger of strangulation and the loss of all chances of a spontaneous radical cure, when a reducible hernia is neglected, and allowed to remain down, there are other motives for keeping up the tumor with a truss. The vast size to which neglected herniæ sometimes increase not only prohibits all active exertion, but, by involving in the male the integuments of the penis, incapacitates the patient from the act of copulation, and gives rise to excoriation from the discharge of the urine over the swelling. Probably, too, the testis may be affected by the pressure of a very large scrotal hernia. (*Morgagni, De Caus. et Sed.* ep. xxxiii. art. 12; *Schmucker*, *Vermischte Chir. Schriften*, b. iii. p. 195.) Disorders of the intestinal functions invariably attend these large ruptures, and increase in frequency and violence in proportion to the size of the swelling and age of the patient. All the movable viscera of the abdomen gradually find their way into the hernial sac, if a rupture be entirely neglected. (*Lawrence, On Ruptures*, p. 80, edit. 4.)

Treatment of Irreducible Herniæ, free from Inflammation, and unattended with troublesome or dangerous Symptoms.

Mr. Pott, and all the best writers on ruptures, ascribe the incapacity of reduction, in most cases, either to the largeness of the quantity of the contents, an alteration made in their form and texture, or to adhesions which they have contracted with each other or their containing bag. The reduction is also sometimes prevented by transverse membranous bands within the sac. Mr. Pott was also aware that ruptures are sometimes rendered difficult to be reduced by the cæcum being contained in the hernial sac. Of this fact he was as much convinced as the nature of such kind of things would permit; that is, by observations made both on the living and the dead. This statement, made many years back, deserves particular notice, because its truth is confirmed by the modern observations of Scarpa.

Mr. Pott has adverted to the kind of impediment to reduction produced by the thickening of the neck of the sac, when the hernia is long neglected, and suffered to remain in the scrotum without any bandage to support its weight.

The same author reckons an alteration produced by time, and constant, though gentle, pressure, in the form and consistence or texture of the omentum, as no infrequent cause why neglected omental ruptures become irreducible. When a portion of omentum "has been suffered to remain for a great length of time in the scrotum, without having ever been returned into the belly, it often happens that although that part of it which is in the lower part of the hernial sac preserves its natural soft, adipose, expansile state, yet all that part which passes through what is called the neck of the sac is, by constant pressure, formed into a hard, firm, imcompressible, carnous kind of body, incapable of being expanded, and taking the form of the passage in which it is confined, exactly filling that passage, and rendering it impossible to push up the loose part which fills the scrotum.

"The same reason for incapacity of reduction is also sometimes met with in ruptures of the intestinal kind, from an alteration produced on that part of the mesentery which has been suffered to lie quiet for a great length of time in the neck of an old hernial sac.

The other impediment to the return of old ruptures is the connection and adhesion of the parts, either with each other or with the sac containing them. This is common to both the intestinal and omental hernia, and is produced by slight inflammations of the parts, which have been permitted to lie long in contact with each other. These adhesions are more or less firm, and more or less extensive, in different cases; but even the slightest will almost always be found an invincible obstacle to the reduction of the adherent parts by the hand only. They are most frequently situated at the lower part of the sac, but sometimes at its mouth. (*Sir A. Cooper*, op. cit. p. 27.)

Irreducible herniæ, from any of the foregoing circumstances, are capable of no relief from surgery but the application of a suspensory bandage for the purposes of lessening the inconvenience of the weight of the tumor, and of checking, by means of pressure, the increase of the swelling. But (according to Sir Astley Cooper), if the hernia be omental only, its increase, and the subsequent descent of the intestine, may safely be prevented by a spring truss. Yet he acknowledges that there is so much difficulty in determining the precise nature of the hernia, and whether some small convolution of intestine may not have descended, that the truss should not be applied without a most careful examination; and he recommends the spring to be weak. If the instrument should produce pain, or interrupt the functions of the bowels, it ought to be immediately discontinued.

Persons having irreducible herniæ "should be particularly careful not to make any attempts beyond their strength, nor aim at feats of agility; they should take care to suspend the loaded scrotum, and to keep it out of the way of all harm from pressure, bruise, &c. When the tumor is very large, a soft quilted bolster should be worn at the bottom of the suspensory to prevent excoriation, and the scrotum should be frequently washed for the same reason; a loss of skin in this part, and in such circumstances, being sometimes of the utmost importance. Such sufferers ought also to be particularly attentive to the office of the intestinal canal, to see that they do not, by any irregularity of diet, disorder it, and they should be careful to keep themselves from being costive." Mr. Pott observes, however, that the quiet, inoffensive state of this kind of hernia is by no means to be depended upon: many things may happen to it, by which it may be so altered as to become hazardous, and even fatal; an inflammation of that part of the gut which is down, any obstruction to the passage of the aliment or fæces through it, a stricture made either on what has been long down, or on a new portion which may at any time be added to it, are always capable of so altering the state of the case as to put the life of the patient into danger.

"Indeed, the hazard arising from a stricture made on a piece of intestine contained in the sac of an old irreducible hernia, is in one respect greater than that attending one that has been found at times reducible, since, from the nature of the case, it will hardly admit of any attempt towards relief but the operation, which, in these circumstances, must necessarily be accompanied with additional difficulty."

Patients with irreducible hernia are exposed indeed to various dangers and inconveniences; as, for instance, to laceration of the intestine by accidental blows; to ulceration of it when any pointed or hard body has been swallowed; to dropsy of the hernial sac; and to a fistulous abscess of the scrotum, which can hardly ever be healed except by confining the patient in bed. (See *Sir A. Cooper, On Abdominal Hernia*, chap. vi. ed. 2; *Travers, On Wounds of the Intestines*, p. 37.) Scarpa has recorded an instance where a violent exertion caused the recurrence of symptoms in an irreducible hernia which had long been regarded as cured. The viscera lay in the tunica vaginalis, which was torn to the extent of an inch.

Fabricius Hildanus gives an account of a man who was radically cured of an irreducible rupture of twenty years' date by six months' confinement to bed. (*Cent.* v. obs. 54.) Le Dran and Arnaud relate instances of very large herniæ which disappeared entirely after the patients had been long confined to bed, and rendered much emaciated by tedious illnesses. Some of the moderns have imitated this operation of nature, and, by frequent bleedings and repeated purges, have sometimes so far reduced the size of the hernia, that it has been returned into the abdomen. Mr. Hey has several times succeeded in this way (p. 219). But the practice cannot prove successful when the viscera adhere to the sac, or to the peritoneum, just within the abdomen. The greatest objection to this method of cure is the want of an absolute criterion for distinguishing when the parts do or do not adhere to the hernial sac; and, in advanced years, though one were sure that the viscera were free from the sac, the possibility of hurting the constitution by the necessary evacuations is also another objection. (*Sharp's Critical Inquiry*, p. 15.)

Were the plan to be thought worthy of trial, keeping up a constant pressure on the tumor, by means of a suspensory bandage made to lace in front, would be proper for promoting the absorption of the thickened parts in the hernial sac. Sir A. Cooper has reduced such herniæ after applying ice to them, the good effects of which he imputes to its producing a contraction of the scrotum, and by this means a strong and permanent compression of the tumor. Mr. Earle once mentioned to me the suggestion of keeping up a general pressure on the swelling by means of a bladder containing quicksilver, the quantity of which can be regulated according to circumstances.

Whenever any attempt of this kind succeeds, a truss should be immediately put on, and worn without remission.

However, there are instances on record where the capacity of the abdomen had become so adapted to the diminished quantity of the viscera, that when the contents of the hernia had been reduced, serious complaints arose from their introduction into the belly. Schmucker met with several such cases, in which he was obliged to take off the truss again. Petit has known the reduction of a hernia of this kind prove fatal, the parts not descending again when the truss was removed, the nausea and vomiting continuing, and peritonitis taking place. (*Chirurgische Wahrnehmungen*, vol. ii. p. 243; *Maladies Chir.* t. ii. p. 392.)

Mr. Pott remarks "that an omental rupture which has been so long in the scrotum as to have become irreducible, is very seldom attended with any bad symptoms, considered abstractedly; but it is constantly capable of being the occasion of an intestinal hernia, and all its consequences. Neither is that all; for the omentum, either so altered in form and texture, or so connected, as to be incapable of reduction, may by accident inflame, and either become gangrenous or suppurate, and occasion a great deal of trouble." In a few instances, epiploceles produce very bad symptoms indeed; cases of which are to be found in Garengeot, Dionis, &c.

Symptoms and Treatment of a Strangulated, or an Incarcerated Hernia. — Means to be tried before an Operation.

If the prolapsed parts cannot be immediately replaced, and the patient suffers pain, or is prevented thereby from going to stool, the case is called *an incarcerated hernia*, *a strangulated hernia*, or *a hernia with stricture.*

A patient thus circumstanced is in some danger, and demands immediate assistance. A stricture made on the prolapsed part of the gut by the aperture or canal through which it passes, is the immediate cause of all the bad symptoms, and, of course, the release of the intestine from such stricture is the only thing which can bring relief. This object can only be accomplished by returning the bowel back into the abdomen, or dividing the parts which form the stricture. The former plan is always the most desirable when practicable.

I next proceed to notice the various measures to be adopted for the relief of a strangulated hernia, so as to obtain the best chance of obviating the necessity of an operation. After treating of the merits of each plan, a few remarks will be offered on the order in which these means should be put in practice.

The Taxis.—This is the term applied to the operation of reducing a hernia with the hand. It is to be promoted by the position of the body, which Winslow thought should be placed on an inclined plane, with the thighs bent towards the trunk. Sir A. Cooper advises the same practice, observing that this posture, by relaxing the fascia of the thigh, relaxes also the aperture through which the hernia passes. Every degree of tension, and relaxation of the femoral fascia, must undoubtedly be attended with a corresponding change in the abdominal ring. But flexion of the thigh, besides relaxing this fascia, also relaxes the abdominal, internal iliac, and psoas muscles. In oblique inguinal hernia, the pressure made on the tumor by the hands of the surgeon should always be directed upwards and outwards, along the course of the spermatic cord; and Sir A. Cooper advises it to be continued from a quarter to half an hour.

As the femoral hernia passes downwards, and then forwards, the pressure must be directed first backwards, and then upwards. In umbilical and ventral herniæ, it is to be made straight backwards. No violence should ever be used; for, besides being unavailing, it greatly aggravates the inflamed state of the contents of the hernial sac, and has been known even to burst the intestine. (See *Sir A. Cooper, On Inguinal Hernia, &c.* p. 23.)

Besides bending the thigh, care should also be taken to rotate it inwards, which will have great effect in relaxing the femoral fascia, and tendon of the external oblique muscle.

The manœuvre of gently pulling the intestine downwards, or a little way further out of the ring, previously to the attempt to reduce the hernia, has been suggested. (See *Balfour's New Mode of the Taxis*, in *Med. and Phys. Jour.* Nov. 1824.) The plan, I believe, is not entirely new. Mr. Lawrence says that it will sometimes succeed when the difficulty of reduction is owing to an accumulation of fæcal matter.

The return of a piece of intestine is generally preceded by a peculiar noise, caused by the passage of air through the stricture. It recedes at first gradually, and then slips up suddenly. The omentum goes up slowly to the very last portion, which must be actually pushed through the opening. If the taxis should not succeed at first, it will often do so after the warm bath, bleeding, or cold applications. Small herniæ, being attended with the closest stricture, are the most difficult to reduce; and, for the same reason, crural ruptures do not so often yield to the taxis as inguinal herniæ in the male subject. The taxis becomes less likely to succeed the longer the inflamed viscera have been down, because adhesions are liable to form. Mr. Lawrence observes (p. 63), "When the rupture becomes painful, we are no longer justified in persevering in attempts at reduction by the hand. A sufficient pressure cannot now be endured; and the force which is employed only tends to increase the inflammation, and accelerate the approach of gangrene. *At this period the operation is required, and should be performed without delay.*" Desault even proscribed the taxis altogether in the inflammatory strangulation until the previous use of other means had produced a change in the state of the swelling.

That the taxis is frequently abused and the cause of serious mischief, is a truth which cannot be doubted. "Strangulated herniæ (says Scarpa) very frequently mortify from the negligence of the patients, and their repugnance to submit to an operation, and perhaps still more frequently from the effect of the taxis unskilfully exercised by uninformed surgeons, who are determined, at any price whatsoever, to accomplish the speedy reduction of the viscera. The majority of them make no distinction between the *acute* and the *chronic* strangulation. In both cases, no sooner are the symptoms of strangulation evinced than they begin to handle the swelling roughly, and to push the viscera with all their force, in order to make them return into the abdomen; whilst, when the strangulation is *acute*, and the patient young and strong, the taxis ought never to be practised before all the means proper for diminishing the strength, calming spasm, and relaxing the parts which are to be reduced, have been employed for a certain time. These means, we know, are bleeding, fomentations, emollient clysters, and especially the warm bath, which, next to bleeding, holds the first rank. At this school of surgery I have frequently had opportunities of observing the salutary effect of this treatment. My pupils have more than once seen herniæ which had been painfully handled without any good, reduced, as it were spontaneously, after a bleeding, or whilst the patient was in the bath. If what I have said upon the subject of the *acute* strangulation, and the treatment that it requires, were generally known by surgeons, I think that operations for strangulated herniæ would be less frequent.

"Things are different with regard to the *chronic* strangulation of old large herniæ in feeble or aged persons; for in these cases it is of great importance to support the patient's strength. Bleeding, the warm bath, and other weakening means should also be avoided, which, by producing a general atony, might bring on gangrene of the intestine, either during the strangulation, or after the reduction of the viscera. It is ascertained that these kinds of strangulation are almost always occasioned by an accumulation of fæcal matter, or an extraordinary quantity of air in the hernia. Nothing is more efficacious than cold applications for promoting the action of the bowel on the matter which distends it, or for lessening the volume of the hair. They produce a corrugation of all the scrotum, and contractions of the cremaster, which alone sometimes suffice for reducing the viscera in a much better manner than could be done by the hands of the most experienced surgeon." (*Scarpa, Traité des Hernies*, p. 244—247.) The advice of Mr. Guthrie respecting the taxis is in exact accordance with that of Scarpa. (*On Inguinal and Femoral Hernia*, p. 23.)

Bleeding.—The inflammation which attacks the protruded viscera and spreads thence over the whole abdomen, the temporary weakness, and often fainting, which the sudden loss of blood induces, and the favourable state in which it places the patient for reducing the hernia by the hand, are the reasons in favour of bleeding. Sharp, Pott, B. Bell, Sabatier, Richter, Callisen, Sir Astley Cooper, and Scarpa, names which can never be surpassed in respectability, are all in favour of bleeding. Wilmer and Alanson have published against the practice. Sir Astley Cooper thus expresses himself on the subject of bleeding:—"The object of it is, first, by the general languor which it occasions, to produce a relaxation of the strictured part, and next to prevent the local inflammation from running so high as to occasion mortification, which would render the case fatal, though the protruded parts were returned. The quantity of blood to be drawn should be from fourteen to twenty ounces, according to the strength of the patient's constitution. So much should be taken away as to bring on a degree of faintness, in which state of general relaxation the attempts at reduction should be repeated. A surgeon unaccustomed to the small thready pulse of a person suffering under strangulated hernia, feels apprehensive of taking away blood, conceiving the patient's strength to be fast sinking; but this fear is groundless, as the pulse becomes larger and fuller after this evacuation." (*Sir Astley Cooper, On Abdominal Hernia*, p. 32, ed. 2.)

Mr. Hey has related two cases which strongly evince the manner in which bleeding facilitates the return of a hernia: the protruded viscera, in one instance, went up spontaneously on blood being taken away; in the other, the taxis succeeded immediately afterwards, though the previous attempt had been made in vain (p. 125, 126). Mr. Hey's experience, however, leads him to concur so far with Wilmer and Alanson as to declare that bleeding has generally failed to procure a reduction of the strangulated intestine, though he is persuaded that in many cases it may be used with advantage. But he cannot agree with Wilmer that it generally renders the subsequent operation more dangerous (p. 126). The majority of candid practitioners, I believe, will allow that bleeding is always proper when the hernia is small and recent, the abdomen tense and painful, and the patient young, strong, and plethoric. [Since the introduction of chloroform, bleeding is seldom had recourse to, and never merely to produce faintness and loss of muscular power.]

In some old herniæ, where the symptoms depend upon mere detention of the intestinal matter, without any serious degree of compression of the bowel, and very little pain in the tumor itself, bleeding is not indicated. In these old and well-marked cases of the passive state of the abdominal opening, as Mr. Guthrie calls them, "Bleeding to syncope will only weaken the patient and do little good. The warm bath will not be very effective, and tobacco enemata in elderly persons are sometimes dangerous. The three principal remedies in recent herniæ which have become strangulated are here of little use, save as they act generally in reducing inflammation, because there is no muscular contraction to subdue; whilst, on the other hand, cold steadily applied may be of great service, when combined with such mechanical pressure as may be found advisable. In these cases, stimulating injections are also of great use; and, if they be applied, as Mr. O'Beirne of Dublin advises, by means of a tube ten inches long, with a hole at the end of it, and introduced into the sigmoid flexure of the colon, the happiest results will follow, &c. It draws off the flatus, as well as the watery contents of the bowels, whilst the application of ice, acting on the tumor, condenses the air in the incarcerated intestine, and tends to cause it to pass more readily into the abdomen." (Op. cit. p. 27.)

Purgative Medicines. — Mr. Hey's experience leads him to condemn almost universally the use of purgatives while an intestine remains firmly strangulated. In the entero-epiplocle, when the intestine has retired, and the omentum remains strangulated, or in a simple strangulation of the omentum, where the intestine has not been prolapsed, he deems purgatives of great utility. So likewise in very large and old herniæ, where there is reason to doubt whether the disease is not to be considered as a morbid affection of the intestinal canal rather than the effect of strangulation, purgatives, he believes, may be as useful as in the simple ileus without hernia. While the intestine remains firmly strangulated, they usually increase the vomiting, and add to the distress of the patient. If they are to be tried at any time with hope of success, the trial would appear to have the greatest advantage when the vomiting has been removed by means of an opiate; yet Mr. Hey had repeatedly given them in vain during such an interval of relief. (*Practical Obs. in Surgery*, p. 128.)

Purgatives are supposed to operate by exciting the peristaltic action of the intestine, and thereby extricating it from the stricture. Not only Hey, but Pott and Richter, have joined in their general condemnation. Sir Astley Cooper also disapproves of cathartics, except when the symptoms are very slight, and there is either no vomiting, or only at distant intervals. (*On Abdominal Hernia*, part i. p. 34, ed. 2.) Under these circumstances, he has known opium, joined with calomel and cathartic extract, produce stools, and relieve the patient.

Purgative clysters certainly have not the objection of increasing the irritation, but their efficacy is not deserving of much confidence. Mr. Hey never saw one case in which either purgative or emollient clysters produced a return of a strangulated hernia. Such injections will empty the large intestines, but they do no more. It is common also for a natural evacuation to be the immediate consequence of strangulation (p. 131). Mr. Guthrie's opinions, with regard to cases likely to be served by stimulating clysters, have already been noticed.

Warm Bath.—" Many instances (says Hey) are upon record of the good effect of warm bathing in procuring the reduction of a strangulated hernia. I have often seen it useful, but I have often seen it fail. Whenever it is used in this disease, the patient should be placed, if possible, in a horizontal position. Gentle efforts with the hand to reduce the prolapsed part are perhaps attended with less danger, and with greater prospect of success, while the patient lies in the bath, than in any other position. The free use of opiates coincides with that of warm bathing, and, under some circumstances, these means deserve to be tried in conjunction" (p. 132).

Cold Bath, and Cold Applications.—The cold bath, and dashing of cold water on the patient, are little to be depended on, though success has sometimes been obtained in this manner. (*Petit, Mal. Chir.* t. ii. p. 325; *Hey*, p. 136.)

Wilmer strongly recommended the application of cold to the tumor itself; and this plan has acquired the approbation of the most celebrated modern surgeons. It is sometimes tried in conjunction with the effect of tobacco clysters. Cold applications, in the form of ice, were indeed particularly recommended by B. Bell. The best way is to pound the ice, tie it up in a bladder, and place it on the rupture. Its effect is to lessen the pain, to diminish the bulk caused by flatus, to make the skin over the tumor contract, and thus promote the return of the parts. When ice cannot be procured, Sir Astley Cooper employs a mixture of equal parts of nitre and muriate of ammonia. To one pint of water, in a bladder, ten ounces of the mixed salts are to be added. "If, after four hours (says this distinguished surgeon), the symptoms become mitigated, and the tumor lessens, this remedy may be persevered in for some time longer; but if they continue with unabated violence, and the tumor resist every attempt at reduction, no further trial should be made of the application." (*On Inguinal and Congenital Hernia.*) When ice is not at hand, ether sometimes proves a good substitute, when allowed to evaporate from the surface of the swelling.

Care must be taken that the cold be not so applied as to freeze the scrotum and bring on sloughing. (*Sir A. Cooper*, p. 15.) In large old herniæ, the application of ice is often attended with remarkable efficacy; and in other cases, as Sir Astley Cooper has explained, if it does not completely succeed, it arrests the progress of the symptoms. (*On Abd. Hernia*, part i. p. 34, ed. 2.)

Opiates.—Mr. Hey met with several cases in which opiates, given freely (in athletic persons after bleeding), procured a reduction of strangulated hernia. He could not say, however, that this remedy was generally successful; but it appeared to him to have the advantage of removing, for a time, the pain and vomiting usually attendant on strangulation, even though it proved ultimately inefficacious. Opiates should be given in large doses, when it is wished to try their effect in procuring reduction; and whenever the symptoms of strangulation return, after having been removed by opiates, the operation should be performed without delay (p. 134, 135).

Sir Astley Cooper states that opium allays the vomiting, and, after venesection, promotes the reduction. (*On Abdominal Hernia*, part i. p. 34.)

Tobacco Clysters.—For this purpose some surgeons prefer a decoction of tobacco, made by infusing, or boiling, one drachm of the plant, for ten minutes, in a pint of water. Next to the operation, tobacco clysters are the most certain means of bringing about the reduction of the strangulated parts. Besides exciting the action of the intestines, they exert a peculiarly depressing influence on the whole system, reducing the pulse, and causing nausea and sickness, cold sweats, and fainting, under which circumstances the parts often recede spontaneously, or may be easily reduced. Sir A. Cooper prudently advises injecting half the above quantity at first; for he has seen two drachms, and even one, when used as an infusion, and introduced at once, prove fatal (p. 24). The rest should be injected when it appears that the tobacco does not operate with the extraordinary violence with which it does in a few particular constitutions.

A case published by Sir C. Bell looks to me very much like an example of the occasional poisonous effects of the tobacco. At least, no particulars of any fatal mischief, either in the tumor or abdomen, are detailed; and it is remarked of the patient, "His strength held up until the tobacco clyster was administered to him, after which he very suddenly fell low and sank." (*Surgical Obs.* part ii. p. 189.) The smoke proved fatal in an instance witnessed by Desault (*Œuvres de Chir.* t. ii. p. 344); and an infusion of ʒij. to ℥viij. of water seemed to produce suddenly mortal effects in another example on record. (*Edinb. Med. and Surgical Journ.* vol ix. p. 159.)

[The tobacco enema is almost discarded in the present day, the introduction of chloroform having superseded every other means of depriving the patient of muscular effort.]

When the patient is old or considerably debilitated, the tobacco clyster should not be employed; for if it fail the constitution will not afterwards be in a state to bear the operation. I have known it succeed, however, in an aged person. A woman, above sixty years old, was brought to University College Hospital with a strangulated femoral hernia. The taxis and other means not having answered, I recommended the operation; but she obstinately refused to submit to it. As a last expedient, I directed the tobacco clyster to be employed, and in half an hour the hernia returned almost of itself. In another case admitted into the same hospital, encouraged by the foregoing one, I tried the tobacco clyster for the relief of a strangulated femoral hernia in an aged female, but, as the parts could not be reduced, I performed the operation; the sickness ceased; stools soon followed; and the pain and fever entirely subsided. But the weakness was such that nature made little or no effort to heal the wound; the hernial sac sloughed, and the case ended fatally on the sixth or seventh day. This example, I should say, was against the employment of tobacco clysters in old persons.

Poultices and Fomentations have not the confidence of any experienced or intelligent surgeon. Whoever, in these urgent cases, wastes time in trying the effects of such applications, merits censure for his credulity, ignorance, and unfitness to undertake the treatment of a rapid disease, in which, as Pott remarks, if we do not get forward, we generally go backward; and whatever does no good, if it be at all depended upon, certainly does harm, by occasioning an irretrievable loss of time.

Of the Order in which the preceding Methods should be tried, and of the Time when the Operation should be no longer delayed.

In the treatment of a strangulated hernia, a surgeon cannot be too deeply impressed with the danger of spending time in the trial of methods of inferior efficacy, or of such as are evinced to be ineffectual in the cases before them. The rapidity with which gangrenous mischief sometimes arises, and the patient loses his life, has been proved in a multitude of unfortunate examples, and should act as a warning to all practitioners against the danger of deferring the operation too long. In the course of my reading, however, I have not met with so remarkable an instance of the sudden mortification and rapidly fatal termination of a hernia as the following case, recorded by Baron Larrey in speaking of the fatiguing and forced marches performed by the French soldiers in Egypt. These marches, he says, brought on in one case, "a hernia which formed suddenly, and became at the same time strangulated. The man was immediately brought to my ambulance; but a spontaneous gangrene, which had all on a sudden attacked the intestine, and extended to the other abdominal viscera, caused the patient's death in the space of two hours, and made it impossible for me to do the operation for him. This is the second example that I have been acquainted with in which the effects were thus rapid." (*Mém. de Chir. Militaire*, t. i. p. 196.)

The taxis is generally among the first things to be tried; and Sir A. Cooper recommends the attempts to be continued for a quarter or half an hour. When these have been ineffectual, the patient, if the circumstances do not forbid, should be immediately bled, and a large opening made in the vein, so that the suddenness of the evacuation may be most likely to bring on fainting. The taxis should then be tried again.

When the strangulation is very *acute*, and the patient young and strong, perhaps it may be most advisable to follow the advice delivered by Scarpa and Desault, which is, to bleed the patient, and put him in the warm bath, before the taxis is attempted at all.

If bleeding alone has been practised, and the manual efforts at reduction should not now succeed, the warm bath may be employed, *provided it can be got ready in a very short time*, but none should ever be lost in waiting for it to be prepared. When the bath is used the taxis may be attempted as the patient lies in the water, a situation in which I have succeeded in reducing several herniæ.

Certainly not more than one hour should ever be allotted for putting in practice the first attempts at reduction, bleeding, and the warm bath.

The plan should be, while the trial of one thing is going on, another should be preparing; so that, when the preceding measures have been tried in vain, the application of a bladder filled with ice or the solution of nitre and muriate of ammonia, and, if the patient be not aged nor of too debilitated a constitution, the injection of tobacco, in the form of smoke or decoction, should never be delayed for want of due previous preparation of all the requisites. Both these measures should be practised at the same time, immediately after the failure of the taxis, bleeding, and the warm bath. Sir Astley Cooper computes that four hours are enough for the trial of the tobacco clyster, together with cold applications.

In omental herniæ, the necessity for operating may frequently be obviated by the good effects of bleeding, purgative medicines, and clysters, and leeches applied to the tumor. Mr. Lawrence has justly observed, that "when, as it very frequently happens, the aid of the surgeon is not required until the complaint has lasted for some time, a trial of the tobacco, together with the topical use of cold, should be immediately resorted to, as circumstances will not admit of delay in the previous use of less powerful remedies" (p. 148, ed. 3).

Every man who has seen much of herniæ will immediately recognise the propriety of the following sentiments of the experienced Hey:—"I can scarcely press in too strong terms the necessity of an early recourse to the operation, as the most effectual method of preserving life in this dangerous disease. If Mr. Pott's opinion be true, that the operation, when performed in a proper manner and in due time, does not prove the cause of death oftener than perhaps once in fifty times, it would undoubtedly preserve the lives of many to perform it almost as soon as the disease commenced, without increasing the danger by spending much time in the use of means which cannot be depended upon for a cure. I have twice seen this disease prove fatal in about twenty-four hours. In such cases it is evident there is little time for delay. A surgeon who is competent to perform the operation is not perhaps consulted till the intestine is on the point of being mortified, or is actually in a state of mortification. The dilemma into which he is then cast is painful indeed. But when the fullest opportunity is afforded him of using the best mode of treatment, I am satisfied that his success will be the greatest when the operation is not long delayed. This, at least, has been my own experience. When I first entered upon the profession of surgery, in the year 1759, the operation for strangulated hernia had not been performed by any of the surgeons in Leeds. My seniors in the profession were very kind in affording me their assistance, or calling me into consultation when such cases occurred; but we considered the operation as the last resource, and as improper until the danger appeared imminent. By this dilatory mode of practice, I lost three patients in five upon whom the operation was performed. Having more experience of the urgency of the disease, I made it my custom, when called to a patient who had laboured two or three days under the disease, to wait only about two hours, that I might try the effect of bleeding (if this evacuation was not forbidden by some peculiar circumstances of the case) and the tobacco clyster. In this mode of practice, I lost about two patients in nine upon whom I operated. This comparison is drawn from cases nearly similar, leaving out of the account those cases in which a gangrene of the intestine had taken place.

"I have now, at the time of writing this, performed the operation thirty-five times, and have often had occasion to lament that I had performed it too late, but never that I had performed it too soon. There are some cases so urgent that it is not advisable to lose any time in the trial of means to produce a reduction. The delay of a few hours may cut off all hope of success, when a speedy operation might have saved the life of the patient" (p. 141, &c.)

To determine the exact moment when to give up the trial of the preceding measures, and to have immediate recourse to the operation, is certainly difficult; but no one can doubt that it is generally better to operate too early than too late.

All directions must be general ones, liable to many exceptions; in rapid cases, little or no time should be allotted to the trial of any plan, and the operation should be done without the least delay. In other instances, we have full time to try the effects of everything at all likely to succeed. The symptoms which ought to guide us in having recourse to the operation arise from an attack of inflammation in that part of the intestine contained in the hernial sac, and from its spreading into the abdominal cavity. It is in proportion to their violence that we ought to urge the performance of the operation. Sir A. Cooper considers pain on pressing the belly, and tension, as the symptoms which point out its immediate necessity. He adds, "Indeed, there is scarcely any period of the symptoms which should forbid the operation; for, even if mortification has actually begun, the operation may be the means of saving life, by promoting the ready separation of gangrenous parts." (*On Inguinal and Congenital Hernia*, p. 27.)

According to Mr. Guthrie, if a patient labour under a strangulated hernia, even one of recent formation, and the general symptoms are very severe, the operation should not be delayed, although the tumor itself may be comparatively but little painful. "These general symptoms are the pain at the umbilicus, the irritability of the stomach, the anxiety of countenance, and the failing state of the pulse. If, in a young healthy man, strangulation had existed only four or six hours, the swelling were tense and painful when touched, the nausea and sickness frequent, the pain at the umbilicus severe and increased on pressure, the pulse small and hard, the countenance distressed, Mr. Guthrie would be for the immediate performance of the operation. If the part were but little painful, and the umbilicus not acutely sensible, he would defer the operation until the effect of bleeding unto syncope, in combination with the hot bath, had been ascertained. Mr. Guthrie remarks that a hernia of recent formation cannot remain in a state of incarceration ending in strangulation for a longer period than ten hours, without placing the patient's life in great jeopardy." (*On Inguinal and Femoral Hernia*, p. 24.) I have sometimes operated directly, without expending time in the trial of any measure but the taxis: of course, these were urgent and advanced cases.

[In all cases of strangulated hernia after the taxis has failed in the warm bath, probably more lives would be saved by the patient being placed, without further delay, under the influence of chloroform, and if the taxis should be again unsuccessful, by at once proceeding to perform the operation.]

Whenever the surgeon has succeeded in reducing the parts without having recourse to the knife, if the symptoms of pain, inflammation, &c. ran high before such reduction, they will not always cease immediately afterwards. As they probably depend on the reduced bowel having been inflamed by the stricture, the body should be kept open, and the diet and regimen should be low and sparing, whilst the least degree of pain and tension remain; in short, till all complaint is absolutely removed from the abdomen, and the intestines do their office freely and without trouble. (*Pott.*)

SYMPTOMS OF A STRANGULATED HERNIA.

According to Sir Astley Cooper, one of the earliest symptoms of a strangulated hernia is pain about the diaphragm, followed by continual eructation. The patient is next troubled with vomiting and costiveness. He feels a great inclination to have stools, but cannot succeed in his attempts to expel the fæces. There is some pain in the swelling, and a great deal at the part where the stricture is situated. Afterwards the abdomen becomes considerably distended with air, such distension not arising from inflammation, but from the cause here mentioned, as is proved by pressure on the abdomen not giving at first any pain. The vomiting becomes more frequent, and fæculent matter is ejected from the stomach, into which it is brought by what is called the antiperistaltic action of the bowels. A clyster will sometimes bring away a portion of fæculent matter, but the quantity will be extremely small. While the abdomen is in this tense state, but unaccompanied with pain, and while there is frequent vomiting of the fæces, the pulse is hard, frequent, and very distinct; but, in the next stage of the symptoms, when the abdomen is not only tense, but painful on being touched, the pulse is extremely small and frequent. The vomiting and eructations continue, and the patient is pale, and covered with a cold perspiration. The tumor becomes very tense, hard, and in general a little inflamed on the surface of the skin. With respect to the hiccough which now succeeds, and which has usually been considered as a sign of the presence of gangrene, Sir Astley Cooper declares that it is now known not to be so, patients having had it for many hours, and yet recovered after the operation. The truth of this observation was exemplified in two instances in which I have had occasion to operate. Hiccough sometimes continues several days after the operation. If the protruded parts be not now returned by means of the operation or otherwise, "the tension of the belly, the restlessness, and fever having been considerably increased for a few hours, the patient suddenly becomes perfectly easy, the belly subsides, the pulse, from having been hard, full, and frequent, becomes low, languid, and generally interrupted, and the skin, especially that of the limbs, cold and moist; the eyes have now a languor and a glassiness, a lack-lustre not easily to be described; the tumor of the part disappears, and the skin covering it sometimes changes its natural colour for a livid hue; but whether it keeps or loses its colour, it has an emphysematous feel, a crepitus to the touch, which will easily be conceived by all who have attended to it, but is not so easy to convey an idea of by words; this crepitus is the too sure indicator of gangrenous mischief within. In this state, the gut either goes up spontaneously, or is returned with the smallest degree of pressure; a discharge is made by stool, and the patient is generally much pleased at the ease he finds; but this pleasure is of short duration, for the hiccough and the cold sweats continuing and increasing, with the addition of spasmodic rigors and subsultus tendinum, the tragedy soon finishes."

ANATOMY OF INGUINAL HERNIA.

This subject must necessarily precede the account of the operation, which would otherwise be unintelligible. It is chiefly in the anatomical information relative to hernia, and in the mode of operating, that modern surgeons have a decided superiority over their predecessors; for, before Gimbernat, Camper, Sir Astley Cooper, Hey, Lawrence, Scarpa, Hesselbach, Langenbeck, and Cloquet, published their several works on hernia, the anatomy of the disease was but imperfectly understood. Of all the eminent men who have rendered our knowledge of the anatomy of hernia more correct, none has equalled Sir Astley Cooper in the number and importance of original observations. His description of the inguinal canal, the first accurate one ever given; his account of the fascia transversalis (a texture which had not been contemplated, with reference either to anatomy or disease, previous to his researches); his interesting observations on the muscularity of the internal ring; his description of the fascia propria of crural hernia; and an infinite number of pathological and practical facts, make Sir Astley Cooper the individual whose labours, more than those of any other surgeon, have contributed to the advancement of this most important and difficult subject.

The tendinous fibres of the aponeurosis of the external oblique muscle, as they run downwards and forwards towards the pubes, separate from each other so as to leave a triangular opening, called the external abdominal ring, which is usually more capacious in the male than the female subject. The upper and inner pillar (as it is termed) of this aperture is inserted into the symphysis of the pubes, and is the weakest of the two; the lower and outer one, which is the strongest, is chiefly a continuation of Poupart's ligament (*Hesselbach, Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche,* p. 4), and is fixed into the tuberosity and crista (*pectineal line*) of the same bone. Some tendinous fibres cross the upper and outer angle of the ring (*inter-columnar fibres*), so as to diminish the triangular appearance of the whole aperture: these are particularly strong in old herniæ. The anterior and thicker layer of the aponeurosis of the internal oblique muscle joins the tendon of the external oblique; the posterior and thinner one joins that of the transversalis; but the lower portion of this tendon, together with the corresponding part of the transversalis, goes wholly in front of the rectus muscle. Thus, the inferior border of the obliquus internus and transversalis, which originates from the upper half of Poupart's ligament, lies behind the outer pillar of the abdominal ring. Sir A. Cooper first noticed that a thin fascia proceeds from the inner edge of Poupart's ligament, and spreads over the posterior surface of the transversalis muscle. This fascia forms a partition between the peritoneum and the outer opening of the abdominal ring; and were it not for its existence, inguinal herniæ would probably be much more frequent. In front of it are the aponeuroses of the internal oblique and transverse muscles. Hesselbach, who has named the small smooth point, situated directly behind the outer opening of the abdominal ring, its *crural surface*, distinctly states that it is formed by delicate fleshy and tendinous fibres of the internal oblique muscle [the fibres are tendinous in this position, not tendinous and fleshy] (*Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche*, p. 4); and that behind them is the weakest part of what he names the *internal inguinal ligament*, (*fascia transversalis*,) in the rear of which is the peritoneum, with the intervention of a very loose cellular substance. (Op. cit. p. 26.) The *internal inguinal ligament* of Hesselbach is therefore clearly the same thing as the above fascia (*fascia transversalis*) first described by Sir A. Cooper. This point of the abdomen is one of the three weak places on the inside of the inguinal region, where herniæ are liable to occur; yet, weak as it appears to be, it is not the most common situation of such tumors. A computation has been made that, in a hundred cases of inguinal hernia, not ten occur at the point here specified. (*H. J. Brüninghausen, Unterrich über die Brüche, &c.* Wurzb. 1811.) Mr. Lawrence observes that, if we trace the fascia transversalis from the crural arch upwards, we shall find it divided immediately into two portions, an internal and external, which leave between them a considerable interval just in the middle of the crural arch. The former of these, which is the strongest, and most decidedly fibrous, is connected by its inner edge to the outer margin of the rectus, and to the inferior margin of the tendon of the obliquus internus and transversus; and both are gradually lost above, between the peritoneum and transversus. (*On Ruptures*, ed. 4, p. 179.)

The spermatic vessels, joined by the vas deferens, run in front of the epigastric artery, very near the place of its origin. They then pass through an opening in the above fascia (*internal abdominal ring*), go under the edge of the internal oblique and transverse muscles, and next obliquely downwards and forwards, first between the above fascia and aponeurosis of the external oblique muscle, then between the last-named structure and conjoined tendons of the transversalis and internal oblique, to the opening of the external ring. When arrived on the smooth surface immediately behind this ring, they describe an obtuse angle, and pass forwards and downwards into the scrotum. (*Hesselbach*, op. cit. p. 5.)

Thus, the spermatic cord, before it actually emerges at what is named the abdominal ring, runs through a kind of canal, to which the epithet *inguinal* is often applied. This oblique passage of the cord through the abdominal parietes was well known to and elegantly delineated by Albinus. Gimbernat makes distinct mention of it in his *Account of a New Method of operating for Femoral Hernia*, p. 19, 32. But Sir A. Cooper has the merit of having given the earliest correct account of it in reference to hernia; a subject rendered complete by the more recent elucidations of Hesselbach, Scarpa, Langenbeck, and Cloquet.

The external abdominal ring is then only the outer opening of the canal or passage through which the spermatic cord passes before it emerges. The inner ring, at which the viscera first protrude in the most common cases of inguinal hernia, is situated about an inch and a half from the external ring, in the direction towards the anterior superior spinous process of the ilium; or, according to Sir Astley Cooper and Hesselbach, the inguinal canal is almost an inch and a half in length, the average distance of the outer pillar of the external ring from the inner pillar of what the latter terms the posterior ring being about sixteen lines. (Op. cit. p. 14.) This inner opening is rather nearer to the pubes than to the anterior superior spine of the ilium; it is formed in the fascia transversalis, and from its margin the infundibuliform fascia or fascia propria of an oblique inguinal hernia is derived.

"The precise point at which the hernia most commonly begins (says Scarpa) is that which corresponds in the fœtus to the communication of the tunica vaginalis with the peritoneum, and in the adult to the passage of the spermatic cord [through the internal ring and] under the transverse muscle. In the sound state, the peritoneum presents at this part a small funnel-like depression, the depth of which increases in proportion as the spermatic cord is pulled from above downwards. It is this small pouch, this sort of digital appendage, whose progressive augmentation constitutes the hernial sac. Resting upon the anterior surface of the spermatic cord, it first makes its appearance under the inferior edge of the transverse muscle; thence it extends itself in the separation of the inferior fleshy fibres of the internal oblique muscle, always following the spermatic cord, in front of which it is situated; and, after having in this manner passed through the whole of the canal, which extends from the iliac region to the pubes, it lastly protrudes at its external orifice, which is the inguinal (*external abdominal*) ring, properly so called. In all this track the hernial sac, as well as the spermatic cord, is situated above the femoral arch (*Poupart's ligament*), the direction of which it follows. The canal which it traverses is of a conical shape, the apex of which is towards the ilium, and the base at the external orifice of the ring." (*Scarpa, Traité des Hernies*, p. 44, 45.)

The inguinal canal is wider, and its apertures are much more distinct, in the male, than the female subject.

The epigastric artery runs behind the spermatic cord, along the inner margin of the internal opening of the above canal, then upwards and inwards, so as to pass at the distance of half an inch, or an inch, from the upper extremity of the outer opening, or external abdominal ring.

In common cases of oblique inguinal hernia, the viscera protruded at the inner opening of the inguinal canal lie over the spermatic cord, and form a tumor on the outside of the abdominal ring.

When the viscera have entered the above-described digital pouch of the peritoneum, and the inguinal canal, but do not protrude through the external abdominal ring, the case is sometimes termed an *incomplete inguinal hernia* (*bubonocele*), and *complete* when they pass out of that opening. The viscera may continue for a long while quite within the inguinal canal, and even become strangulated there: sometimes, also, they are prevented from passing further towards the external ring by some kind of impediment; and, in this circumstance, if the hernial sac have any addition made to its contents, it may expand between the external and internal oblique muscles, as Hesselbach had an opportunity of seeing in the body of a female. (*Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche*, p. 28.) The stricture may take place either at the internal or external opening of the inguinal canal. In recent and small herniæ, according to Sir A. Cooper, the strangulation is most frequently situated at the inner opening; in large old ruptures, at the external abdominal ring. Even when the parts completely protrude out of the latter opening, the strangulation may exist at the inner one; but there may occasionally be two strictures, viz. one at each opening. (See *Lawrence*, *On Ruptures*, p. 183, edit. 3.)

In the foregoing part of this article, I have briefly adverted to the doctrine that the upper part of the inguinal canal is endowed with muscularity. "The lower edge of the transversalis muscle (observes Sir Astley Cooper) has a very peculiar insertion, which I have hinted at in my work on hernia. It begins to be fixed into Poupart's ligament, almost immediately below the commencement of the internal ring, and it continues to be inserted behind the spermatic cord into Poupart's ligament, as far as the attachment of the rectus [and into Gimbernat's ligament]. Thus the inguinal canal is endowed with muscular contraction, which, under the action of the abdominal muscles, serves to close it and lessen the propensity to hernia. Sometimes a portion of muscle descends from the tendon of the transversalis, in the course of the linea semilunaris, to be inserted into the fascia transversalis behind the cord, and into Poupart's ligament. It is this circular insertion of the transversalis which is the cause of stricture in inguinal hernia, in the course of the canal, and nearly at the upper ring.

"Behind this insertion of the transversalis muscle the internal portion of the fascia transversalis appears, adhering strongly to the tendon of that muscle at the back of the inguinal canal.

"Thus the inguinal canal is, at its anterior part, formed by the tendon of the external oblique; at its posterior, by the tendon of the transversalis, and by its folded muscular fibres, behind which is the fascia transversalis, into which those fibres are also inserted." (See *Obs. on the Structure and Diseases of the Testis*, p. 35, 4to. Lond. 1830.)

[The anterior boundary of the inguinal canal is formed for its lower two-thirds by the tendon of the external oblique alone, and for its upper third by the fleshy fibres of the internal oblique as well as the tendon of the external oblique; the posterior boundary is constituted for its upper two-thirds by the transversalis fascia only, but for the lower third by the conjoined tendons of the transversalis and internal oblique together with the transversalis fascia.]

Mr. Guthrie also describes the internal ring, or superior opening of the inguinal canal, as muscular; and he even supposed that "the opinion that this opening is in many instances a muscular one," was first advanced by himself in 1816. [Mr. Guthrie here means the upper part of the inguinal canal, not the opening in the transversalis fascia properly called the internal abdominal ring.] This claim cannot, however, be maintained against that of Sir Astley Cooper, who, in 1804, made the following observations with regard to the arrangement of the muscles at the internal ring:—"Hereby (says he) may be explained the opinion which some surgeons have entertained of the *spasmodic* nature of the stricture,—a state which it was difficult to account for when the seat of strangulation was supposed to be confined to the external ring, as this tendinous aperture possesses no muscular action, and cannot assume the state of spasm" (p. 28, part i.) In another place, in noticing the means for reducing strangulated femoral hernia, Sir Astley Cooper remarks: "These means (tobacco and opium, &c.) are less frequently effectual here than in the inguinal hernia, which is probably owing to two causes; namely, to the nature of the parts through which the hernia descends, and the smallness of the aperture forming the mouth of the sac. In the inguinal hernia, the parts are so connected with muscles, that any relaxation brought on in these affects the aperture through which the hernia descends; but, in crural hernia, the seat of the stricture is in parts less connected with the action of the muscles, and general relaxation has little effect on them." (Part ii. p. 9.) Mr. Swan, who attended Sir Astley Cooper's lectures in the winters of 1810-11 and 1812-13, heard him then explain that the lower part of the transversalis muscle was the cause of stricture in inguinal hernia. (See *Mr. Aston Key's Remarks in Lond. Med. Gaz.* 1833-34, p. 283.) As this gentleman observes, "if recent evidence be required, it may be found in Sir Astley Cooper's description of the cremaster in his work on the *Testis*. In plate 5, fig. 1, is a view of the muscular structure in the inguinal canal; and the explanation of the plate says, 'C. C. transversalis muscle, arising from Poupart's ligament, and passing around the spermatic cord at the internal ring, so that the fibres of this muscle appear behind as well as before the spermatic cord; and thus the inguinal canal is rendered a muscular canal.'" In explanation of plate 6, fig. 1, there is also the following note:—"Muscular fibres are always found proceeding from the transversalis muscle upon that part of the fascia transversalis which forms the posterior surface of the inguinal canal." The love of truth, then, obliges me to assign to Sir Astley Cooper the merit of this, as well as of numerous other original observations on hernia.

One question yet remains to be settled. Is the encircling of the spermatic cord by the fibres of the transversalis only an occasional variety, or is it the ordinary condition of it? I know that several lecturers on anatomy take the former view. (See *Lond. Med. Gaz.* 1833-34, p. 399.) M. Cloquet had seen the lower margin of the transversalis at a very considerable distance above the ring. He had also seen the spermatic cord enter the inguinal canal, passing between the fibres of the same muscle, which were only separated, without accompanying the cord, as those from the internal oblique do. These facts M. Cloquet manifestly speaks of, as deviations from what is most usual. M. Cloquet likewise notices another variety in the anatomy of the parts. "In the majority of subjects (he observes) the spermatic cord passes underneath the lower border of the internal oblique, which it draws with it, to form the cremaster. In these cases, the anterior arches only exist, but in some individuals it evidently traverses the fibres of this muscle; and these arches exist then not only in front, but also behind the testis and tunica vaginalis, which thus become everywhere surrounded by them." (See *Jules Cloquet's Description of the Parts concerned in Inguinal and Femoral Herniæ, translated by A. M. M'Whinnie*, p. 13.) On the same subject, Scarpa says, "The lower muscular fibres of the internal oblique separate from each other to allow the spermatic cord to pass between them." (*On Inguinal and Scrotal Hernia*, p. 25, English ed.)

The hernial sac descends through the external abdominal ring over the spermatic cord, and is covered by a fascia sent off from the tendon of the external oblique muscle (*intercolumnar fascia*). Beneath this fascia, the cremaster muscle is also situated over the sac, which, after it has descended a certain way, lies on the tunica vaginalis, as well as the spermatic cord. [Under this again is another fascia, derived from the internal ring, and in immediate contact with the hernial sac, called by the several names of *fascia propria, fascia infundibuliformis, fascia spermatica interna.*]

As the epigastric artery naturally runs first behind the spermatic cord, and then along the inner margin of the internal ring, and as the viscera are protruded over the cord, they must be situated on the outer side of the artery, which runs first behind the neck of the sac, and then on its inner side. Hence the inner margin of the sac, when inspected on the side towards the abdomen, seems to be formed, as it were, by the track of the vessel. (See *Lawrence*, p. 179.) That this is the ordinary situation of the epigastric artery, in relation to the oblique inguinal hernia, is confirmed by the concurrent testimonies of Camper, Chopart, Desault, Sabatier, Sir A. Cooper, Hesselbach, Scarpa, &c., and by preparations to be seen in almost every museum.

In recent oblique inguinal herniæ, the internal and external rings are at some distance from each other, the first being situated obliquely upwards and outwards in relation to the former ; but the pressure of the protruded viscera gradually forces the internal opening more towards the pubes, and nearer to the abdominal ring, so as to render the neck of the hernial sac, and the inguinal canal, very short. (*Hesselbach*, p. 29.) Thus, in large herniæ of long standing, the opening into the abdomen is almost direct, and the epigastric artery becomes situated nearer the pubes than in the natural state.

Though such is the ordinary direction in which inguinal hernia protrudes, there are occasional varieties. In one of these, the viscera, instead of descending through the inguinal canal, are at once thrust through the external abdominal ring itself (*direct inguinal hernia*), and the opening into the belly is then direct; the hernial sac, instead of passing on the external side of the spermatic vessels, as is usual, now lies on their inner or pubic side.

The following is Scarpa's description of the displacement of the epigastric artery in the greater number of cases of inguinal hernia :—" This artery, which, in the natural state, runs about ten lines from the external abdominal ring, has its situation and direction so changed in subjects affected with hernia, that it crosses the posterior part of the neck of the hernial sac, and is pushed from the outer to the inner side of the abdominal ring. In order to comprehend the reason of this displacement, it is necessary to recollect what I have elsewhere said of the formation of inguinal hernia, and of the manner in which the spermatic cord crosses the epigastric artery. The hernia begins to form at the very place where the spermatic cord passes under the inferior margin of the transverse muscle, and this place is rather nearer the ilium than that where the epigastric artery passes towards the rectus muscle. In its progressive extension, the hernial sac constantly follows the same track as the spermatic cord, since it is situated upon its anterior surface. As has been already explained, this cord crosses the epigastric artery; consequently the hernial sac must necessarily pass with the cord above this artery, before protruding from the canal of the abdominal ring. At the same time, the internal orifice of the hernia becoming larger, and the inguinal canal shortened by the approximation of its two orifices to each other, it follows that, at the period when the hernia begins to make its appearance in the groin, the epigastric artery is unavoidably situated behind the neck of the hernial sac, and is pushed from the outer to the inner side of the ring. The removal of the epigastric artery from one side of the ring to the other (says Scarpa) is a phenomenon which may be regarded as almost constant in oblique inguinal hernia.

[If there be any obliquity in the neck of the sac, the epigastric artery will not be displaced to the extent supposed by Scarpa; in fact, the artery will move with the neck of the sac only. Wherever this is situated in oblique inguinal hernia, there will be the epigastric artery in close contact with its inner side. It is therefore only in those cases of long standing, where the internal ring is drawn down to the situation of the external ring, and where the inguinal canal is consequently obliterated, that the epigastric artery is so displaced as to be situated as far inwards as the inner border of the external abdominal ring. In such cases the artery will be found to surround three parts of the neck of the sac, the posterior, the inner, and the upper side. We have several times dissected cases of this kind, which could hardly be distinguished from cases of direct inguinal hernia. In these instances we have remarked that the artery so surrounded the upper as well as lower and inner part of the neck of the sac, that the only safe direction to divide the stricture would be upwards and outwards, and that Sir A. Cooper's advice to cut directly upwards in all cases would almost of necessity lead to the wounding of this artery.]

Scarpa continues : — " I have examined the bodies of a great number of subjects affected with this species of hernia, and it has been only in a very few that I met with the epigastric artery retaining its natural situation on the outer side of the abdominal ring. In investigating the reason of this exception, I have observed in all the individuals who presented it a very remarkable weakness and flaccidity of that part of the abdominal parietes which extends from the ilium to the pubes. In all, *the displaced viscera had passed through the aponeurosis of the transverse and internal oblique muscles;* not in the vicinity of the ilium, as is commonly the case, but *at a little distance from the pubes,* giving to the upper pillar of the ring a curvature that is extraordinary, and disproportioned to the smallness of the hernia. [This is the direct inguinal hernia of Sir A. Cooper.] I observed also that the neck of the hernial sac did not pass in an oblique direction from the ilium to the pubes, but that it protruded from the abdomen almost in a direct line from behind forwards. In short, in these individuals, the small cul-de-sac of the peritoneum, which constitutes the origin of the hernial sac, had not begun to be formed under the edge of the transverse muscle, at the point where the spermatic cord runs outward; but *it had passed through the aponeurosis of the internal oblique and transverse muscles, at a little distance from the pubes, and within the point at which the spermatic cord crosses the epigastric artery.* The small hernial sac, having at this part come into contact with and united to the spermatic cord, protruded at the external orifice of the inguinal canal, without displacing the epigastric artery from its natural situation.

"This species of hernia, properly speaking, is a mixture of the ventral and inguinal. It resembles the former, inasmuch as the hernial sac pierces the aponeurosis of the transverse and internal oblique muscles; the latter, inasmuch as it passes out at the abdominal ring, conjointly with the spermatic cord." (*Scarpa, Traité des Hernies*, p. 68, &c.)

Hesselbach particularly adverts to a *triangular space* to be seen on the posterior surface of the inguinal region: the inner boundary of it is formed by the outer edge of the rectus muscle; the lower by the horizontal branch of the os pubis, and the external shortest boundary by the epigastric artery. Now, says he, when it is considered that this artery ascends obliquely inwards, between the inner opening of the inguinal canal, and the above triangular space, one cannot fail to know on which side of the neck of the sac the artery must lie in the two species of inguinal, as well as in crural, hernia; for in those herniæ which originate in the above triangular space, this artery lies at the outer side of the neck of the hernial sac; while in every hernia that takes place through the inner opening of the inguinal canal, the same vessel is situated at the inner side of the neck of the sac. To one species of inguinal hernia Hesselbach applies the epithet *external*, and to the other *internal*, according to the situation of the point at which they first protrude. By Sir A. Cooper they are named *oblique* and *direct*, which are also very proper terms. The external inguinal hernia is much more frequent than the internal, and is said to occur oftener on the right than the left side of the body; a circumstance coinciding with another observation, viz. that in children the tunica vaginalis remains longer open on the right than the left side.

The circumstance of there being two forms of inguinal hernia formerly caused considerable perplexity: surgeons knew that the epigastric artery lay sometimes at the inner, sometimes at the outer side of the neck of the hernial sac, but knew not how to account for this variation. Hence arose the very different opinions about the proper method of dividing the ring when the hernia was strangulated; some authors directing the incision to be made obliquely upwards and inwards, and others upwards and outwards. But, as a modern writer has judiciously remarked, had they paid greater attention to the direction of the swelling formed by the neck and body of the hernial sac in the groin, and to the position of the spermatic cord, which is as inconstant as that of the epigastric artery; and had they dissected the parts in the diseased as well as healthy state, they could not have failed soon to have suspected that every inguinial hernia does not originate exactly at one and the same point. Though the internal, or direct inguinal hernia, had been occasionally noticed by surgeons many years ago, and Mr. Cline, in particular, saw an example of it in the year 1777, and always mentioned it in his subsequent lectures, yet the earliest satisfactory history of the differences of the two forms of inguinal hernia was given by Sir A. Cooper, in his great work on hernia; and the tract in which Hesselbach pointed out the nature of the internal inguinal hernia in a very particular manner, I believe is the next publication in which the subject is explained. (*Anat. Chir. Abhandlung über den Ursprung der Leistenbrüche*, Wurzb. 1806; and *Neueste Anat. Pathol. Untersuchungen über den Ursprung, &c. der Leisten-und-Schenkelbrüche*, 4to. Wurzb. 1814, p. 18, 26, 28, &c.) According to the latter author, since each form of inguinal hernia presents characteristic appearances externally, the surgeon can have no difficulty in determining the species of hernia; which discrimination must be highly important in the taxis, in the application of a truss, and especially in performing the operation. The sac of the external scrotal hernia can only pass down within the fascia infundibuliformis, and the expansion of the cremaster as far as this latter part is separate from the cord and tunica vaginalis. Hence, the testis, covered by its tunica vaginalis, lies under the lowest part of the hernial sac, while the vessels of the spermatic cord, in a more or less separated form, are situated behind the posterior part of the sac, viz. the spermatic veins externally, and the vas deferens internally, and the artery in the middle. Should the hernia descend still further, the testis being included as well as the sac within the tendinous expansion of the cremaster, it cannot glide out of the way, but must be pressed still further downwards by the sac, so as to continue invariably under its fundus, but sometimes inclined a little behind it. (*Hesselbach*, p. 34.) And, as the same author justly observes, the position of the spermatic cord and testis, and the oblique direction of the swelling in the external species, are the two strongest characters by which every case of inguinal hernia may be discriminated. I know of only one *direct* case in which the cord was behind the sac, as in the common external inguinal hernia; it was seen by Mr. Lawrence. (*On Ruptures*, p. 210, ed. 4.)

[Two kinds of direct inguinal hernia are now recognised by surgeons; they have been distinguished from each other by the terms of superior and inferior. The latter is the more common, and has been sufficiently described in the preceding two columns. The former, or *superior direct* inguinal hernia, will be readily understood by a reference to the anatomy of the posterior surface of the abdominal wall in the inguinal region. It will be remembered that a triangular space here exists, already alluded to, bounded internally by the rectus muscle, externally by the epigastric artery, and below by the inner half of Poupart's ligament. This triangular space is opposite to the external abdominal ring, and to the inner two thirds of the inguinal canal. It is divided unequally by the remains of the umbilical artery as it ascends obliquely upwards and inwards to gain the umbilicus. The ordinary direct inguinal hernia protrudes into the larger space which is situated between the rectus muscle and the remains of the umbilical artery. The *superior direct* or more rare kind takes the smaller space left between the latter structure and the epigastric artery. Both kinds of direct inguinal hernia would therefore be situated internal to the epigastric artery. But the superior internal inguinal hernia would enter the inguinal canal close to this artery, and would pass under the lower edge of the transversalis and internal oblique muscles. It would here come in contact with the cord, and would gain a covering from the cremaster muscle. In its further descent through the external ring into the scrotum it would of course retain its position with regard to the cord and the cremaster muscle. The coverings of this hernia would be the same as in the oblique inguinal kind, viz. besides the skin and superficial fascia, the intercolumnar fascia, the cremaster fascia, and the fascia transversalis. It would differ from oblique inguinal hernia in not passing through the internal ring, in not passing under the deep covering of the cord (fascia infundibuliformis), and in having the epigastric artery on the outside of the neck of its sac, while the remains of the umbilical artery would be in contact with its inner side. It would differ from the inferior direct hernia, in its relation to the remains of the umbilical artery, in its oblique position in the inguinal canal, and, lastly, in being covered by the cremaster muscle.]

Although the spermatic cord in the external inguinal hernia commonly lies behind or under the hernial sac, there are cases in which the vas deferens is found on the outer side of it, while the rest of the spermatic cord lies, as it usually does, on the inner side, or rather under it. (*Sir A. Cooper.*) Le Dran, Schmucker, and Blizard found the whole cord situated in front of the sac. Sometimes the vas deferens runs on the front and inner part, and the rest of the cord on the back and external part of the swelling. (*Camper*, *Hey.*) The vessels of the cord have been known to be before, and the vas deferens behind the sac. (*Camper*, *Sir A. Cooper.*)

Upon this part of the subject, the reader may deem the following passage interesting :—“ While the hernia is of moderate size (says Scarpa), the surrounding cellular substance is not very greatly compressed, and no change is observed in the situation of the spermatic vessels. The artery and veins of this name always form, with the vas deferens, one single cord, which is intimately adherent to the posterior surface of the hernial sac. But, in proportion as the tumor increases in size, the cellular substance, which immediately surrounds it and unites it to the spermatic cord, is more and more distended and compressed. At length, at a certain period, the distension is carried to such a pitch, that the spermatic vessels are separated from one another, and change their position with respect to the hernial sac. This kind of gradual unravelling of the spermatic cord is quite similar to that which would be produced by pulling the surrounding cellular substance in two opposite directions. Such is the reason why, in scrotal hernia of large size, the spermatic artery, the vas deferens, and the spermatic veins, are found separated upon the posterior surface of the sac. All these vessels, instead of being conjoined in one cord, are divided by interspaces, which are sometimes very considerable. Ordinarily, the vas deferens is less separated from the spermatic artery than from the vein of this name. In some subjects, Camper has seen it situated on one side of the sac, and the artery and veins on the other. (*Icones Herniarum*, tab. v. *L. O.* tab. viii. 1, 2.)

When an oblique inguinal hernia is dissected, a fascia, of greater or less thickness, is found immediately under the skin and *superficial fascia:* it is often termed the *intercolumnar fascia*, or *fascia spermatica externa.* Under this is *the covering produced by the cremaster.* When the *integuments*, *superficial* and *intercolumnar fasciæ*, and the *cremasteric covering*, have been removed, another investment is exposed, derived from the fascia transversalis, where it forms the internal ring, and called by M. Jules Cloquet the *funnel-shaped sheath*, and by others, *fascia propria*, *fascia spermatica interna.* Within this is the hernial sac itself, composed of peritoneum.

It is observed by Professor Scarpa, that “the cremaster muscle, in cases of old large scrotal herniæ, acquires a thickness which is really surprising. Its fibres, which are naturally very thin, become from four to six times more considerable. Being spread over the neck and body of the hernial sac, they sometimes present a remarkable consistence, and a yellowish colour. Such alteration, however, does not prevent the muscular texture from being discovered; and Haller was not mistaken about it.” (*Opusc. Patholog.* p. 317.) Pathology furnishes us with several examples of similar changes of organisation. In certain cases, the muscular coat of the bladder, that of the stomach and intestines, and even the exceedingly delicate fleshy fibres of the ligaments of the colon, are found to have become yellow, and much thickened.

In old scrotal herniæ (says Scarpa) it is not unusual to find an intimate adhesion of the fibres of the cremaster muscle to the edges of the abdominal ring. This may depend on the pressure which the contents of the hernia make on those edges, and perhaps it may also depend on the union of the cremaster muscle with the prolongation of fascia (*intercolumnar fascia*), which is continued from the margins of the ring to the groin and scrotum. However this may be, certain it is, that in old large scrotal herniæ there is much difficulty in introducing a probe between the fleshy fibres of the cremaster and the margin of the abdominal ring; and that, on the contrary, in recent herniæ, a probe passes as easily between the edges of the ring and the cremaster, as between this muscle and the hernial sac.

Scarpa concurs with Sir Astley Cooper, respecting the fact of the peritoneal hernial sac not being in general perceptibly thickened. In a very enormous hernia, the pressure of the contents is so great, that instead of thickening the sac, it renders it thinner, and even makes it ulcerate. The protruded viscera have been met with immediately beneath the integuments, when the sac has been burst by a blow. (*Cooper*, *J. L. Petit.*)

The outer surface of the peritoneal part of the hernial sac is always most closely adherent to the other more external coverings by means of cellular tissue. This connection is formed so soon after the first occurrence of a hernia, that any chance of returning a hernial sac into the abdomen has generally been considered as chimerical. There must, however, be a certain space of time before adhesions form, though it must be exceedingly short. Upon this point Scarpa observes, that in recent and small inguinal herniæ, the intestine, strangulated by the neck of the hernial sac, has been known, in more instances than one, to have been reduced by the taxis, and carried with it the whole of the sac into the abdomen. Observations, not less authentic, inform us, that, after the operation for hernia, when the viscera could not be reduced on account of their adhesions to the sac, they have been seen, notwithstanding such adhesions, to get nearer to the ring daily, and, at length, spontaneously to return into the belly together with the hernial sac. M. Louis, he thinks, was wrong in denying the possibility of these facts (*Acad. Royale de Chir.* t. xi. p. 486.)

Scarpa argues, that, "under certain circumstances, the cellular tissue will bear, without laceration, a considerable elongation, and afterwards shrink again. Thus, we often see a viscus, which has suffered a considerable displacement, return spontaneously into its natural situation. In oblique inguinal hernia, the spermatic cord is elongated, and descends further than in the natural state. No laceration of the cellular tissue, however, is then occasioned; for, if the hernia be kept reduced, the spermatic cord becomes shorter, daily retracts, and at last has only the same length which it had previously to the disease. When a sarcocele becomes large and heavy, the portion of the spermatic cord naturally situated within the belly is by degrees drawn out into the scrotum; but, after the tumor is extirpated, this portion ascends again, and of itself returns into its original situation. The same thing happens after the operation for strangulated inguinal hernia. The hernial sac retracts and reascends progressively towards the ring. This alone would prove, that the cellular tissue which surrounds the spermatic cord, and unites it to the hernial sac, is highly endowed with the property of yielding, and afterwards returning to its original state. Can the same property be refused to the cellular tissue which unites the sac to the surrounding parts?

"While the inguinal hernia is recent, and not of much size, the cellular tissue in question possesses all its elasticity, and hence the hernial sac and the spermatic cord may easily ascend towards the abdominal ring. I have had occasion (says Scarpa) to make this observation upon the dead body of a man who had an incipient inguinal hernia. The small hernial sac was capable of being pushed back into the ring with the utmost facility; and in carefully examining the parts, both within and without the belly, it appeared to me that the cellular substance which united the sac to the spermatic cord and cremaster muscle was disposed to yield equally from without inwards, and in the direction precisely opposite; that is to say, it made an equal resistance to the protrusion and the reduction of the hernial sac. Monteggia has seen a case exactly similar; although, according to his own expressions (*Institut. Chirurg.* t. iii. sec. 2, p. 249), the hernial sac was not very small, it adhered very loosely to the surrounding parts, and it admitted of being entirely reduced into the abdomen with great facility."

In large old scrotal herniæ, Scarpa allows that such reduction is quite impracticable:—"In these the cellular tissue which unites the sac to the spermatic cord and cremaster muscle, has acquired such a density, that it does not oppose less resistance to the further enlargement of the hernia, than to the efforts of the surgeon who endeavours to effect its reduction." (*Scarpa, Traité des Hernies*, p. 57, &c.)

In the dead subject, Cloquet found the sac of a direct inguinal hernia reduced into the abdomen, whither it seemed to have been drawn by a piece of omentum adherent to what had, in its protruded state, been its fundus. (*Recherches sur les Causes, &c. des Hernies*, p. 102.) The investigations of the same author prove, that complete or incomplete inversions of the sac may also happen in femoral and in direct inguinal hernia, without the existence of any adhesion; but that the intimate union between the sac and spermatic cord hinders the event in external or common inguinal ruptures. Le Dran dissected a case in which the sac of a femoral hernia, with its contents, had been returned into the abdomen in a mass. Dupuytren saw a similar case. (*Clin. Chir.* t. i. p. 559.) And in another place, he states, that he had seen forty instances of herniæ being returned in a mass, without any abatement of the bad symptoms (p. 564). The observations of Cloquet also tend to confirm the possibility of the latter occurrence, which he describes as happening with more facility in the internal or direct inguinal rupture, than in the crural, and with most difficulty in the external or oblique inguinal hernia.

In females, when an inguinal hernia occurs (which is uncommon), the round ligament of the uterus bears the same relation to the tumor as the spermatic cord in males. According to Sir Astley Cooper, the sac is much more considerable above the abdominal ring than below it; and hence difficulty in the operation. All the cases which he has seen have been intestinal. The stricture is, in almost all cases, at a considerable distance above the abdominal ring; it may be divided upwards or outwards with safety, as the epigastric artery is situated more towards the linea alba. (See *Lancet*, vol. ii. p. 172.)

Mr. Lawrence had a very rare instance pointed out to him, in which an inguinal hernia in a female was situated on the inner side of the epigastric artery. On the 12th of March, 1831, I operated upon Mrs. Smith, of No. 14 Cumberland Street, Middlesex Hospital, for a strangulated internal inguinal hernia; she recovered in the most favourable manner. A still rarer case was examined by Hesselbach; it was not only an example of an internal inguinal hernia in a woman, but of one in which the epigastric artery arose from the obturatrix artery an inch from the origin of this latter vessel from the inner side of the external iliac; the obturatrix first passed an inch obliquely downwards and inwards over the crural vein, and immediately afterwards, on the horizontal ramus of the pubes, made a sudden turn backward and downward to the obturator foramen; and at this bend arose the epigastric artery, which ran transversely inward along the horizontal ramus of the pubes, behind the neck of the hernial sac, at the inner side of which it ascended to the rectus muscle, accompanied by the ligamentous remains of the umbilical arteries, which were close behind it. (*Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche*, p. 17.)

[According to Hesselbach's nomenclature, on account of the position of the artery, this ought to be called an external inguinal hernia, although it did not pass out of the internal ring, but directly through the abdominal wall, between the internal ring and the remains of the umbilical artery. According to Sir A. Cooper it might be termed a direct inguinal hernia with the epigastric artery on the inside of the neck of the sac from irregularity of distribution of that artery.]

Marks of Discrimination between Inguinal Herniæ and other Diseases.

The disorders in which a mistake may possibly be made, are *Varicocele*, *Bubo*, *Hydrocele*, and *Hernia Humoralis*, or *Inflamed Testicle.*

For an account of the manner of distinguishing the first complaint from a hernia, see Varicocele.

"The circumscribed incompressible hardness, the situation of the tumor, and its being free from all connection with the spermatic process, will sufficiently point out a bubo, at least while it is in a recent state; and when it is in any degree suppurated, he must have a very small share of the *tactus eruditus*, who cannot feel the difference between matter, and either a piece of intestine or omentum.

"The perfect equality of the whole tumor, the freedom and smallness of the spermatic process above it, the power of feeling the spermatic vessels and the vas deferens in that process, its being void of pain upon being handled, the fluctuation of the water, the gradual formation of the swelling, its having begun below and proceeded upwards, its not being affected by any posture or action of the patient, nor increased by his coughing or sneezing, together with the absolute impossibility of feeling the testicle at the bottom of the scrotum, will always, to an intelligent person, prove the disease to be a hydrocele." The transparency of a hydrocele is also another criterion. Mr. Pott, however, allows that there are some exceptions, in which the testicle cannot be felt at the bottom of the scrotum, in cases of hernia. "In recent herniæ, while the sac is thin, has not been long or very much distended, and the scrotum still preserves a regularity of figure, the testicle may almost always be easily felt at the inferior and posterior part of the tumor. But, in old ruptures, which have been long down, in which the quantity of contents is large, the sac considerably thickened, and the scrotum of an irregular figure, the testicle frequently cannot be felt, neither is it in general easily felt in the *congenital hernia* for obvious reasons."

On one point, Sir Astley Cooper differs from Mr. Pott. "The hydrocele (he observes) involves the *spermatic cord* and testis, so as to render them with difficulty distinguished by the touch; whilst, in hernia, they may in general be readily felt behind the tumor." The discrepancy may be reconciled by supposing that one of these eminent surgeons is speaking of a hydrocele of great size, which obscures the cord, and that the other is alluding to the disease in a less advanced stage. Sir Astley Cooper has seen cases of hydrocele, "in which there was unusual difficulty in deciding upon the nature of the complaint. When it becomes so large as to extend upwards through the abdominal ring to the abdomen, the form of the tumor is precisely the same as that of hernia; and it even dilates when the patient coughs, owing to the sudden pressure upon that part of it which lies above the ring. The transparency, the fluctuating feel, and the observed progress of the swelling from below upwards, are then the only distinguishing marks.

"A tumor sometimes appears in the scrotum, which descends in the erect posture, returns when the body is recumbent, distends upon coughing, fluctuates, and is transparent. This disease is a collection of water, which runs backwards and forwards, between the cavity of the abdomen and that of the tunica vaginalis, owing to the opening of this membranous sheath never having been closed. When this disease is complicated with ascites, the part becomes distended to an enormous size. It is readily distinguished from a hernia by its transparency and fluctuation." (See *A. Cooper, On Hernia*, part i. p. 16, ed. 2.) [To this condition the term congenital hydrocele is usually applied.]

Hydrocele of the spermatic cord is another case still more likely to be mistaken for a hernia than the common form of hydrocele. (See HYDROCELE.) When situated entirely below the ring, its want of connection with the abdomen makes it readily distinguishable from a hernia; but when it passes within the ring to the abdomen, some difficulty occurs in understanding its nature. If there is no transparency, and the fluctuation is indistinct, the surgeon should be very cautious in operating on such a tumor.

Sir Astley Cooper was requested to see a boy who had a tumor extending from the upper part of the scrotum through the abdominal ring, along the cord to the abdomen; but it did not project sufficiently to enable Sir Astley to judge whether there was either fluctuation or transparency. However, as the tumor interfered with the boy's pursuits, he cut down upon it with extreme caution. When he had reached the surface of the cyst, he found the spermatic vessels running upon it, and was obliged to open the lateral portion of the cyst to avoid them. This sac contained a piece of small intestine, everywhere adherent to its inner surface, so as to have prevented reduction. The vas deferens was felt behind the sac. The hernia had therefore insinuated itself between the spermatic blood-vessels and the vas deferens. (See *A. Cooper*, *On Hernia*, ed. by *C. Aston Key*, part i. p. 61.)

Dr. J. B. Davidge, late professor of anatomy in the University of Maryland, had frequently been consulted by persons who had been wearing trusses for years, while their disease was merely hydrocele of the cord; and, in one case, the sac had been burst by the violent efforts made to reduce it. Dr. Reese, of New York, has also known this mistake committed in several instances. In another, a surgeon, deceived by such a hydrocele happening to be attended with long and obstinate constipation, nausea, vomiting, hiccough, abdominal distension, pain in the tumor, &c. dissected down to what he supposed to be the hernial sac, and divided the tendon of the external oblique, when the hydrocele gave way and its contents were discharged. (*Amer. ed. of this Dict.*) It seems extraordinary that the surgeon in this case should have divided the abdominal ring before he had opened the sac, or ascertained the situation of the stricture, so as to know whether the tendon of the external oblique required to be cut or not. The operation of opening the cyst of the hydrocele, though performed unawares, was only a common method of cure, and, in fact, ended in it. The manner of proceeding I am unable to account for, unless it was intended to try Petit's plan of cutting the stricture and reducing the hernia without opening the peritoneal sac at all.

In *hernia humoralis*, the pain in the testicle, its enlargement, the hardened state of the epididymis, and the generally preceding gonorrhœa, are circumstances fully elucidating the diagnosis. The observation of Pott, that, in inflammation of the testicle, the spermatic cord is exempt from all unnatural fulness, is not correct. I have known it enormously swollen and accompanied by obstinate constipation and vomiting; indeed, the swelling, when the case arises from gonorrhœa, mostly commences in the cord. "Nothing," says Sir Astley Cooper, "but great want of attention can cause a hernia to be confounded with an enlargement of the testis. This latter is sufficiently distinguishable, not only by the absence of symptoms characterising hernia," but also by the form of the gland, its weight, the pain, and that peculiar and intolerable sensation always produced by pressure on this organ. (*Obs.*)

Hæmatocele is recognised from a hernial tumor by adverting to its cause, which is a wound or contusion of the scrotum; its firmness; the attendant dark redness of the skin; its freedom from impulse when the patient coughs, and of the upper part of the cord from swelling. (*Sir A. Cooper*, ib.)

Hernia may be complicated either with hydrocele or sarcocele. Sir A. Cooper mentions an instance in which there was on each side a diseased testicle, and a hydrocele communicating with the abdomen. (*On Hernia*, ed. 2, part i. p. 17.) See Hydrocele.

Inguinal Hernia within the Canal.

When the parts only protrude into the inguinal canal, and not out of its lower aperture, they are covered by the aponeurosis of the external oblique muscle. The transverse and internal oblique muscles pass over the neck of the hernia, and cause the strangulation when it happens. The tumor is small; for, if the protrusion increases, the parts escape through the lower opening of the canal. Exceptions, however, are on record. Thus, Mr. Lawrence dissected a case in a female, where the aponeurosis of the external oblique was distended by a swelling equal in bulk to two fists, while another portion of the sac, as large as an egg, projected through the ring. Hesselbach's 8th plate also represents a hernia within the canal, of considerable size, in a female. As, in the ordinary circumstances of this form of inguinal hernia, there is no very manifest swelling, the case is no doubt often looked upon and treated, as Sir Astley Cooper remarks, as an inflammation of the bowels. (*On Inguinal and Congenital Hernia*, p. 48.)

When an inguinal hernia does not descend through the abdominal ring, but only into the canal for the spermatic cord, it is covered by the aponeurosis of the external oblique muscle, and the swelling is small and undefined.

[This kind of hernia is often called a bubonocele, or incomplete inguinal hernia.]

Now and then, the testicle does not descend into the scrotum till a late period, and its first appearance at the ring, in order to get into its natural situation, may be mistaken for a hernia; unless the surgeon pay attention to the absence of the testicle from the scrotum, and the peculiar sensation occasioned by pressing the swelling.

Points of Difference between the External and Internal Inguinal Hernia, &c.

According to Hesselbach, the characteristic marks of the external bubonocele and scrotal hernia are: 1st. The direction of the tumor in the groin. 2ndly. The fleshy fibres of the cremaster. 3rdly. The position of the spermatic cord and testis. 4thly. The situation of the epigastric artery. 5thly. The origin of the hernia itself. 6thly. A preternatural shape of the body of the hernial sac.

1. The neck of the hernial sac, distended by the protruded viscera, raises up the front side of the inguinal canal, and superincumbent integuments, into an oblong swelling, which extends obliquely inwards and downwards towards the abdominal ring, and terminates in the tumor, formed by the body of the hernial sac. From its origin it becomes gradually more prominent and broad; and the greater the quantity of viscera protruded, and the larger the body of the sac, the more manifest is this oblique swelling, particularly when the neck of the hernia is of its natural length. In strangulated cases, the direction of the tumor is still more striking, every part of the hernial sac being then considerably distended. When the inguinal canal, and of course the neck of the hernial sac, are shortened, the swelling undergoes a proportional diminution in its length; and then its resemblance, to the tumor attending an internal or direct inguinal hernia, where the opening through which the parts pass is long and slanting, is so great, that the cases can only be discriminated by one circumstance, viz., the situation of the spermatic cord; and even this criterion is of course wanting in females. (*Hesselbach*, p. 57, 58.) Hesselbach clearly explains, that the obliquity of the swelling is seated in the neck of the hernial sac. He observes, that when an internal inguinal hernia in a female subject passes into the labium, the descent takes place in a very sloping direction inwards, and therefore it may at first be supposed to be an external case. But, on further examination, the oblique swelling will be found to occupy the body of the hernial sac, and to reach upwards and outwards from the labium to the external abdominal ring Now, if this point be attended to, this hernia cannot be mistaken for an external bubonocele, the course of which from the external ring is obliquely upwards and outwards. As Sir Astley Cooper has remarked, if there be any obliquity of an internal or direct inguinal hernia, it will incline towards the linea alba.

Hesselbach reminds us, that an internal inguinal or scrotal hernia may be conjoined with an external incomplete bubonocele; a kind of case easily made out with a little attention; for the place of division between the two sacs is indicated by a more or less deep groove. The nature of the disease will also be still clearer, if one of the tumors admit of reduction. A specimen of such a double hernia is to be seen in the museum at Würzburg.

It is further noticed by Hesselbach, that when the situations of the external and internal herniæ are compared, the first of these swellings will be found to be rather further than the other from the symphysis of the pubes; a difference ascribed to the effect of the internal oblique muscle, the lower fibres of which, inserted into the linea ilio-pectinea, run in a curved direction transversely over the anterior and inner part of the neck of the hernial sac, and are applied so closely to it, that it cannot approach quite so much towards the symphysis of the pubes, as the neck of the internal hernia does.

2. Most of the fibres of the cremaster lie on the back of the neck of the sac, but others are also scattered over its external and internal sides. Some fibres may also be perceived on its fore part, which are remarkable, because they run in a transverse curved direction with their convexity down-

wards, fasciculi of which descend also below the abdominal ring. These are the fibres of the cremaster, which proceed within the ring transversely upwards over the spermatic cord, and are pushed out of that opening by the hernial sac. These arched fleshy fibres are not always, though generally, perceptible; and, when they are present on the fore part of the hernial sac, Hesselbach accounts them a sure criterion of an external scrotal hernia.

3. The spermatic cord passes behind the oblique hernia, and not on the outer side of it, as in a direct case.

4. The situation of the epigastric artery, and its displacement inwards by the neck of the sac, of an oblique hernia, have been sufficiently explained.

5. With respect to the mode in which the oblique hernia originates, the disease sometimes takes place suddenly, without any exciting cause being observed, cabable of accounting for the effect. Here, says Hesselbach, the predisposing cause must have been great. In this quick manner, the congenital hernia, which is one of the oblique cases, frequently arises. The direct inguinal hernia is observed mostly to take place very suddenly, yet only after violent occasional causes. Sir Astley Cooper records two cases from external violence: one in a gentleman who received a blow on the groin in riding; the other in a boy, in consequence of a kick from his schoolmaster. In the greater number of cases, he has found the direct inguinal hernia accompanied by diseases of the urethra. "One of the specimens (says he) in my possession, contains six herniæ of this kind." After death, several strictures were met with in the urethra, behind one of which a stone was impacted. (*On Abdominal Hernia*, part i. p. 67.)

In adults, an oblique inguinal or scrotal hernia, on the right side, contains generally some of the ileum, and, when the swelling is large, it may include the cæcum, and sometimes a piece of omentum. In one child, ten weeks old, and in another still younger, the appendix vermiformis was protruded and connected by a natural band to the posterior side of the peritoneum. When, in these ruptures of the right side, the cæcum, or in those of the left, the colon, are found closely connected with the hinder side of the hernial sac, the connection is not to be looked upon as the effect of disease, since it is the perfectly natural relation of those bowels with the peritoneum. On the left side, the parts most commonly protruded are the colon and omentum.

With regard to the *internal,* or *direct inguinal hernia*, the place of its first protrusion has been already described. The protruded peritoneum and viscera, according to Hesselbach's account, *pass from behind straight forwards*, between the fibres of what he names the internal inguinal ligament, and the fleshy fibres of the internal oblique muscle; they then pass, at the inner side of the spermatic cord, out of the abdominal ring, where the hernia presents *a circular globular swelling, suddenly formed in consequence of some violent effort.* The neck of the hernial sac is very short; shorter than it can ever be in an oblique inguinal hernia; and, when the tumor is of the above shape, the passage through which it passes is annular, narrower in some instances than others, and its margin is tendinous. Sir Astley Cooper has never known it acquire the enormous size which the oblique inguinal hernia sometimes attains. (*On Abdominal Hernia*, part i. p. 67.) From the few cases, which Hesselbach has seen of this form of the disease, he is also led to believe that the hernial sac is rarely so large as in the oblique inguinal hernia (p. 41). According to Sir Astley Cooper, the direct inguinal hernia occurs when the tendon of the transversalis is unnaturally weak, does not exist at all, or has been broken. (*On Inguinal Hernia*, p. 51.) Cloquet states, that the sac either propels before it, and thus receives a covering from the fascia transversalis, or passes through an opening in it. (*Recherches Anat.* p. 83.) In another work, he gives the particulars of a direct inguinal hernia of the right side, where the protrusion took place through a laceration in the fascia transversalis. (*Pathologie Chirurgicale*, p. 126.) Mr. Lawrence dissected a case, where the fascia was neither thinner than usual nor broken, but it had been protruded before the peritoneum, and formed a thick aponeurotic covering to the hernial sac. Mr. Stanley has always found it thus covered; and some specimens, illustrative of the fact, have been placed by him in the museum of St. Bartholomew's Hospital. (*On Ruptures*, p. 209, 211, ed. 4.) According to Langenbeck, this is the usual state of the parts. (*Comment.* § 105, tab. 17, 18, & 19.) Examined by accurate dissection, the course of the direct inguinal hernia appears to Sir Astley Cooper to be as follows:—"The sac first appears between the fibres of the tendon of the transversalis, nearly an inch directly above the ring, generally protruding before it the fascia transversalis. It then passes under the lower edge of the tendon of the internal oblique muscle. The epigastric artery runs upon the outer side of the hernial sac. The spermatic cord has no connection with it above the ring. The hernia then emerges from the abdominal ring, the spermatic cord being on its outer side, and it is covered with the fascia given off by the tendon of the external oblique (*intercolumnar fascia,*) but *not by the cremaster muscle.*" (*On Abdominal Hernia*, part i. p. 67, ed. 2.) There is some diversity in the descriptions given of the coverings of the direct inguinal hernia. In the dissection of a double scrotal hernia by Mr. Todd, where both protrusions were of the direct kind, "the cremaster muscle, on one side, was distinctly spread out on the fore part of the sac; while, on the other side, the character of the muscle was completely lost." (See *Dublin Hospital Reports*, vol. i. p. 231.) In a case described by M. Jules Cloquet, the coverings were besides the integuments and superficial fascia, 1. the intercolumnar fascia; 2. fleshy and aponeurotic fibres of the internal oblique muscle; 3. a thin fibro-cellular covering derived from the margin of a lacerated opening, in the fascia transversalis, by which the hernia had escaped; 4. the hernial sac itself. (See *Jules Cloquet*, *Pathologie Chir.* p. 126, 4to.) In general, if the hernia is at all covered by the cremaster, it can only be just at its outer part, as represented in the plate in Sir Astley Cooper's great work. (See p. 70, part i. ed. by *Mr. C. Aston Key.*) There must necessarily be some variety in the number of coverings of this hernia, in different cases, according to the circumstance of its being attended, or not, with a laceration of the conjoined tendon of the internal oblique and transversalis muscles. If weak, they may yield and form a covering. Sometimes, however, as already stated, the tendon of the transverse muscle is lacerated, and the hernia passes out, under that of the internal oblique. The fascia transversalis also may be completely lacerated, or it may be dilated into another investment. We may say, then, that the direct hernia is at all events seldom covered by the cremaster, but that it may have one covering which the oblique hernia has not; namely, that which is formed by a weak and dilated portion of the tendon of the transversalis muscle. In other respects, the coverings of the two herniæ are alike. The earlier dissections made by Hesselbach, led him to suppose, that the opening, through which the protrusion happens, is always annular, and the swelling in front of the ring globular; but subsequent cases, which he has met with, have informed him, that the opening is frequently sloping and longish; in which circumstance, the resemblance of the tumor to that of the external hernia with a shortened neck, is such, that the only mark of distinction between the two cases is the position of the spermatic cord. In females, even this criterion is of course deficient. (*Hesselbach*, p. 57.) Though individuals of almost every age are subject to internal hernia, they are much less common, than external cases. According to Hesselbach, they may be known by the following characters:—1. The swelling, formed by the body of the hernial sac, immediately in front of the abdominal ring. 2. The situation of the spermatic cord. 3. That of the epigastric artery.

1. The neck of the hernial sac, besides being very short, does not, like that of an external inguinal hernia, take an oblique direction, but advances straight from behind forwards, through the abdominal ring; and, as the body of the sac lies directly over the neck, none of the swelling formed by the distension of the latter part can be felt; nor does any other tumour, produced by the body of a hernial sac, ever cause a circular spherical swelling directly before the abdominal ring. The situation of the neck of this kind of hernia must already apprise us, that it is nearer than the external to the symphysis of the pubes; or, as Sir Astley Cooper states, the tumor below the abdominal ring is situated nearer the penis, than the swelling caused by an external or oblique inguinal hernia. (*On Abdominal Hernia*, part i. p. 67, ed. 2.) In women, the shape of the tumor is the only character by which the case can be distinguished. (*Hesselbach*, p. 43.) Above the abdominal ring, as Sir Astley Cooper has explained, "the sac passes directly upwards, so that no part of it takes the usual oblique direction towards the anterior superior spinous process of the ilium, but rather the contrary direction towards the linea alba."

2. The spermatic cord passes on the outer side of the direct inguinal hernia, instead of behind it, as in oblique cases, particularly at and above the abdominal ring. (See *Sir A. Cooper*, op. cit. part i. p. 67, ed. 2.) Hesselbach describes the cord as lying either upon the outer side, or outer half of the fore part of the upper portion of the hernial sac, the blood-vessels forwards, and the vas deferens backwards. When the sac is adherent to the whole length of the cord, below the external ring the testis is not situated under the fundus of the sac, as in the oblique scrotal hernia, but either at the fore part or outer side of the body of the sac. The hernial sac, as far as the abdominal ring, is excluded from any of the coverings of the spermatic cord [but, at this opening, it descends between the cremasteric covering of the cord and the external spermatic fascia].

3. The epigastric artery always ascends obliquely inwards at the outer side of the neck of the hernial sac. Hesselbach has never seen but one case of internal inguinal hernia, in which there was a deviation from this rule. The example has been already mentioned; and was one in which the epigastric artery arose from the obturatrix about an inch from the origin of this last vessel. The viscera, usually contained in an internal inguinal or scrotal hernia, on the right side, are the lower part of the small intestines, and sometimes omentum; on the left, a part of the small intestines, frequently omentum, and, when the tumor is large, the colon may also protrude. A protrusion of the bladder may accompany the disease, but that organ is of course always excluded from the cavity of the hernial sac. When the remains of the umbilical artery are situated more outward than usual, and lie over the centre of the space, at which the protrusion happens, an internal inguinal hernia may be double, the prolapsus happening on each side of that ligamentous substance, which is itself also pushed outwards. In consequence of the accidental presence of some very strong tendinous fibres at the centre of the fascia, called by Hesselbach the internal inguinal ligament, there may also be two distinct protrusions, with separate hernial sacs (p. 46).

When the surgeon, by a due consideration of the foregoing circumstances, has formed a judgment respecting the nature of the hernia, he will be better qualified to regulate the treatment of the case. Thus, in the external or oblique inguinal hernia, he will know that the pressure employed for the reduction of the bowels should be made in the direction of the neck of the hernial sac, viz. obliquely upwards and outwards, towards the anterior superior spinous process of the ilium; but, that when the neck of the same kind of hernia is very short, and the posterior side of the inguinal canal has been removed by the approximation of the internal to the external ring, the pressure should be made nearly in a straight line from before backwards. For what Hesselbach terms the long-necked external inguinal hernia, the pad of a truss should be so constructed as not merely to press upon the external abdominal ring, but also upon the neck of the sac and the inner opening of the inguinal canal. But, when the neck of the hernia is very short, the pad should be nearly of the same form as that required for an internal inguinal hernia. (*Hesselbach*, p. 38; and *Brünninghausen, Gemeinnützige Unterricht über die Brüches, &c.* Würzb. 1811.) For this last case, or the direct inguinal hernia, Sir Astley Cooper recommends the truss to be longer than for an oblique bubonocele, because the hole, through which the sac emerges from the abdomen, is one inch and a half farther inwards towards the pubes. (Op. cit. part. i. p. 67.) In attempting the reduction of an internal inguinal hernia, the pressure should be directed nearly straight backwards; and the pad of the truss should only act upon the external abdominal ring. (*Hesselbach*, p. 46.) The direction given by Sir Astley Cooper is, that the tumor should be grasped with one hand, "but the fingers of the other are to be placed at the external abdominal ring to *knead* the hernia at that part, directing the pressure upwards and inwards, instead of upwards and outwards." (*Ib.*) It is a case in which the intestine often continues strangulated after the reduction within the ring. (See *Sir A. Cooper; Lancet*, vol. ii. p. 142.)

OPERATION FOR STRANGULATED INGUINAL HERNIA.

Sir Astley Cooper particularly recommends operations for strangulated herniæ to be performed before any peritoneal tenderness exists, which renders the issue very doubtful, though the parts be liberated by the division of the stricture. Such tenderness is not to be confounded with the tension produced by the inflation of the intestines. (*On Abdominal Hernia,* part i. p. 36, ed. 2.) "The herniæ of the very young and the very old require the operation less frequently than those of the middle period of life, when the fibres are firmer and the muscular strength more robust. In the tenderness of youth and the relaxation of age, the reduction of the hernia by the taxis is almost always practicable; and it is principally in old persons that much time elapses before the strangulation produces fatal effects; the period of their sufferings having been known to be protracted to twenty days." (*Sir A. Cooper*, op. cit. part i. p. 37, ed. 2.)

The operation consists in dividing the integuments; dissecting down to the sac, and opening it; removing the stricture; and replacing the protruded viscera. The hair is first to be shaved from the pubes.

The external incision should begin an inch above the outer angle of the external ring, and extend over the middle of the tumor to its lower part; except when the swelling is large, in which circumstance the cut need not extend so far down, as will be presently noticed. The advantage of beginning the wound so high, is to obtain convenient room for the division of the stricture. By the first incision the external pudic branch of the femoral artery may be divided: it crosses the hernial sac near the abdominal ring, and sometimes bleeds so freely as to require to be immediately tied. In general, however, a ligature is unnecessary.

When this incision is carried low down, the caution given by Camper should always be remembered, viz. that there is a possibility of dividing the spermatic vessels, should they happen to be situated, as they sometimes are, in front of the hernia. And, in order to avoid such an accident, which is particularly apt to occur in cases of internal inguinal or scrotal hernia, the incision through the skin should be made obliquely downwards and inwards. (*Hesselbach*, p. 46.) The division of the integuments brings into view the intercolumnar fascia, which is sent off from the tendon of the external oblique muscle, and forms the most superficial covering of the hernia. This and the deeper coverings, cellular substance, &c., intervening between the skin and sac, should be carefully divided, one after another, at one point, with the knife and dissecting forceps; the edge of the former instrument being turned horizontally, lest the incisions be carried too deeply at once, and the viscera contained in the sac wounded.

After making a small opening through a part of the fascia covering the sac, some practitioners introduce a director, and divide this fascia upward and downward, as far as the tumor extends. The same manner they next pursue with regard to the cremaster muscle, and fascia transversalis. Thus the sac becomes completely exposed. When this method is followed, Sir A. Cooper advises the incisions not to be carried upward nearer than one inch to the abdominal ring, for reasons which will be presently explained.

However, it may be rationally doubted whether there is any good in these formal and successive divisions of the whole length of the coverings of the sac, and it is certain that they protract the operation; for the manner in which the sac adheres to its super-imposed investment prevents the latter from being raised and cut without trouble and delay. As the grand object, after the skin has been divided is to make a small opening into the sac sufficient for the introduction of a director, dissecting down at one particular place answers every purpose, and enables us, in the end, to lay open the whole of the sac and its coverings in the shortest time. Let the operator only take care to raise the successive layers of fibres with the forceps, and divide the apex of each elevated portion with the knife held horizontally. As there is commonly a quantity of fluid in the sac, and it gravitates to the lower part, to which the intestine seldom quite descends, this is certainly the safest situation for making the first opening into the sac. The operator, however, should not rely upon the presence of such fluid, and cut too boldly; for sometimes it is absent, and the viscera may be in immediate contact with, nay, adherent to, the inner surface of the sac.

The circular arrangement of the vessels of a piece of intestine, and its smooth polished surface, sufficiently distinguish it from the hernial sac, which has a rough cellular surface, and is always connected with the surrounding parts; although these adhesions, in a very recent case, may be but slight. (*Lawrence*, *On Ruptures*, p. 232, ed. 4.)

I have mentioned, that Sir A. Cooper, only advises cutting the fascia, and other coverings of the sac, to within an inch of the abdominal ring; and, of course, he also recommends limiting the division of the sac itself to the same extent. His reasons for this practice are, to avoid making the closure of the wound more difficult, and to lessen the danger of peritoneal inflammation.

Having laid open the hernial sac with a probe-pointed bistoury, guided by a director, or the fore-finger introduced into the opening, made at the lower part of the sac, the next desideratum is to divide the stricture, unless the viscera admit of being easily reduced without such a division being made, as occasionally happens.

According to Sir Astley Cooper, the external abdominal ring is the principal point of strangulation in old and large oblique herniæ; and, in other cases, the stricture is more commonly seated at the internal ring, where the spermatic cord first quits the abdomen. "The strangulating pressure is here made by the internal oblique and transversalis muscle and its tendon, which pass over the hernial sac in a semi-circular direction, and by the fascia transversalis, arising from Poupart's ligament, the semi-circular border of which passes under the sac." (See *Sir A. Cooper*, *On Hernia*, part i. p. 29, ed. 2.)

Dupuytren calculated, that in at least eight out of every nine cases of strangulated oblique inguinal hernia the stricture was seated at the neck of the hernial sac. (*Clin. Chir.* t. i. p. 558.) This observation also led him to believe, that such stricture was formed by the neck of the sac itself, in consequence of change in the structure and disposition of this part of the peritoneum. In a recent protrusion, however, it is manifest that the strangulation cannot depend upon any thickening of the neck of the sac. We shall presently find also, notwithstanding the statement of Dupuytren respecting the great frequency of strangulation by the neck of the hernial sac, that he takes into the account the pressure made by the sharp margins of the inner ring. Hernia, constituting bulky external swellings, he found less subject to be strangulated in the neck of the sac, than cylindrical ones; but congenital herniæ were the most liable of all to a stricture so situated. He remarks, that, whenever the stricture is at the neck of the sac, the whole, one half, a third, or a quarter, of the hernia, may be pushed towards the abdomen, whence it afterwards descends again; but that for these circumstances to happen, the tumor must be cylindrical, the inguinal canal wide, and the peritoneal surface not adherent. If, says Dupuytren, the stricture were at the external ring, within the canal, or at its upper orifice, the tumor could not undergo such movement, because these parts are nearly unyielding, while the neck of the sac is quite otherwise, on account of the looseness of its connections. Dupuytren cautions surgeons not to be deceived by this apparent reduction; but, to use every possible means to make the parts descend again; and, if these will not answer, he advises dividing the external ring, and drawing down the intestine. He had been called upon to adopt this practice in more than ten cases in the Hôtel Dieu. (*Clin. Chir.* t. i. p. 565.) Another observation made by this celebrated surgeon, is, that when the stricture is situated at the external abdominal ring, the tumor, formed by the hernia, does not reach above this point. All the track of the inguinal canal is undistended, soft, and indolent to the touch, while the external ring itself is closed, hard, and tense. On the other hand, when the stricture is at the neck of the hernial sac, that is, as high up as the superior orifice of the inguinal canal, this canal is always full, hard, and painful; and a cylindrical tumor can be felt, directed from below upwards, and from within outwards. So far is the external ring from causing the constriction, that the finger may sometimes be insinuated between its margin and the protruded parts. In some patients Dupuytren found the strangulation existing all along the inguinal canal; a case, in which he recommends that canal to be laid open its whole length. He also notices the occasional existence of two strictures, a slight one at the external abdominal ring, and a closer one at the neck of the sac. (Op. cit. p. 565.)

The recollection of the frequent situation of the stricture higher up than the external ring, is of vast practical importance. I have seen several cases, where surgeons, imagining that the external ring caused the strangulation, divided it, and then pushed the hernia seemingly into the abdomen, but in reality only into the inguinal canal. The bad symptoms of course went on, and the patients lost their lives. Dupuytren was present at an operation where the same things happened. We should therefore, be careful to ascertain the seat of stricture, by drawing the protruded bowel gently down, and introducing the finger within the sac.

It is observed by Dupuytren, that when the stricture is placed at the upper orifice of the inguinal canal, the parts sooner become gangrenous, because the edges of this opening are so sharp, that they make great pressure on the neck of the sac; while the external ring, which is wider, and has blunter margins, causes a slower strangulation, and less pressure on the intestine. In the first case, the operation must in general be performed sooner than in the last. (*Dupuytren, Clin. Chir.* t. i. p. 566—569.)

When the mouth of the hernial sac becomes the seat of stricture, Sir Astley Cooper ascribes the circumstance to its inner part having been thickened by the pressure of the tendons of the internal oblique and transverse muscles; and "if a truss has occasioned much pressure on its outer side, the whole circle of the sac becomes thickened in consequence: thus, the cause of the stricture at the mouth of the sac is occasioned by parts external to the sac." (*Sir A. Cooper, On Hernia,* p. 30, part i. ed. 2.)

The common, and probably the best, practice, is to divide the hernial sac, together with the stricture. When this latter is situated at the external abdominal ring, the surgeon is to introduce the end of a director a little way into the neck of the sac, within the aperture in the tendon, and with a probe-pointed bistoury, guided on the director *he is to cut the stricture upwards and outwards, or else directly upwards;* Sir A. Cooper especially recommends the latter direction, because it is applicable to all cases, even the less frequent ones, in which the hernia protrudes at the inner side of the epigastric artery; and, in all common instances, we know that this vessel runs upward round the inner side of the neck of the sac; a course prohibiting the division of the stricture upwards and inwards.

In the external or oblique inguinal hernia, the method of cutting the stricture upwards and outwards is perfectly safe; but when the case is what Hesselbach calls internal, and the viscera descend on the inner side of the epigastric artery, it is a plan, which would endanger the latter vessel, and ought never to be adopted. As the epigastric artery ascends between the fascia transversalis, and the peritoneum, and not directly behind the tendon of the external oblique muscle, it is manifest, that the external abdominal ring itself may be safely divided in any direction, so far as that vessel is concerned. It is with reference to the division of a stricture more deeply seated at or near the internal ring, that the direction of the cut is of the highest importance in relation to the epigastric artery. Sir A. Cooper's rule of always cutting in one direction, viz. upward, which I believe was first advised by Rougemont, and afterwards by Autenrieth (*Dissert. Moment. circa Herniotom. præcipue circa evitandum Art. Epigastr. Læsionem.* Tub. 1799), is an excellent one, because it is easy for the memory, and will answer very well, even when it is not in the power of the surgeon to pronounce positively whether the case is a short-necked external inguinal hernia, or an internal one with an oblong oval fissure, cases having a great external resemblance to oblique hernia, especially in women, in whom there is not the spermatic cord as a criterion; for, after all, this part, when present, is the surest guide, and that on which Desault founded his perfectly safe advice, viz. when the cord is at the posterior or inner side of the neck of the hernial sac, to divide the ring upwards and outwards, but inwards and upwards when it lay at the outer or on the fore part of the sac. (*Œuvres Chir. par Bichat*, t. ii.) At all events, this advice is subject but to one exception, which is the very rare one of the epigastric running round the inner side of the neck of the sac in an internal bubonocele; a possibility which has been already explained, and which leads Hesselbach particularly to recommend, with Sir Astley Cooper, the division of the ring, in every internal or direct inguinal hernia, to be made straight upwards (p. 47). Indeed, the long-necked external bubonocele is the only case, in which he thinks the latter plan should give way to that of cutting upwards and outwards. The safety and propriety of the method of always cutting upward, are strikingly illustrated by what Scarpa observes. He states, that the right direction of the incision of the ring is directly upwards, parallel to the linea alba. "I have (says he) operated in the way which I recommend, upon several dead subjects, who had either external, or internal inguinal hernia, directing my incision in the course of a line drawn from the upper part of the ring parallel to the linea alba: in all, I constantly left the epigastric artery untouched, even when I extended the cut about an inch above the inguinal ring." (*Scarpa, Traité Pratique des Hernies*, p. 111.) Only one objection, so far as I know, has been made to this plan, and it is founded on the alleged impossibility of introducing the knife, so as to cut straight upwards, when the neck of the hernial sac is long, because then the sides of the inguinal canal are in the way. (*Hesselbach*, p. 40.) No more of the parts forming the stricture should be cut, than is just sufficient for allowing the protruded viscera to be reduced, without bruising, or otherwise hurting them; and, if the stricture be at the external ring, I consider the middle of its upper column to be as good a point as any for the requisite incision.

Sir A. Cooper, in his valuable work on Inguinal Hernia, advises a mode of dividing the stricture, considerably different from the usual method. He directs the finger of the operator to be introduced into the sac (which in his plan, we know, is left undivided for the space of one inch below the ring). When the stricture is felt, a probe-pointed bistoury is to be conveyed over the front of the sac into the external ring (between the two parts), and the latter only is then to be divided, in the direction upward, opposite the middle of the neck of the sac, and to an extent just sufficient to allow the protruded parts to be returned into the abdomen, without being hurt. The two chief advantages which Sir A. Cooper imputes to this method, are, that the danger of peritoneal inflammation will be less, and that the epigastric artery, if wounded, would not bleed into the abdomen. With regard to this proposal, it has been observed by Mr. Lawrence, "An accurate comparative trial of both methods would be necessary, in order to determine the weight of the first reason. The second circumstance cannot be a matter of any importance, if we cut in such a direction as will avoid the risk of wounding the artery. Many circumstances present themselves as objections to this proposal. The manœuvre itself, although perhaps easy to the experienced hand of so able an anatomist as Sir A. Cooper, would, I am convinced, be found highly difficult, if not impracticable, by the generality of surgeons. This difficulty arises from the firm manner, in which the sac and surrounding parts are connected, we might almost say, consolidated together. The experience of Richter (*Traité des Hernies*, p. 118) shows, that this objection is founded in reality. He once tried to divide the ring, without cutting the sac, but he found it impracticable. If the stricture is so tight, as to prevent the introduction of the finger, there must be great danger of wounding the protruded parts. The practice would still be not advisable, even if it could be rendered as easy as the common method of operating. Sir Astley leaves an inch of the sac, below the ring, undivided: thus a bag remains ready to receive any future protrusion, and the chance of a radical cure is diminished." (See *Lawrence, On Ruptures*, p. 249, ed. 4.)

Mr. Aston Key has proposed to revive the method of operating, adopted by Petit and the second Monro; viz. that of removing the stricture and replacing the protruded intestine, without dividing the sac. (See *Mem. On the Advantages, &c. of Dividing the Stricture in Strangulated Hernia, on the Outside of the Sac*, 8vo. Lond. 1833.) Mr. Key concludes from various cases, which he has recorded, that the principal cause of the fatality of operations for hernia, is exposure, or injury of the intestine, or both, and consequent peritoneal inflammation. "The exposure of a bowel in a state of incipient, or active inflammation (says Mr. Key), the handling it in this susceptible state, the incision made into a peritoneal bag already disposed to, if not in an actual state of, inflammation, are, as every surgeon will admit, (and as his forcible efforts to reduce the hernia without the knife prove that he feels them to be,) dangers of no ordinary magnitude to a patient labouring under a strangulated intestine. I do not feel that I have exaggerated the risk of inflammation; for, frequently, enteritis comes on, when at the time of the operation the bowel appears to be healthy, and the abdomen free from tenderness; and when general inflammation precedes the operation, the release of the intestine by the knife rarely succeeds in checking it" (p. 51).

Mr. Key dwells likewise upon the great danger of roughly handling a hernia, particularly a large one, and of employing much force in repeated and long continued efforts at reduction by means of the taxis. He argues, that, as these proceedings cannot fail to bruise the protruded bowel, this part, like other contused tissues, must have a much better chance of recovery if its surface be not exposed. Mr. Key does not, however, recommend the plan of not opening the sac in every example. For instance, he acknowledges, that some forms of adhesion, either of the intestinal folds to one another, or to the sac, or to its neck, may render it necessary to open the sac more or less extensively. A case of adherent omentum does not, however, appear to Mr. Key a case in which it is always requisite to open the sac. The first case, in which he tried the method which he advocates, was an old irreducible umbilical hernia, in which a fold of intestine had recently protruded. On dividing the edge of the tendon, slight pressure caused the bowel to return into the abdomen. The object of removing diseased omentum with the knife, or ligature, does not appear to Mr. Key to be always a good ground for laying open the sac. Gangrene of the protruded intestine seems to him to be a case absolutely requiring that the sac should be opened. So also is the case of strangulation by the neck of the sac itself, though he deems such an occurrence rare.

The following is Mr. Key's description of his method in oblique inguinal hernia: "The incision should begin at the neck of the tumor, or where it seems to quit the abdomen, and should be continued downwards for about an inch and a half. This will lay bare the lower portion of the external oblique tendon, where it forms the ring. A small opening should then be made in the tendon, just above the ring, sufficient to admit the end of the director, which will enable the operator to ascertain if the stricture be at the upper or lower opening. The size of the hernia, and the length of time it has existed, will in some measure serve to guide him; but he may immediately decide the point by passing the director downward under the edge of the external ring, and feeling whether it embraces the tumor firmly, or not, or by making pressure on the swelling below, he may feel if the fluid contents of the tumor can be forced upward above the ring, so as to distend the sac in the inguinal canal. This point being decided, if the stricture be at the lower ring, he has only to pass his director under its margin, and to divide it to a sufficient extent.

"If the stricture exists higher up, at the neck of the sac, where it will be found in the majority of herniæ of this description, the opening in the tendon should be enlarged to the extent shown in the second drawing, for the purpose of passing the director under the deeper stricture. The lower margin of the two muscles will be brought into view, with some of the descending fibres of the cremaster. These may be separated by disturbing the cellular membrane with the end of the director; and the instrument may then be introduced under the transversalis muscle till it reaches the stricture. The director, thus introduced, passes before the fascia transversalis, and all risk of wounding the peritoneum, or epigastric artery, is then obviated; but, when that fascia is very thin, it will perhaps often allow the director to pass beneath it.

"The instrument should be depressed upon the sac, in order to carry its point under the border of the transversalis, which may be divided to the extent required. This operation is more difficult than the division of the stricture in femoral hernia. The principal difficulty lies in the accurate separation of the lower edge of the internal oblique muscle, for the easy passage of the director. The stricture, however, is not so firm in inguinal as in femoral hernia, and the introduction of the director under the transversalis tendon will not be difficult, when it is fairly passed up to the neck of the sac, before the attempt is made. The steps of the operation will be much the same in those smaller herniæ, which are lodged in the inguinal canal." (*C. Aston Key*, op. cit.)

Respecting this mode of operating, I may observe, that there can be no doubt of its being calculated to lessen the risk of the patient being destroyed by peritonitis; but I apprehend that the greater difficulty of accomplishing it, than the common operation, and the fact of some excellent anatomists having been baffled in their attempts to perform it on the living subject; will continue to prevent its general adoption. I have known the attempt made in one or two instances, and given up. However, if a surgeon were confident that he could execute the plan, (and Mr. Key's directions would greatly assist him,) I would not object to his doing so, if there were no circumstances in the case likely to render the opening of the sac necessary.

[Mr. Luke also strongly advocates Petit's method of operating for strangulated hernia, and gives some valuable statistics of the results of this practice in his hands. (*Medical Gazette*, vol. i. 1839—40; and *Medico-Chirurgical Transactions*, vol. xxxi. 1848.) At page 103, in the last named work, he says:—"Since 1841, with four exceptions, I have invariably attempted to perform the operation for hernia without opening the sac, a circumstance worthy of notice in this place, because, to a certain extent, we may conclude from it what will be the general results, both as regards the successful performance and mortality of the operation, provided it be adopted by the profession generally, as it has been by myself, as an ordinary rule of practice.

"Inclusive of cases occurring between 1831 and 1841 (which were selected), I have attempted the performance of Petit's operation in eighty-four cases. Of this number, the operation was completely successful, without opening the sac, in fifty-nine. In twenty-five it was necessary to open the sac to effect a reduction of the hernial contents, the opening generally varying in extent from one-half to one-quarter of an inch. With respect to the mortality amongst these patients,—of the fifty-nine in whom the sac remained unopened, seven died; of the twenty-five in whom the sac was opened, eight died:" Mr. Luke afterwards, p. 105, op. cit. deducts the selected cases, and also four others from the eighty-four above mentioned, leaving fifty-four cases, the analysis of which he considers would give a fair account of the amount of success attending this mode of operating. "Of the fifty cases, the sac was opened in twenty-one, of which three died; and not opened in thirty-three, of which two died. Thus, in upwards of three-fifths of the whole number, Petit's operation was successfully completed.

"It should be recollected whilst comparing these results with each other, as well as with the results of the ordinary operation, in which the sac is opened extensively, that in opening the sac, in cases of failure, it has not usually been divided beyond a very limited extent (varying from one-quarter of an inch, to one inch and a quarter), and that consequently, the irritation, from exposure of the hernial contents, and from the rough and immediate handling which they too often undergo when already in a condition of high inflammation, is almost wholly avoided.

"With respect to the causes for opening the sac in these twenty-one cases, it appears that in three Petit's operation was successfully completed; but the sac was opened after the reduction of the strangulated parts into the abdomen, to remove some doubts as to their perfect liberation. The proceeding in each case, however, was ascertained to be wholly unnecessary. In ten, the stricture was caused by the neck of the sac. In one, the stricture was at the inner ring. In one, the hernia (femoral) extended to the umbilicus and into the scrotum, the intestine being very greatly distended by flatus, and having its peritoneal coat rent by the distension. In two, the opening was accidental; in four, the cause of the sac being opened is not stated.

"When an analysis is made of the different kinds of hernia, a great disproportion is found in the amount of success attending the attempts to complete the operation; from which we may infer the difficulties that have been encountered in each, respectively, and also what are probable in other cases. Amongst the fifty-four cases, there were thirty-one of femoral, twenty of inguinal, and three of umbilical hernia: of the thirty-one cases of femoral hernia, the sac was opened in seven, of which one died; and not opened in twenty-four, of which one died. Of the twenty cases of inguinal hernia, the sac was opened in thirteen, of which two died; and not opened in seven, amongst which there was not any death. Of the three cases of umbilical hernia, the sac was opened in one, followed by recovery; and not opened in two, of which one died."

Mr. Luke considers it of great importance that the seat of stricture should be ascertained by manipulation, before the operation is commenced. "This information is attained through a knowledge of the fact, that the stricture presents the communication of impulse from one part of the tumor to another, beyond the stricture. Nothing more, therefore, is required in availing ourselves of that knowledge, than to press the tumor firmly between the fingers of one hand, with a view to cause impulse, while, with the fingers of the other hand at the neck of the sac, the precise point at which impulse ceases is carefully ascertained. At that point will be found the seat of stricture."

There can be no doubt, that the mortality in cases of strangulated hernia would be considerably lessened by the general adoption of Petit's operation of dividing the stricture, without opening the peritoneal sac. When the hernial contents cannot be released in this way, either from adhesions within the sac, from stricture at the neck of the sac, or from other complications, if the plan recommended by Mr. Luke, of making as small an opening as possible in the sac were generally followed by surgeons, it is also probable that the death rate in this frequently fatal disease, might be still further diminished.]

If the stricture should be at the inner opening of the canal for the spermatic cord, Sir A. Cooper advises the operator to introduce his finger into the sac, as far as the stricture, and then to insinuate a probe-pointed bistoury, with the flat part of its blade turned towards the finger, between the front of the sac and the external abdominal ring, till it arrives under the stricture formed by the lower edge of the transversalis and obliquus internus. Then the edge of the instrument is to be turned forward and the stricture cut in the direction upward. This plan of not cutting the neck of the sac, is liable to all the objections stated by Mr. Lawrence, in regard to the case in which the strangulation takes place at the external abdominal ring. Sir A. Cooper's bistoury is a very proper one for dividing the stricture, as it only has a cutting edge to a certain distance from the point. Perhaps, on the whole, we may infer, that it is both most easy and advantageous to divide the neck of the sac, together with the stricture, whether this be situated at the external ring, or higher up.

The method of cutting the stricture from without inwards, I consider objectionable, on the ground of the risk of wounding the bowels in this mode being greater than that of any accident from wounding the epigastric artery, when it arises in an unusual manner, and deviates from its regular course; the possible occurrence of which accident made Dr. Hesselbach, junior, an advocate for this questionable practice. (See *Sicherste Art des Bruchschnittes*, 4to. Bamberg. 1819.)

When the stricture is at the upper opening of the inguinal canal, the external ring should not be cut, unless it prevent the operator from reaching the more deeply seated strangulation, as is often the case.

Dupuytren cuts the stricture upwards and forwards, using no director in this stage of the operation, because, as he says, the bistoury is apt to slip out of the groove, and wound the intestine. (See *Clin. Chir.* t. i. p. 600.)

Room being made for the reduction of the protruded parts into the abdomen, by the division of the stricture, they are to be immediately returned, if sound, and free from adhesions. This object is considerably facilitated by bending the thigh. The intestines are to be reduced before the omentum, but, when a portion of mesentery is protruded, it is to be returned before either of the preceding parts. The intestine should always be reduced, unless it be found in a state of actual mortification. It often appears so altered in colour, that an uninformed person would deem it improper to return it into the abdomen. However, if such alteration should not amount to a real mortification, experience justifies the reduction of the part. Sir A. Cooper has judiciously cautioned the operator not to mistake the dark chocolate-brown discolorations for a state of gangrene. With these the protruded part is frequently found affected; and, as they generally produce no permanent mischief, they ought to be carefully discriminated from the black-purple, or lead-coloured spots, which usually precede mortification. To determine whether a discoloured portion of intestine be positively mortified, some recommend pressing forward the blood contained in the veins; and if they fill again, it is looked upon as a proof that the bowel is still possessed of life.

In returning a piece of intestine into the abdomen, the surgeon should first introduce the part nearest the ring, into this aperture, and hold it there till another portion has succeeded it. This method is to be continued till the whole of the protruded bowel is reduced.

The employment of force or violence, in the endeavours to return the contents of a hernia in the operation, cannot be too severely reprobated; a method the more pernicious, because such parts are more or less in a state of inflammation.

It is always better to enlarge the stricture, than pinch and bruise the bowel in trying to get it through an opening which is too small. Distension of the intestine sometimes prevents the reduction, but, when this is the only impediment, the part may generally be returned as soon as its contents have been compressed into the intestinal canal above the stricture. It is better, however, to dilate the strangulation a little more, than use any force in trying to get the intestine back into the abdomen in the manner just suggested.

Reduction is sometimes impeded by the protruded parts adhering to each other, or to the hernial sac. The intestines are not often very firmly adherent together. The omentum and inside of the sac are the parts which are most subject to become intimately connected by adhesions. The fingers will, commonly, serve for breaking any recent slight adhesions which may have taken place between the intestines and inside of the hernial sac.

When those adhesions are firm, and of long standing they must be cautiously divided with the knife; an object which can be most easily and safely accomplished, in case they are long enough to permit the intestine to be elevated a little way from the surface of the sac. But, provided their firmness and shortness keep the external coat of the bowel and inner surface of the sac in close contact, the greatest care is requisite in separating the parts with a knife, so as to avoid wounding the intestine. In doing this, the most prudent and safe method, is not to cut too near the bowel, but rather to remove the adherent parts of the sac, and return them with the intestine into the abdomen. Every preternatural connection should always be separated before the viscera are reduced. Sir A. Cooper mentions, that a fatal obstruction to the passage of the intestinal matter has arisen from the mere adhesion of the two sides of a fold of intestine together (p. 31). When the adhesions which prevent reduction are situated about the neck of the sac, and out of the operator's view, it is best to make the wound through the skin and abdominal ring somewhat larger, so as to be able to separate the adhesions with more safety.

Having reduced the parts, the operator should introduce his finger for the purpose of being sure that they are fairly and freely returned into the abdomen, and no longer suffer constriction, either from the inner opening, from the external ring, or the parts just within the cavity of the peritoneum.

In strangulated enteroceles the peritoneal coat of the bowel is capable of bearing the pressure, longer than the mucous, which is soon circularly divided by it. But, if the strangulation has lasted two or three days, the cellular tissue is cut through; and, in some instances, even the peritoneal coat itself. In operating upon such cases, the bowel should not be drawn out at all, before a free division of the stricture has been made, because it would occasion a risk of tearing one portion of the intestine from the other, and producing an extravasation in the abdomen. (See *Dupuytren, Clin. Chir.* t. i. p. 569.)

Sometimes a strangulated hernia is complicated with a hydrocele; a circumstance which may render it necessary either to cut through the latter swelling, or to limit the incision into the hernial sac, according as the hydrocele happens to cover the whole of the front of the sac, as seen by M. Cloquet and by Mr. Stanley, or merely to advance in front of the lower part of the rupture. (*Lawrence, On Ruptures,* p. 276, ed. 4.) See HYDROCELE.

TREATMENT OF THE OMENTUM.

In an entero-epiplocele, this part, if healthy and free from gangrene, is to be reduced after the intestine. When, however, it is much diseased, thickened, and indurated, as it frequently is found to be, after remaining any considerable time in a hernial sac, the morbid part should be cut off. Its reduction in this circumstance would be highly improper, both because an immoderate enlargement of the wound would be necessary, in order to be able to put the diseased mass back into the abdomen, and because, when reduced, it would, in all probability, excite inflammation of the surrounding parts, and bring on dangerous symptoms. (See *Hey*, p. 172.)

The diseased omentum should always be cut off with a knife; and if any of its arteries should bleed, they ought to be taken up with a tenaculum, and tied separately with a small ligature. An unreasonable apprehension of hæmorrhage from the cut end of the omentum has led many operators to put a ligature all round this part, just above the diseased portion which they were about to remove. This practice, cannot be reprobated in terms too severe; for a frequent effect of it is to bring on a fatal inflammation, and even mortification of the omentum, extending within the abdomen, as high as the stomach and transverse arch of the colon. Sir Astley Cooper has remarked with great truth, that it is surprising this custom should ever have prevailed. The very object of the operation is to extricate the omentum from its strangulated state, arising from the pressure of the surrounding tendon; and no sooner has this been done than the surgeon includes it in a ligature, which produces a more perfect constriction than that which existed before the operation was undertaken.

"When the omentum has suffered strangulation for a few days," says Mr. Lawrence, "it often becomes of a dark red or livid colour; and there is an appearance, on cutting it, as if some blood were extravasated in its substance. This, I believe, is the state which surgeons have generally described under the term of gangrene" (p. 262).

When cut in this state, it does not bleed. I need hardly observe that the dead part must be removed, and never reduced. Some have advised leaving the omentum in the wound, especially in cases of old herniæ, in which it has been a long while protruded. Hey mentions cases, showing that granulations form very well, and that the wound becomes firmly healed when this plan is followed (p. 180, &c.) Every one, however, will acknowledge the truth of what Mr. Lawrence says on this subject. The method "is attended with no particular advantage, but certainly exposes the patient to the possibility of ill consequences. The omentum, left in the wound, must be liable to injury, inflammation, or disease. Unnatural adhesions, formed by this part, have greatly impaired the functions of the stomach. Some cases are recorded, where the unfortunate patient has never been able to take more than a certain quantity of food without bringing on instant vomiting; and others where it has been necessary for all the meals to be taken in the recumbent position, with the trunk curved and the thighs bent. (*Gunz.*) To avoid the possibility of such afflicting consequences, we should, after removing any diseased portion carefully replace the sound part of the omentum in the abdominal cavity." (*On Ruptures*, p. 291, ed. 4.)

Dupuytren objected to the plan of cutting away the omentum, on account of the tediousness of the process of taking up the arteries, some of which may not after all be tied, and then hemorrhage will take place. He also bears testimony to the danger of including the mass of omentum in a ligature. His practice consisted, therefore, in reducing the omentum, if possible, after largely dilating the stricture. He admits, however, that there will be a considerable chance of inflammation from the efforts made in the reduction; and that local and general bleeding, and other antiphlogistic measures may be called for. (*Clin. Chir.* t. i. p. 597.) The prudence of reducing a large mass of diseased or hypertrophied omentum I must continue to doubt, notwithstanding the authority of Dupuytren. I have seen it done, but almost always with an unfavourable result.

TREATMENT WHEN THE INTESTINE IN THE SAC IS MORTIFIED.

Sometimes on opening the hernial sac, the intestine is found to be in a gangrenous state, although the occurrence could not be previously known, owing to the integuments and the hernial sac itself not being affected with the same mischief. In ordinary cases, however, both the skin and sac become gangrenous at the same time with the contents of the hernia. The tumor, which was previously tense and elastic, becomes soft, doughy, emphysematous, and of a purple colour. Sometimes the parts also now spontaneously return; but the patient generally survives only a few hours.

Sir A. Cooper has accurately remarked, that in other instances, the skin, covering the swelling, sloughs to a considerable extent, the intestine gives way, and, as the fæces find vent at the wound, the symptoms of strangulation soon subside. When the patient continues to live in these circumstances, the living part of the intestine becomes adherent to the hernial sac, the sloughs separate and come away, and thus an artificial anus is established, through which the fæces are sometimes discharged during the remainder of life. (See ANUS, ARTIFICIAL.)

Frequently, however, things take a more prosperous course; the fæces gradually resume their former route to the rectum, and, in proportion as the artificial anus becomes unnecessary, it closes up. Many instances of this sort have fallen under my own observation. (See ANUS, ARTIFICIAL.) The chance of a favourable event is much greater in some kinds of herniæ than in others. When the strangulation only includes a part of the diameter of the gut, the fæces are sometimes only partially discharged through the mortified opening. This quantity lessens as the wound heals, and the patient gets perfectly well. (*Louis, Mém. de l'Acad. de Chir.* t. iii.; *P. S. Palm, De Epiplo-enterocele crurali incarcerata sphacelata, cum deperditione notabili substantiæ intestini, sponte separati, feliciter curata alvo naturali restituta,* 4to. Tub. 1748; *Haller, Disp. Chir.* t. iii.) A small gangrenous spot or two may end in the same manner. Mortification, as well as wounds, of the large intestines, is much more frequently followed by a recovery than the same affection and similar injuries of the small intestines. Mortification of the cæcum and its appendix, in a hernial sac, has happened several times without materially disturbing the usual course of the fæces to the anus, and the patients have soon recovered. (*Med. Obs. and Inq.* vol. iii. p. 162; *Hey's Pract. Obs.* p. 162, &c.)

The grand thing, on which the establishment of the continuous state of the intestinal canal depends, in all these cases, is the adhesion which the living portion of the bowel, adjoining the mortified part, contracts with the peritoneum all round. In this manner, the escape of the contents of the bowels into the cavity of the peritoneum becomes in general completely prevented. The two ends of the sound portion of intestine, after the mortified part has separated, open into a membranous cavity, which previously constituted a portion of the peritoneal sac, and now unites the extremities of the gut. The gradual contraction of the wound closes the membranous cavity externally, and thus the continuity of the canal is restored. The two ends, however, are not joined so as to form a continued cylindrical tube, like that of the natural gut; but they are united at an angle more or less acute, and the matter, which goes from one to the other, decribes a half circle in a newly formed membranous cavity that completes the canal; a subject which has been more fully explained in another part of this work. (See ANUS, ARTIFICIAL.)

It is an observation of Sir A. Cooper, that the degree of danger, attending an artificial anus, depends on the vicinity of the sphacelated part of the intestinal canal to the stomach. Thus, if the opening be in the jejunum, there is such a small extent of surface for absorption between it and the stomach that the patient dies of inanition.

Let us now suppose, that the mortified state of the intestine has only been discovered after laying open the hernial sac in the operation. The mischief may only consist of one or more spots, or it may be of the whole diameter of the protruded bowel. In the first case, the proper practice is to divide the stricture, and return the intestine into the abdomen, with the mortified spots towards the wound. Mild purgatives and clysters are then to be exhibited. The most favourable mode, in which a case of this kind ends, is when the intestinal matter gradually resumes its natural course, after being either partly or entirely discharged from the wound. But sometimes the patient sinks under the disease, or an artificial anus continues for life.

The repeated observations of modern surgeons have now decided that no ligature, passed through tht mesentery, to keep the gangrenous part of the bowel near the wound, is at all necessary. The parts in the neighbourhood of the ring have all become adherent together, in consequence of inflammation, at the same time that the parts in the hernial sac mortified; and, of course, the partially gangrenous bowel, when reduced, is mechanically hindered by these adhesions from slipping far from the wound. Desault and De la Faye both confirm the fact that the intestine never recedes far from the ring; and, even were it to do so, the adhesions which it soon contracts to the adjacent surfaces would, as Petit has explained, completely circumscribe any matter which might be effused, and hinder it from being extravasated among the convolutions of the viscera. (*Mém. de l'Acad. de Chir.* t. i. ii.)

When the chief part, or the whole, of the diameter of the protruded bowel is mortified, the first and most urgent indication is to relieve the bad symptoms arising from the distension of the intestinal canal above the stricture. "Let a free incision, says Mr. Lawrence, be made through the mortified part of the gut, in order to procure that evacuation of the loaded canal which nature attempts by the process of gangrene." If the intestine has already given way, a free division of the integuments and sac allows the exit of the accumulated matter; and the opening in the gut may be enlarged, if necessary. (*On Ruptures,* p. 299, ed. 4.) By such treatment, Sir Astley Cooper rescued from the grave a female, who was pregnant at the time of the operation, and was some months afterwards safely delivered. (*On Abdominal Hernia,* part i. p. 49, ed. 2.)

In cases of mortification of the protruded bowel the division of the stricture is unnecessary, since all the mischief which the bowel can receive from it is done. This subject is well explained by Mr. Travers. (See *Inq. into the Process of Nature in repairing Injuries of the Intestines, &c.* p. 300, &c.) Mild purgatives and clysters will be proper to unload the bowels, and determine the course of the fæces towards the anus. Should, however, the stricture appear, after the mortification, to impede the free escape of the intestinal contents, a moderate dilatation of it must undoubtedly be proper.

Mr. Lawrence has clearly exposed the impropriety of sewing the ends of the intestinal canal together, introducing one within the other, supported by a cylinder of isinglass, &c. put into their cavity, in those cases in which the whole circle of the intestine has mortified and been cut away, as was advised by former writers. By drawing the intestine out of the cavity, in order to remove the dead part, the adhesions behind the ring, on which the prospect of a cure chiefly depends, must be entirely destroyed; and new irritation and inflammation must be unavoidably produced, by handling and sewing an inflamed part. The adhesions would even be likely to render the scheme impracticable, as happened in a case related in the *Journ. de M. Le Roux,* t. xxi. p. 260. (*On Ruptures*, p. 314, ed. 4.)

Instead of such practice, Mr. Lawrence judiciously recommends dilating the stricture, and leaving the subsequent progress of the cure entirely to nature. The sloughs will be cast off, and the ends of the gut are retained by the adhesive process in a state of apposition to each other, the most favourable for their union. Thus, there is a chance of the continuity of the intestinal canal becoming established again.

Whatever experiments it may be allowable to make in wounds combined with protrusion and division of the bowels, nothing, I think, is now more completely established, than the absurdity and danger of attempting to stitch the bowels in cases of hernia.

Operation for large Inguinal Herniæ.

When the tumor is of long standing, exceedingly large, perhaps extending half way down to the knees, and its contents have never admitted of being completely reduced, the indication is to divide the stricture, provided a strangulation take place; but without laying open the hernial sac, or attempting to reduce the part.

The reasons against the common plan of operating, under such circumstances, are, the difficulty of separating all the old adhesions, the hazardous inflammation which would be excited by laying open so vast a tumor, and the probability that parts, so long protruded, might even bring on serious complaints, if reduced. J. L. Petit, and, afterwards, Dr. Monro, advised the sac not to be opened. (See *Mal. Chir.* t. ii. p. 372 ; *Description of Bursæ Mucosæ*, 1788.) Mr. Lawrence recommends an incision of two or three inches in length to be made through the integuments over the abdominal ring. The fascia covering the hernial sac is then to be exposed by dissection, and an opening made in it. This will permit a grooved director to be put under the tendon ; and the probe-pointed bistoury may be conducted, by means of the groove, to the part that requires division. If great difficulty should be experienced in accomplishing our object in this manner, a small aperture may be made in the sac near the ring, when the tendon may be divided with ease. The parts, after being thus liberated, should be returned into the belly by pressure on the swelling, if adhesions do not prevent it : at all events, they generally admit of being replaced in part. (*Lawrence, On Ruptures*, p. 269, ed. 4.) A very interesting case has been recorded, in which the foregoing advice was deviated from, and a large scrotal hernia laid open; when it was found that nearly a foot of the colon was contained in the swelling, and could not be reduced. The integuments could not cover it; yet its surface granulated, the skin extended itself as the cicatrix contracted, over the swelling, which also diminished, and, in about six weeks, the cure was completed. (See *Journ. of Foreign Med.* No. xv. p. 460.)

Operation when the Hernia is so small that it does not protrude externally through the Ring.

In this kind of case, there is little appearance of external tumor; consequently the disease is likely to be overlooked by the patient and surgeon, and some other cause assigned for the series of symptoms. The manner of operating, in this form of the disease, differs from that in the common scrotal hernia : the incision is to be made in the direction of the spermatic cord, and the stricture will be found at the internal ring. (*A. Cooper, On Inguinal Hernia.*)

[The coverings of the hernia will be the tendon of the external oblique, the cremaster muscle, and more or less of the fleshy fibres of the internal oblique and transversalis muscles ; and lastly, the transversalis fascia; these must, of course, be divided.]

Treatment after the Operation.

Evacuations from the bowels should be immediately promoted by means of clysters, oleum ricini, or small doses of sulphate of magnesia, dissolved in peppermint water; but the patient should not be allowed to quit the recumbent position, or get on the night-stool, as doing so is apt to bring on a protrusion of the bowels again. (See case in *Lancet*, vol. ii. p. 148.) The safest plan is to let something be put under the patient for the reception of the fæces. In the course of another day, if costiveness return after the effects of the first medicines, and tenderness and tension of the belly come on, local and general bleeding, with the exhibition of liberal doses of calomel joined with opium, are strongly indicated. For some time the diet is to be low. When symptoms of inflammation of the bowels and peritoneum threaten the patient, general bleeding, leeches on the abdomen, fomentations, blisters, doses of the oleum ricini, and clysters, are the means deserving of most dependence, and should be resorted to, without the least delay. In these circumstances, the warm bath, sometimes recommended, I think is more likely to do harm than good, by the disturbance to which it subjects the patient. When all danger of peritoneal inflammation is past, and the patient is very low and weak, bark, wine, cordials, and a generous diet must be directed. The effervescing saline draught with opium is the best medicine for quieting the disturbance of the stomach after the operation. Opium and cordials are the most eligible for checking diarrhœa. As the operation does not usually prevent the parts from becoming protruded again, a truss must be applied before the patient leaves his bed, and afterwards constantly worn.

[In the after-treatment of cases which have been operated on for strangulated hernia, too much importance has been hitherto attributed to the speedy evacuation of the contents of the bowels, and too little consideration given to the injured, and more or less inflamed state of the portion of the intestine just released from considerable and long-continued pressure. In the present day, most surgeons abstain from administering aperient medicines, and allow the injured intestine as much repose as possible. Repeated doses of opium are often prescribed for the first few days, thus imitating the practice usually adopted after operations on the rectum. In a few days, if all tenderness has subsided, and the bowels do not act spontaneously, gentle aperients are given, or a simple enema administered. Should the symptoms indicate an extension of inflammatory action to the peritoneum generally, local bleeding by leeches, and the administration of calomel and opium in repeated doses, are chiefly depended upon. General bleeding is less frequently had recourse to than formerly, and even stimulants, in certain cases, are not considered inadmissible.]

OPERATION FOR STRANGULATED DIRECT INGUINAL HERNIA.

Sir Astley Cooper advises an incision to be made through the integuments, along the middle of the tumor, from its upper to its lower part, following the longitudinal direction of the swelling, so that, if it has any inclination inwards towards the umbilicus, the incision is to incline in the same way. The fasciæ, or coverings of the hernia, being thus exposed, are to be divided, over the surface of the tumor, from the abdominal ring down to its lower extremity. The hernial sac is then to be cautiously opened from an inch below the ring. The finger is then passed into the sac, and the stricture felt for. If it is at the abdominal ring, Sir Astley Cooper introduces a blunt-pointed bistoury between the sac and the ring, and cuts the latter directly upwards. If the stricture is above the ring, he follows it with the knife, still in the same direction and anterior to it, opposite the middle of the mouth of the sac, till the dilatation is sufficient to allow his finger to slip into the cavity of the abdomen. Then the protruded parts, if in a fit state for reduction, are to be returned. "The parts (he observes) anterior to the sac, above the ring, and divided by the knife, are the tendons of the transversalis and internal oblique." (See *Sir A. Cooper*, op. cit. part i. p. 68, ed. 2.)

[In addition to the skin and superficial fascia the parts to be divided during the operation w be the intercolumnar fascia, the tendons of the tra versalis and internal oblique muscles, the transv salis fascia, and lastly, the hernial sac.]

Mr. C. H. Todd had an opportunity of disse ing an exceedingly uncommon variety of dir inguinal hernia, where the parts, "instead of pa ing anterior to the cord, protruded between t cord and the inferior pillar of the ring; so tl the cord formed a sort of arch, embracing t neck of the sac for nearly two thirds of its circu ference, close to the external abdominal openin (See *Dublin Hospital Reports*, vol. i. p. 23 Hence, in operating on inguinal hernia, Mr. To always makes it a rule, after exposing the sup ficial fascia, and before dividing the parts con guous to the neck of the sac, "to feel a minutely examine those parts (particularly if th appear unusually bulky," and to satisfy hims as to the situation of the spermatic cord. "Ha ing done this (says he), I proceed with confiden to expose the superior pillar of the ring, whi ought, in every instance, to be completely denud before a bistoury is introduced to cut the stri ture." (*Ib.*)

PROPOSALS FOR THE RADICAL CURE OF INGUINAL HERNIA.

Of castrating the patient, applying caustic, of the operation of the punctum aureum with th view, I need only say that they are barbaro and not at all calculated for the attainment of t desired end. A description of these methods m be found in Paré, Wiseman, &c.

The old operation, termed the *royal stitch*, w one of the most promising plans. It consisted putting a ligature under the neck of the herni sac, close to the abdominal ring, and then tyi that part of the sac, so as to render it impervio by the adhesive inflammation thus excited. T royal stitch, performed in this manner, has bee actually attended with success. (*Heister*, vol. ii Umbilical rupture was cured by Saviard o similar principles; and Desault radically cure nine cases of exomphalos in children by tying th hernial sac.

Schmucker cured two irreducible ruptures, fr from strangulation, by cutting away the body the sac, after tying its neck. (*Chir. Wahrnel mungen*, b. ii.) In one case Sir A. Cooper foun cutting away the sac alone insufficient.

Petit, Sharp, Acrel, &c., record cases whic prove the danger and general inefficacy of th royal stitch.

Richter recommends scarifying the neck of th sac, with the view of producing an adhesion of it sides to each other, a plan which, he says, h found successful.

In 1829, M. Belmas suggested the scheme o introducing into the upper part of the hernial sa a little bladder or pouch, made of goldbeater' skin, and filled with air. The plastic matte (fibrine), which is soon effused, penetrates the material of which the little bladder is composed, and becomes, in some measure, combined with it. *The whole is alleged to acquire organisation*, and to contract adhesions to the ring and neck of the sac, so as to constitute a barrier against the descent of the viscera. The plan is asserted to have succeeded both on man and animals. The particulars, which are curious, are given by M. Velpeau.

ee *Nouveaux Elémens de Méd. Opér.* t. ii. p. 6.)

Mr. Jameson, of Baltimore, even ventured, at e urgent solicitation of a lady, whose hernia (a noral one) had returned after having been angulated and operated upon, to try to accom- sh a radical cure on Taliacotian principles. In t, he is stated to have formed a flap of the ape of a lancet out of the integuments, with its oad end towards the former wound. After ving been carefully raised and twisted into the itable direction, it was introduced into the sac thin the crural canal. Here it was secured by sing the wound with sutures and applying a ndage. This venturesome proceeding is alleged have been completely successful. The expe- nent has not yet, I believe, been tried in any er case ; and doubts may be entertained whe- er it deserves it, unless the patient were deter- ned voluntarily to place his life in serious danger, stead of being content with the relief afforded a truss. Another proposal for the radical cure of rnia is the employment of firm wooden blocks, the place of a soft pad with the truss. A favour- le report upon the subject has been drawn up Dr. Reynell Coates and other American sur- ons.

The radical cure of reducible hernia has of late years ich engaged the attention of surgeons, and especi- y two methods, which have been followed by con- lerable success, are now being practised in some our London and provincial hospitals. The first that of Professor Wützer, of Bonn, in which the rotum, together with the hernial sac and its verings, are invaginated in the inguinal canal, d maintained there by a wooden plug till in- mmation and adhesion of the invaginated struc- res have taken place. The other is that of Mr. ood, assistant surgeon to King's College Hospi- l. (*Medico-Chirurgical Transactions*, vol. xliii. 71.) In this method the sac and its coverings e invaginated through an opening in the skin he latter being left in situ), and attached by bcutaneous sutures to the boundaries and ori- es of the inguinal canal. The intention in this eration is to obtain adhesion between the sur- ces held in contact by the ligatures, and also to rrow the inguinal canal itself by bringing its alls and the margins of its orifices closer together, l adhesion and consolidation have been accom- ished.

As all these procedures are intended to super- de the palliative measure hitherto depended on in the treatment of reducible herniæ, namely, properly adjusted truss, it behoves both the sur- on and the patient to weigh well the advantages ssessed over the truss by these so-called radical ethods of cure. To the working man the truss is an pensive instrument. Under the continual exer- n of his daily work it is liable to get out of der, to break, and to be a constant source of ex- nse and annoyance. The boon to him of an eration, conducted in a public hospital, which ould free him from these troubles, would indeed great. It should also be borne in mind that the earing a truss is by no means a certain preven- re of strangulation, although it considerably sens the risk of this serious occurrence. With e more affluent the consideration of expense is important ; the leisure they can devote to obtain- a perfectly fitting instrument, of a construction best suited to their individual case, the absence of all necessity for violent bodily exertion, will in all probability induce most of this class of persons to be satisfied with the palliative means afforded by the truss. Surgeons themselves, I apprehend, from their knowledge of the close proximity of the important structures involved in these operations, will not frequently become the subjects of them ; notwithstanding they may know that very few fatal cases have occurred, and that a very large majority of the operations have been, as far as is yet known, successful, and unattended with danger.

Wützer's Method.—The instrument used by Wützer is a cylinder of wood, with a movable concave cover. The cylinder is perforated longitudinally, to convey a needle, which emerges from an opening near its extremity. The cover is supported by an upright stem projecting from the upper surface of the cylinder, near its handle. It is made to approximate the cylinder by means of a screw, and is perforated near its extremity to receive the needle, after the latter has passed through the cylinder. This instrument has been improved by Professor Rothmund, of Munich, who prefers an oval to a perfectly round cylinder, and a silver to a steel needle ; but the principal advantage of Rothmund's instrument is in the contrivance for fixing the whole apparatus, which is effected by the needle. This consists in a spring at the handle, which keeps the needle from slipping. The needle is armed also with a movable point, which is replaced by a blunt knob after use ; and in order to suit canals of different capacities, the cylinder is made to vary in thickness by the addition of lateral pieces. The operation is performed in the following way :—The fore finger is placed on the scrotum, about the centre of the tumor formed by the hernial sac. It is then directed through the external ring into the inguinal canal, pushing before it the scrotum, the hernial sac, and its coverings. The next step of the operation is to substitute the cylinder for the finger. This must be done with great care. The surgeon should assure himself that the cylindrical plug has passed through the external ring into the inguinal canal, and that it and the invaginated structures so completely fill the canal that no intestine can protrude. The needle, previously placed in the cylinder so as to reach the orifice near its point, but not to project beyond it, is now thrust through the invaginated structures and the abdominal wall. This fixes the cylinder in its place. The cover is now adjusted, and by turning the screw is made to press the living tissues between it and the cylinder evenly, and with moderate force. The sharp point of the needle is then removed, and replaced by the blunt knob. The operation being finished, the patient is placed in the recumbent position in bed, with his knees flexed and the scrotum supported. The cover of the instrument may be raised and readjusted from day to day, so as to regulate the pressure. In a few days some redness and swelling will manifest themselves in the neighbourhood of the puncture; and before the first week has passed a little pus may be seen to ooze from it. A serous fluid may also be noticed to escape from between the invaginated skin and the cylinder. The whole apparatus may now be removed by withdrawing the needle, and the invaginated parts will be found to retain their position. The patient must keep his bed for another week or a fortnight, during which period the puncture must be daily dressed and a compress and bandage applied, in order to secure adhesion of the sides of the sac and consolidation of the invaginated plug with the walls of the inguinal canal. A light truss and a suspensory bandage should be worn for the next three months, and violent exercise refrained from. After this period the cure may be considered complete, the truss and suspensory bandage may be dispensed with, and the patient be permitted to undergo bodily exertion without restraint. In the after treatment, Rothmund endeavours to produce adhesion of the surfaces of the inverted skin, as well as of the sac, and for this purpose he smears the cylinder with unguentum cantharidis ; while Wützer is content to allow the invaginated skin to take its chance of adhesion, or otherwise, depending for the cure upon obliteration of the sac and its adhesion with its coverings to the interior of the inguinal canal.

In the *Medico-Chirurgical Transactions* for 1854, in the *Medical Times and Gazette* for Jan. 23rd, 1858, and in the *Dublin Quarterly Journal* for May of the same year, will be found ample information on this subject, in communications by Mr. Spencer Wells. With regard to the statistics of Wützer's operation, he states, at page 360 of the last-named journal, that it has been performed about fifty times by British surgeons, and that "of these there has not been a death or dangerous symptom in any one case." At page 362, op. cit. he continues : "I think I may say, therefore, that the experience of British surgeons, so far as it has gone, speaks strongly in favour of the operation ; and if we look to the continent we find a much larger score of recorded experience. Wützer, in a letter to me in 1853, says: "I am not able at present to give you the statistical results of all the cases upon which I have operated, as I have not time to collate them. I can now only say that, since the autumn of 1838, I have frequently practised my operation in the Cliniques every session, before many witnesses, and that I have never seen severe peritonitis follow it, still less any fatal result. All those operated on have not been cured. In several, relapse followed: but this was traceable either to the patient leaving off the truss too soon, or undertaking very hard bodily labour soon after the operation." Professor Sigmund, of Vienna, informed me that he had performed the operation nineteen times in the great hospital of that city, with complete success in fifteen cases. No death happened, but in two cases there was some gangrene of the integuments, and in two, relapse occurred. I have heard that death did follow in one case at Brussels, but that the operation was very unskilfully performed upon a patient suffering at the time from primary syphilis ; so that this misfortune is not to be attributed to the operation, but to the operator.

"Last autumn I was in Munich, and I called on Professor Rothmund, who has a larger experience of the operation than any other surgeon. I saw him perform the operation in one case, and saw two men, upon whom he had operated, on one three days, and on the other ten days before. I had a long conversation both with the professor and his assistants. They said the increasing number of patients coming for operation was the best proof of its safety and success. At first Rothmund found it difficult to induce ten patients to submit to it in a year ; now they apply every day. They are mostly working men, and one tells the other how he has been cured. On inquiry as to relapse, the answer confirmed my previous impressions, namely, that in cases where the canal is not larger than to admit the finger easily, the radical cure may be relied on with almost absolute certainty, and that the probability of relapse increases with the size of the canal and rings. When the rings are very large and the canal very short, the chief use of the operation is to make a truss effective. In these cases of widely dilated rings and short canal, my impression was that the operation might be hazardous; but the experience at Munich shows that this fear is unfounded, provided very large cylinders be used, so that the rings are well filled and descent of intestine by the side of the cylinder is impossible. Rothmund has done the operation about 400 times in the clinical hospital at Munich, and he told me that he had done it much more frequently in private practice, so that he felt convinced he must have operated a thousand times, and without one fatal result."

Gerdy's Method.—Invagination of the scrotum, together with the hernial sac and coverings, originated with M. Gerdy. His plan was more simple than that of Wützer, requiring sutures only to maintain the invagination. Having invaginated the structures above mentioned as far as possible by the finger, he introduces along the latter a canula concealing a needle to the end of the inverted scrotum, he now presses on the needle, and transfixes the structures covering the extremity of his finger. Two points of suture being thus formed, a piece of bougie is fixed by the threads over the parts invaginated in the inguinal canal. By these means inflammation and adhesion of the inverted cutaneous surface, as well as of the other tissues occupying the canal, are sought to be effected. A compress and bandage should be methodically applied during the period required for the consolidations of the tissues implicated in the operation.

Mösner's Method. — Another ingenious plan for accomplishing the radical cure of a reducible hernia is that by seton combined with invagination, attributed to Mösner. The seton is passed, after temporary invagination, through the summit of the invaginated structures. These are allowed at once to resume their natural position, and when unfolded the seton will of course have its orifices widely separated; one will be in the skin of the scrotum, and the other in that of the inguinal region opposite the position of the internal ring, while the seton itself will be lodged in the inguinal canal. The seton composed of a single or double thread is to remain for a fortnight or three weeks, during which period pressure by a compress and bandage is also to be applied. The resulting inflammation occupying the whole length of the inguinal canal, cannot fail to be accompanied by the deposit of more or less of adhesive material and by suppuration. When the seton is withdrawn, and for some weeks afterwards moderate pressure is to be maintained with the hope of securing adhesion and consolidation of the parts forming the boundaries of the canal.

The following table of the results of Wützer's and of Mösner's operation is given by Rothmund. (*Nélaton, Elémens de Pathologie Chirurgicale*, vol. iv. p. 223.)

	Cured.	Amelioration.	No Result.	Deaths.
Wützer's Operation,				
Males . . 140	117	4	6	0
Females . 7	5	—	2	0
Mösner's Operation, 34	29	2	1	1

Nélaton comes to the conclusion that in children and in adults up to the age of thirty-five, the pressure of a truss should be depended upon for the radical cure of a reducible hernia; but that after this age some operation on the principle of invagination should be performed, or the injection of iodine into the hernial sac be practised. Of this latter method he speaks with little confidence, both as to its efficacy and as to the certainty of lodging the iodine solution in the sac, without at the same time infiltrating the cellular tissue by any of the instruments contrived for that purpose.

Mr. Wood's Method.—The subcutaneous invagination of the hernial sac and its coverings, combined with a more definite approximation of the walls of the inguinal canal, by a more methodical and scientific application of sutures, as suggested by Mr. Wood, requires a detailed description for its proper comprehension, and in justice to that gentleman I transcribe his own account of the operation. (*Medico-Chirurgical Transactions*, vol. xliii. p. 76.)

"The pubes and scrotum of the affected side being shaved, the patient should be laid upon his back with the shoulders raised. The surgeon will find it most convenient to stand on the side to be operated on. The hernia must then be reduced, and held up by an assistant pressing with his fingers over the internal ring. With a small narrow bladed tenotomy knife, an incision is made to the depth of the skin only, of about three quarters of an inch in length, in the scrotum over the centre of the lower part of the hernial tumor, at least two inches below the spine of the pubes. Then the knife being insinuated flatways between the skin and fascia, is made to separate the former from the latter all round the edges of the incision, over an area of at least two inches in vertical by one and a half inch in transverse diameter. This, from the loose attachment of the skin at this part, is easily done. The knees of the patient should next be drawn up towards the abdomen, and held together so as to relax the structures connected with Poupart's ligament. Then the forefinger of the operator is passed through the opening in the skin and made to invaginate the detached fascia through the external ring into the inguinal canal. This will be most effectually done by using the right hand for the right side and *vice versâ*. The operator should endeavour to commence the invagination of the fascia from as low a point as the external incision will admit, so as to push the finger as much as possible between the sac of the hernia and the spermatic cord, which should at the same time be put on the stretch by traction upon the testis with the disengaged hand. The invaginating finger should be made to reach the internal opening of the hernia.

"The position of the spermatic cord, lying above and behind Poupart's ligament, can then be distinctly made out. When the point of the finger has reached the internal opening, it will be placed behind the lower border of the internal oblique muscle, the position of which will be made more evident to the operator by hooking it forward upon the point of the finger. He will then be sensible of the edge of the conjoined tendon (into which the muscle is inserted internally), at the outer side of his finger (in reference to his own hand), passing downwards behind the canal, to be inserted with Gimbernat's ligament into the pectineal line of the pubes. Next, a stout blunt-pointed needle mounted on a strong handle, with a well marked curve, is to be passed along the outer border of the invaginating finger, and pushed through the conjoined tendon and internal pillar of the external ring, till the point is seen to raise the skin on the surface of the finger. In this manœuvre the point of the needle must be carefully preceded by that of the finger. The skin is then to be drawn inwards and a little upwards, as much as its attachments will allow it to slide, and the point of the needle pushed through. A strong smooth hempen thread (well waxed, and then soaped) is then passed through the needle's eye, and the latter withdrawn, leaving one end of the thread in the puncture. The invaginating finger is then passed behind Poupart's ligament, between it and the spermatic cord, as far from the edge of the external pillar of the external ring, and as near to the internal ring, as possible. The ligament may then be raised forwards towards the surface upon the finger. The needle carrying the end of the ligature which it has before withdrawn, must then be passed along the internal border of the invaginating finger to the deep surface of Poupart's ligament, about its centre (midway between the iliac and pubic spines), and pushed carefully through towards the skin. When its point begins to raise the skin, the latter is to be again slid outwards and a little downwards, till the point of the needle appears at the puncture before made: through this the instrument is to be a second time pushed, the loop of the thread seized, and the needle again withdrawn, leaving a loop in the puncture and carrying the free end of the thread. The invaginating finger is then to be again placed on the inner side of the spermatic cord, which is to be pushed outwards by it. The point of the finger is then to be pressed against the centre of the posterior wall, so as to push back the conjoined tendon, etc. The thick tendinous structure, formed by the triangular ligament and conjoined tendon, will then be felt covering the edge of the rectus muscle on the inner side of the finger, raised by the muscle considerably in relief. Into this the needle is to be next thrust, so as to take up a portion of it about half an inch above the pubic spine, close to its insertion into the pectineal line, and external to the border of the rectus muscle, which affords a very plain guide, and protects the peritoneum from injury.

By sliding the original puncture in the skin downwards to its utmost extent, the needle can easily be passed a third time through it. The needle is then freed from the ligature and withdrawn. We have, then, passing through the puncture of the skin in the groin, the two ends of the ligature and a central loop. The upper of the ends passes through the upper part of the conjoined tendon, where the fibres of the oblique muscle begin to be inserted on it; the lower, through the triangular ligament and conjoined tendon, close to the insertion of Gimbernat's and Poupart's ligaments into the pubis; and both through the aponeurosis of the external oblique forming the inner pillar of the ring. The central loop passes through the centre of Poupart's ligament and the lower fibres of the internal oblique muscle arising from it. Thus, we leave in the canal two threads passing across the invaginated fascia, and, in large and old cases, across the sac, immediately above and in front of and investing the spermatic cord, and connecting the inferior and external boundary of the canal or Poupart's ligament with the superior internal and posterior boundaries formed by the fascia transversalis conjoined tendon and triangular ligament. A pad of boxwood, or what is still better, of glass or porcelain, about two inches long and one inch wide, flattened so as to be oval in section, and with the ends rounded off, is next applied obliquely upon the skin, along the course of the inguinal canal, with the centre opposite the puncture. The two free ends of the ligature are drawn to the outer side, and the loop to the inner side of the pad, so as to cross beneath it. One end of the thread is then passed through the loop and tied in a loop knot to the other."

Where operative procedure is undertaken for the radical cure of hernia, I am much inclined to recommend the more simple methods of Gerdy and of Mösner to the profession, for further trials, in preference to the more complicated proceedings of Wützer, Rothmund, and of Mr. Wood. I would venture also to suggest a combination of Gerdy's and Mr. Wood's operation, in which the sutures might be applied to the boundaries of the inguinal canal as nearly as possible according to Mr. Wood's directions, but passed through the invaginated skin, instead of subcutaneously, as above described. Lastly, it appears to me that, to Mösner's longitudinal seton, transverse ones might be advantageously added, or that Gerdy's operation with an upper, lower, and central suture instead of an upper one only, might be more effectual.]

CONGENITAL HERNIA.

Before the beginning of the sixth month of the fœtal state, the testicle is situated just below the kidney, upon the psoas muscle, where it receives its arteries from the aorta, and sends its vein on the right side into the lower vena cava, and, on the left, into the corresponding renal vein; and where also it receives a covering from the peritoneum, just like the other abdominal viscera. From the lower part of the testicle and epidydimis proceeds a long fibrous substance, called the *gubernaculum*, and it lies in the track which that organ afterwards follows in its descent into the scrotum. The gubernaculum is believed to have some influence in guiding the testicle in the right course to its final situation. Between the beginning of the sixth month, and end of the seventh, the testicle has either descended as low as just above the abdominal ring, or else is passing through it, or arrived a little below it. (*Wrisberg. Comm. Reg. Societ. Götting.* 1785.)

When the testicle passes through the abdominal ring into the scrotum, it is received into a production of the peritoneum, which afterwards constitutes the tunica vaginalis reflexa; while that peritoneal investment, which was given to the testicle in the loins, is closely adherent to the tunica albuginea.

According to Sir Astley Cooper, it is in the eighth month, that the testis passes out of the abdominal ring, "bringing with it a portion of the peritoneum, which is previously somewhat looser at the lower part of the abdomen, than elsewhere, and which becomes afterwards the tunica vaginalis." (*On Hernia*, part i. p. 74, ed. 2.)

After the descent of the testicle into the scrotum, the communication, between the cavity of the tunica vaginalis and that of the abdomen, commonly becomes obliterated, which latter event is usually effected before birth, sometimes not till afterwards; and, in a few subjects, even as late as the adult state, or it may remain open throughout life.

In congenital hernia, the protruded viscera are situated in the tunica vaginalis, in contact with the testicle; having descended into this position before the closure of the communication with the abdomen. Of course, the tunica vaginalis itself is the hernial sac. The nature of this case was not understood, until it was elucidated by Haller in 1755, and the two Hunters in 1762 and 1764. (See *W. Hunter's Med. Comment.*; *Haller's Opuscula Patholog. and Opera Minora, S.*) Before the periods here specified, surgeons imputed the circumstance of the contents of the hernia and testicle being in contact, to the bowels having made their way, by laceration, through the tunica vaginalis, from the ordinary sac of an inguinal hernia.

From the term *congenital*, we might suppose, that this hernia always existed at the time of birth. The protrusion, however, seldom occurs till after this period, on the operation of the usual exciting causes of herniæ in general. It does not commonly happen till some months after birth; and, in certain instances, not till a late period. Mr. Hey relates a case, in which a hernia congenita was first formed in a young man, aged sixteen, whose right testis had, a little while before the attack of the disease, descended into the scrotum. In the generality of cases, which actually take place during the slow descent of the testicle towards the scrotum before birth, the event may be referred to that organ having contracted an adhesion to a piece of intestine, or omentum, in its passage to the ring. In an infant, which died a few hours after birth, Wrisberg found one testicle, which had not passed the ring, adhering, by means of a few slender filaments, to the omentum, just above this aperture. Sometimes, adhesions of the testicle to the adjacent viscera, instead of leading to the formation of a congenital hernia, only prevent the descent of the former organ. Cloquet examined the body of an old man, in which the left testicle lay on the psoas and iliacus muscles, connected to the sigmoid flexure of the colon, while an inguinal hernia existed on the same side. (*Recherches*, &c. p. 24.) Sometimes, no protrusion at all happens, even though the communication between the tunica vaginalis and abdomen continue open in the adult subject, as is particularly exemplified in a case, recorded by Hesselbach, where such communication existed on each side in a man, thirty-eight years of age, without any hernia. (*Med. Chir. Zeitung,* 1819, p. 110.) The hernia may protrude for the first time in an adult. (See *Case by Sir A. Cooper, On Hernia*, part i. p. 75, ed. 2.)

The appearance of a hernia in very early infancy, Mr. Pott observes, will always make it probable that it is of this kind; but, he was not correct in asserting that, in an adult, there is no reason for supposing rupture to be of this sort, but the patient having been afflicted with it from his infancy; and that there is no external mark or character, whereby it can be certainly distinguished from one contained in a common hernial sac. This statement is erroneous, inasmuch as the hernia congenita, while the bowels are down, is attended with difficulty or impossibility of feeling the testis, which part in the common scrotal hernia is always distinguishable under the fundus of the hernial sac.

Mr. Pott notices that "in very young children a piece of intestine, or omentum, may get pretty low down in the sac, while the testicle is still in the groin, or even within the abdomen. In this case the application of a truss would be highly improper; for, in the latter, it might prevent the descent of the testicle from the belly into the scrotum; in the former, it must necessarily bruise and injure it, give a great deal of unnecessary pain, and can prove of no real use. Such bandage, therefore, ought never to be applied on a rupture in an infant, unless the testicle can be fairly felt in the scrotum, after the gut or caul is replaced; and when it can be so felt, a truss can never be put on too soon." This is also the advice delivered by Sir A. Cooper.

As Mr. Pott has explained, an old rupture, originally congenital, is subject to a stricture made by the sac itself, as well as to that produced by the abdominal ring, or, as might have been added, to that caused by the superior opening of the inguinal canal. The fact he noticed several times, both in the dead and in the living. "I have seen (says he) such stricture made by the sac of one of these herniæ as produced all those bad symptoms which render the operation necessary; and I have met with two different strictures, at near an inch distance from each other, in the body of a dead boy, about fourteen, one of which begirt the intestine so tight that I could not disengage it without dividing the sac.

"In this kind of hernia I have also more frequently found connections and adhesions of the parts to each other than in the common one; (see also *Sir A. Cooper*, op. cit. part i. p. 78.) but there is one kind of connection sometimes met with in the congenital hernia, which can never be found in a common hernial sac, and which may require all the dexterity of an operator to set free; I mean that of the intestine with the testicle.

"If a large quantity of fluid should be collected in the sac of a congenital hernia, and, by adhesions and connections of the parts within, the entrance into it from the abdomen should be totally closed (a case which I have twice seen), the tightness of the tumor, the difficulty of distinguishing the testicle, and the fluctuation of the fluid, may occasion it to be mistaken for a common hydrocele; and if, without attending to other circumstances, but trusting merely to the feel and look of the scrotum, a puncture be hastily made, it may create a great deal of trouble, and possibly do fatal mischief." (*Works* vol. ii.)

This complication may be known, if no adhesions have taken place, by returning all the contents of the tumor into the abdomen, while the patient is in the horizontal posture. "Then, by putting the finger against the abdominal ring, the water will slip by it, and fall down into the scrotum, producing a transparent tumor, or true hydrocele; after which, if the pressure of the finger is a little lessened at the ring, and the patient is desired to cough, the intestine and omentum will be felt falling down into their former situation." (See *Sir A. Cooper, On Hernia*, part i. p. 75, ed. 2.)

Mr. Pott also believed that common ruptures, or those in a peritoneal sac, are generally gradually formed, that is, they are first inguinal, and by degrees become scrotal; but that the congenital are seldom remembered by the patient to have been in the groin only. As the tunica vaginalis is thicker than the peritoneum, the contents of a congenital hernia are not so easily felt as those of a common rupture. In children the hernia generally contains intestine only, the omentum not being in them sufficiently long commonly to protrude.

The sac of a congenital hernia, especially when the case is strangulated, is everywhere equally tense (*Hesselbach*, p. 36), and below it the testis cannot be felt.

The reader must not conclude, however, from the above account that every rupture in children is congenital. Mr. Lawrence has related a case of strangulated inguinal hernia not congenital, which took place in an infant only fourteen months old (p. 65, ed. 3).

The common inguinal hernia, which first protrudes at the inner opening of the inguinal canal, and which has the epigastric artery on the inner side of its neck, as already explained, has been named by Hesselbach *external;* while the less common instance, in which the viscera burst directly through the aponeuroses of the transverse and internal oblique muscles, and pass directly out of the abdominal ring, leaving the epigastric artery on the outer side of the neck of the sac, is distinguished by the epithet *internal*. (*Anat. Chir. Abhandlung über den Ursprung der Leistenbrüche;* Würzb. 1806.) "The inguinal congenital hernia (says Scarpa) cannot be divided into *external* and *internal*. It is evident that it must always be external, since the neck of the tunica vaginalis invariably corresponds to the point at which the spermatic cord passes under the margin of the transverse muscle. As for other circumstances, the tunica vaginalis lies in its whole course in the same manner as the sac of a common inguinal hernia. Like this, it passes completely through the inguinal canal from one end to the other, resting upon the anterior surface of the spermatic cord. Consequently, it passes between the separation of the inferior fibres of the obliquus internus and the principal origin of the cremaster muscle. (See *Wrisberg. Syllog. Comment. Anat.* p. 28.) After coming out of the ring, as it is always united to the spermatic cord, it is enclosed in the muscular and aponeurotic sheath of the cremaster muscle, which accompanies it to the bottom of the scrotum. Since the tunica vaginalis, including the displaced viscera, enters the inguinal canal on the outside of the point, at which the spermatic cord crosses the epigastric artery, it is manifest that, as it follows exactly the direction of this cord, it must also cross the artery, and remove it from the outer to the inner side of the ring, according to the mechanism already explained in speaking of the common inguinal hernia. Hence the displacement of the epigastric artery constantly happens in the inguinal congenital, just as it does in the ordinary external inguinal hernia.

"But, if these two species of inguinal herniæ have some analogy to each other, in regard to the parts which constitute them, yet they present some remarkable differences. 1. The common inguinal hernia, whether internal or external, when it extends into the scrotum, cannot descend beyond the point at which the spermatic vessels enter the testicle. There the cellular substance of the spermatic cord terminates. There the hernial sac must also unavoidably terminate. On the contrary, in the congenital hernia the viscera may descend lower than the testicle, with which they are in immediate contact; and, at length, they even occupy the situation of this organ, which is then pushed upward and backward. 2. In the case of a congenital hernia, the descent of the viscera from the groin to the scrotum commonly takes place in a very short time, and in some measure precipitately. It is much slower and more gradual in the ordinary inguinal hernia. The reason of this difference is very plain. In the first case, the descent of the testicle and the formation of the tunica vaginalis have opened and prepared the way, which the viscera must follow in forming a protrusion; while, in the second, the hernial sac cannot descend into the scrotum, but by gradually elongating the layers of the cellular substance, which joins it to the surrounding parts. This fact is so generally known that experienced practitioners consider the promptitude with which the viscera have descended from the groin to the bottom of the scrotum, as a characteristic sign of a scrotal congenital hernia." (*Scarpa Traité des Hernies*, p. 73, &c.; *Hesselbach*, p. 35, *Pott*; *Sir. A. Cooper*, part i. p. 79, ed. 2.)

In the hernia congenita, the spermatic artery and vein are sometimes on one side of it, and the vas deferens behind it. A preparation, exhibiting this alteration of the cord, may be seen in the museum of St. Thomas's Hospital.

If circumstances will admit of a truss being applied and worn, in cases of congenital hernia, in young subjects, there will be a considerable chance of a radical cure being effected, in consequence of the natural propensity of the opening between the abdomen and tunica vaginalis to become closed.

In the operation, the surgeon has to lay open the tunica vaginalis, instead of a common hernial sac; but, as Sir Astley Cooper judiciously recommends, that membrane should not be opened low down; 1st, because a sufficiency of it should always be left to cover the testicle; and, 2ndly, because the spermatic artery and vein are situated obliquely on the front and lower portion of the tumor. The incision should begin at the upper part of the abdominal ring, and, in large herniæ, extend to a little above the testicle. This lays bare the intercolumnar fascia, the cremaster muscle, and the fascia infundibuliformis, which cover the tunica vaginalis. This latter membrane is then to be cautiously opened, and divided in the direction of the first incision, to within an inch of the abdominal ring above; but downwards no lower than the upper part of the testicle, as a sufficient quantity of the tunica vaginalis should be left to cover this organ. (See *Sir A. Cooper*, op. cit. p. 78, part. ii.) If the hernia were large, and it had been for any time irreducible, the same experienced surgeon would advise the return of the parts without inspection, if the stricture could be removed without opening the tunica vaginalis. The stricture is to be divided on the same principle as that of an oblique inguinal hernia, and much in the same manner. As, in a case of congenital hernia, the parts are always protruded on the outside of the epigastric artery, the stricture may be safely divided towards the ilium, as well as directly upwards. (*Lawrence, On Ruptures*, p. 507, ed. 4.) The tunica vaginalis having been opened, the finger is to be passed into it, the seat of stricture ascertained, and, if this be at the abdominal ring, Sir A. Cooper recommends the dilatation to be made by insinuating the knife between the sac and the ring. "If," says he, "the impediment to the return of the hernia is formed by the transversalis muscle, the knife (still on the anterior side of the sac) is to be carried up to it (the stricture) through the ring; but, if the stricture is in the tunica vaginalis itself, at its orifice into the abdomen, the knife must be introduced within it, and the strictured part cautiously divided." (Op. cit. part ii. p. 78.) According to Sir Astley Cooper, the stricture is generally about an inch and a half from the abdominal ring, except in large cases, when it is nearer to it. The parts having been reduced, the edges of the wound are to be brought together, and retained so by means of one or two sutures, and sticking-plaster.

Instances of strangulated congenital inguinal hernia in young children, are exceedingly rare. Their possibility, however, should be remembered, and even the occasional necessity for operating. Thus, Mr. Adams was called upon to perform the operation on a child, eighteen months old, with this species of hernia strangulated; and the case ended favourably. (See *Dublin Journ. of Med. Science*, vol. ii. p. 321.)

[My experience does not lead me to acquiesce in the opinion here expressed as to the extreme rarity of the occurrence of strangulations in young children. Two such cases have occurred in my own practice, and Mr. James Lane lately operated on an infant four weeks old for strangulated congenital hernia. These cases terminated successfully.]

Encysted or Infantile Hernia.

A new species of hernia congenita was described by the late Mr. Hey, in which a sac, containing the viscera, is included in the tunica vaginalis. He conceived that it arose from the parts being protruded, after the communication between the abdomen and tunica vaginalis had been closed, but not effectually, so that the peritoneum was carried down along with the intestine, and formed a hernial sac within the tunica vaginalis. Such a hernia can only be produced, while the original tunica vaginalis remains, in the form of a bag, as high as the abdominal ring. Sir Astley Cooper believes, that the tunica vaginalis becomes closed at the ring, but remains open above and below it. (*On Hernia*, part. i. ed. 2.) Mr. Hey called the case *hernia infantilis*; Sir A. Cooper *encysted vaginal hernia*. The testis is not involved, and can be distinctly felt below the hernia. The tunica vaginalis ought, in this case, to be freely opened. The strangulation, which arises from the contracted state of the mouth of the sac, may be safely divided, either upwards, as directed by Sir Astley Cooper, or upwards and outwards. Operators should be aware of the possibility of having a sac to divide, after laying open the tunica vaginalis. (See *Hey's Practical Obs.* p. 221 ; *Dr. Ballingall, in Edin. Med. Journ.* No. 87, p. 464 ; and *Sir A. Cooper's Work On Hernia,* p. 79, part. i. ed. 2.)

Mr. C. H. Todd mentions various anatomical facts, which convince him, that "the generally received opinion, respecting the formation of hernia infantilis, is erroneous ; and that, in no instance, is the sac in actual contact with the testicle." Mr. Todd believes, that the hernial sac is protruded completely within the cellular sheath of the cord; and that, when it depends near to the point of insertion of the spermatic vessels into the testicle, its fundus comes in contact with the upper part of the tunica vaginalis testis, and receives from it, on its lower surface, a serous covering, proportioned to the magnitude of the tumor, or degree of distention of the sac. He also thinks, that, although this hernia is more easily formed in an infant, it may occur at any period of life. In University College Hospital, two examples of this hernia have occurred in adult persons, within the last two years. It is a case that appears to be often combined with hydrocele. The most certain diagnostic symptoms seem to Mr. Todd to be ; first, the testicle being situated at the lowest part of the hernia, although the tumor is unusually large. Secondly, the possibility of making the fluid in the tunica vaginalis, when a fluid is lodged in it, pass, by means of a little pressure, for some distance in front of the hernial sac, towards the abdominal ring. If an operation were necessary for the relief of strangulation, Mr. Todd deems it quite practicable in many instances to open the hernial sac, without dividing the tunica vaginalis. The prudence of acting in this way, however, will depend on the extent of that part of the anterior surface of the sac, which is not covered by the serous membrane of the testicle. Mr. Todd would not extend the incision to the bottom of the tumor, and, after cautiously opening the sac, near the abdominal ring, he would make the dilatation of it downwards, the finger having been previously introduced to ascertain the distance to which the fundus of the sac depends. (See *C. H. Todd, in Dublin Hospital Reports,* vol. i. p. 232, &c.)

[I operated some years ago in a case of strangulated infantile hernia. The history given was that of a congenital hernia; the testicle, however, could be readily distinguished situated below the hernia. The swelling had not the ordinary feeling of a strangulated hernia. It was not tense, and the contents of the sac felt movable in the neighbourhood of the inguinal canal. The symptoms of strangulation, however, continued, and the hernia could not be reduced. The operation was therefore performed. On opening the hernial sac, and directing the finger upwards, it was evident that no stricture existed in the ring or in the inguinal canal. On attempting to reduce the bowel it was found to be held by what appeared to be a firm adhesion to the bottom of the sac. On examining this attentively, a stricture was discovered at the lower part of the sac, a portion of which, containing a small knuckle of intestine, had been forced through a small round opening in the tunica vaginalis. It was here strangulated, together with its sac. The stricture being divided, the intestine was readily returned and the case did well.]

Crural or Femoral Hernia.

Verheyen, who wrote in 1710, first distinctly pointed out the nature of crural hernia, which, until then, had been generally confounded with inguinal hernia.

The parts composing this kind of hernia always protrude under Poupart's ligament, and the swelling is situated towards the inner part of the bend of the thigh. The rupture descends on the internal side of the femoral artery and vein, between these vessels and the os pubis, through the *crural ring* or *canal* for the transmission of the same vessels. And, as Hesselbach has remarked, the inner opening of this ring or canal is the predisposing cause of the disease ; the peritoneum spread over it being gradually propelled into it by various occasional causes, so as to complete the tendency to hernia. The actual protrusion of the bowels may be formed either suddenly or by degrees. As soon as the bowels have once passed the outer aperture, or what Cloquet terms more properly the lower opening of the crural canal, the hernia has more room for extending itself forwards and to each side, and the integuments now become elevated into *an oval swelling, the long diameter of which is nearly transverse.* (*Hesselbach,* p. 47.) Gimbernat names the passage through which the femoral hernia protrudes from the abdomen, the *crural,* Hey the *femoral ring,* and Cloquet the *crural canal.*

Females are particularly subject to this kind of rupture. It has been computed that nineteen out of twenty married women afflicted with hernia have this kind ; but that not one out of an hundred unmarried females, or out of the same number of men, have this form of the disease. (*Arnaud.*) I was lately consulted by the friends of a little girl, about eight years old, who has an unequivocal femoral hernia.

"The crural hernia," says Scarpa, "is frequently observed in women who have had several children. It very seldom afflicts young girls, and still more rarely men. In the latter the viscera can more easily escape through the inguinal ring (inguinal canal), by following the spermatic cord, than they can descend along the crural vessels, and raise the margin of the aponeurosis of the external oblique muscle that forms the crural arch. In women an opposite disposition prevails, in consequence of the smallness of the inguinal ring (inguinal canal), which in them only gives passage to the round ligament of the uterus, and, besides, is situated lower down and nearer the pubes, than it is in men ; whilst, on the contrary, the crural arch is more extensive, by reason of the wider form of the pelvis. Morgagni expressly says that he never met with the crural hernia in the dead body of any male subject. *Mihi, ut verum fatear, nisi nondum in fœminis accidit ut eam viderem.* (*De Sed. et Caus. Morb.* epist. xxxiv. xv.) Camper gives us to understand almost the same thing. (*Icones Herniarum, in præfat.*) Hévin often operated for this kind of hernia in females, but only once in the male subject. (*Pathol. et Therap.* p. 406.) Sandifort and Walter have both seen but a single instance of it in the dead body of the male subject. (*Obs. Anat. Pathol.* cap. iv. p. 72 ; *Sylloge Comment.*

Anat. p. 24, obs. 21.) Arnaud himself, to whom modern surgery is highly indebted for many important precepts on the operation for the strangulated crural hernia in both sexes, candidly confesses that he had never had an opportunity of dissecting a hernia of this kind in the male subject." (*Scarpa, Traité des Hernies*, p. 201.)

Scarpa had at his disposal a male subject, in which there was a crural hernia, and he availed himself of the opportunity of examining the parts with the utmost care. He first injected the blood-vessels; he afterwards attentively dissected all the parts concerned in the disease; and he has published an exact description of the particulars, illustrated by an engraving.

According to Hesselbach the femoral hernia, though not common in men, is more frequent than is generally believed, and often overlooked, on account of its being very small. (*Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche*, p. 47.) Thus, in an example published in a modern work, an inguinal and femoral hernia were met with together in a gentleman sixty-three years of age. On examination of the body after death, a small piece of intestine, forming a crural hernia, was found strangulated, and concealed under an inguinal rupture and a mass of fat. (*Sir C. Bell's Surgical Obs.* vol. i. p. 187.)

Mr. Lawrence states that the femoral rupture is not so uncommon in men, as several authors would lead us to suppose. He has seen many instances of it. (*On Ruptures*, p. 409, note, ed. 4.) Dr. Breschet, it seems, has also seen as many as thirty examples of it in the practice of Dupuytren. (*Consid. et Obs. Anat. &c. sur la Hernie Fem.* in his *Concours*, p. 42.)

According to the observations of Scarpa, and all the best modern writers upon surgery, the crural hernia forms, both in the male and female subject, in the cellular substance, which accompanies the crural vessels below Poupart's ligament. The swelling follows the internal side of those vessels, and gradually descends into the fold of the thigh, between the sartorius, gracilis, and pectineus muscles. "Many surgeons believe (says Scarpa) that the hernial sac, and the intestines which it contains, are ordinarily situated above the crural vessels and the trunk of the vena saphena, and sometimes between these vessels and the anterior superior spine of the ilium. But, so far as my knowledge extends, this assertion is not supported by a single accurate description of the crural hernia in the early stage. It is true that when the tumor has in time acquired a large size, and its fundus is inclined in a parallel manner to the fold of the thigh, it partly or entirely covers the crural vessels, and even the crural nerve, as Walter says he once observed. (*Sylloge Comment. Anat.* p. 24.) But it is not thence to be concluded that the tumor in the beginning descended over the crural vessels, much less betwixt them and the anterior superior spinous process of the ilium. Neither must it be imagined that the neck of the hernial sac becomes removed from the inner to the outer side of these vessels. If these two cases ever happen, they must be very rare; and the best authors who have treated of crural hernia concur in stating that in performing the operation they have constantly found the viscera situated at the inner side of the crural vessels, but never at their outside. Even when the tumor, after acquiring a considerable size, is situated transversely over the crural vessels, the neck of the hernial sac has always been found upon their inner side, that is to say, between them and the pubes. Le Dran (*Observ. de Chir.* t. ii. p. 2); La Faye (*Cours d'Opérations de Dionis*, p. 358); Petit (*Œuvres Posthumes*, t. ii. p. 219); Morgagni (*De Sed et Caus. Morb.* epist. xxxiv. xv.); Arnaud (*Mém. de Chir.* tom. ii. p. 768); Gunz (*De Herniis Libellus*, p. 78); Bertrandi (*Trattato delle Operazioni*, t. i. *Annot.* p. 218); Pott (*Chirurg. Works*, vol. ii. p. 152); Desault (*Traité des Mal. Chirurg.* p. 191—195; B. Bell (*A System of Surgery*, vol. i. p. 387); Richter (*Traité des Hernies*, chap. xxxiv.); Nessi (*Instituz. Chir.* t. ii. p. 198); Lassus (*Méd. Opér.* t. i. p. 198), and many other writers, all concur upon this point. "In support of their opinion (says Scarpa) I could cite a great number of cases of my own, which I have collected either in operating on several individuals for crural hernia, or in dissecting the same kind of hernia in the bodies of many female subjects, and in that of the man from whom I have taken the 8th plate. Lastly, also, having had an opportunity of dissecting, in a female, an enormous crural hernia, which descended one third of the way down the thigh, I observed that the neck of the sac did not encroach at all upon the crural vessels, but lay entirely on their inner side." (*Scarpa, Traité des Hernies*, p. 203, 206.) The tumor, on account of its situation, is liable to be mistaken for an enlarged inguinal gland, and many fatal events are recorded to have happened from the surgeon's ignorance of the existence of the disease. Mr. Lawrence once saw an hospital surgeon mistake a crural hernia for a glandular tumor, and the patient died, without any attempt being made to afford relief by the operation (p. 413, ed. 4). (See also Petit, *Mal. Chir.* t. ii. p. 293, &c.) A gland can only become enlarged by the gradual effects of inflammation. The swelling of a crural hernia comes on in a momentary and sudden manner, and, when strangulated, occasions the train of symptoms already described in our account of the inguinal hernia, which symptoms an enlarged gland could never occasion. Such circumstances seem to be sufficiently discriminative, though the feel of the two kinds of swelling is often not of itself enough to make the surgeon decided in his opinion. It is particularly remarked by Hesselbach that while a femoral hernia is incomplete, that is to say within the outer opening of the passage, through which the parts descend, the disease presents itself as a round firm swelling, on the outer side of which the femoral artery can be felt pulsating. This small hernia may be mistaken for an inflamed gland, and the case can only be discriminated by the history of its origin and symptoms. (*Ueber den Ursprung der Leisten-und-Schenkelbrüche*, p. 51.) A femoral hernia may be mistaken for an oblique inguinal, when the expanded part of the swelling lies over Poupart's ligament. As the taxis and operation for the first case ought to be done differently from those for the latter, the error may lead to very bad consequences. *The femoral hernia, however, may always be discriminated by the neck of the tumor having Poupart's ligament above it. In inguinal hernia the spine of the pubes is behind and below this part of the sac; but in femoral hernia it is on the same horizontal level,* *and a little on the inside of it.* (See *Lawrence, On Ruptures*, p. 414, ed. 4.)

In the male subject "the crural hernia, in the early stage (says Scarpa), is situated so deeply in the bend of the thigh that it is difficult, even in the thinnest persons, to feel its neck ; and, in examining its circumference with the extremity of the finger, the tendinous margin of the opening, through which the parts are protruded, can only be perceived with considerable difficulty. On the contrary, the inguinal hernia, however small it may be, is always less deeply situated. It is about half an inch above the bend of the thigh. In carrying the finger round its neck, the tendinous margin of the inguinal ring can be easily felt at its circumference ; and, at the posterior part of the small tumor, the cord, composed of the spermatic vessels, is distinguishable. *When the crural hernia has acquired a considerable size, its neck is always deeply situated in the bend of the thigh ; but its body and fundus assume an oval form, and their great diameter is situated transversely in the bend of the thigh.* Whatever may be the size of the inguinal hernia, it always presents a tumor of a pyramidal form, the base or fundns of which, far from being directed towards the ilium, follows exactly the direction of the spermatic cord, and descends exactly into the scrotum. Besides the symptoms common to all hernial swellings, the crural hernia, when it has attained a certain size, presents some others which are peculiar to it, such as *a sense of stupor and heaviness in the thigh*, and *œdema of the leg, and even of the foot,* of the same side." The reason why œdema and numbness of the limb are particularly remarkable in cases of femoral hernia is justly referred by Hesselbach to the circumstance of the femoral vessels and nerves, with numerous lymphatics, taking their course through the crural ring ; and, according to his observations, the numbness and œdema are especially great when the protrusion is omentum, which makes stronger pressure on the vessels and nerves than commonly happens in a case of enterocele (p. 53).

One case is recorded in which the pressure of an omental femoral hernia on the great vessels had produced a varicose state of the vein, and a partial obliteration of the artery. (See *Jules Cloquet, Pathologie Chir.* p. 88.)

This kind of hernia is not disposed to attain so large a size as that which an inguinal hernia occasionally exhibits. Yet, sometimes its magnitude is considerable, and its contents numerous. Thus, an instance was published by Professor Lallement, in which a femoral hernia, of forty years standing, contained the uterus, Fallopian tubes, the ovaries, a part of the vagina, and a considerable piece of the omentum. (See *Bulletins de la Faculté*, Janvier 1816; and *Jules Cloquet*, in *Pathol. Chir.* p. 104.)

"In women, however (as Scarpa observes), it is less easy to distinguish the crural hernia from the inguinal. In fact, the absence of the spermatic cord, and the nearer situation of the ring to the crural arch, may easily occasion a mistake. Sometimes a woman may even be supposed to have a double crural hernia of the same side, whilst of these two distinct, though neighbouring herniæ, one may be inguinal and the other crural. Arnaud (*Mem. de Chir.* t. ii. p. 605) relates an instance of such a mistake." (*Scarpa, Traité des Hernies*, p. 207, 208.)

This interesting writer takes occasion to observe further, upon this part of the subject, that the portion of the inferior pillar of the abdominal ring, which separates this opening from the internal and inferior angle of the crural arch, is so slender in women, that it is sometimes hard to distinguish the crural from the inguinal hernia, which is not the case in male patients.

Some time ago, the stricture, in cases of femoral hernia, was always supposed to be produced by Poupart's ligament. A change of opinion on this subject, however, took place, in consequence of the observations made by Gimbernat in 1793. "In the crural hernia," says he, "the aperture through which the parts issue, is *not* formed by two bands (as in the inguinal hernia), but it is a foramen almost round, proceeding from the internal margin of the crural arch (Poupart's ligament), near its insertion into the branch of the os pubis, between this bone and the iliac vein; so that in this hernia the branch of the os pubis is situated more internally than the intestine and a little behind, the vein externally and behind, and the internal border of the arch before. Now it is this border which always forms the strangulation." (See *A New Method of operating for the Femoral Hernia.*)

The utility of knowing that it is not Poupart's ligament which produces the strangulation, is insisted upon by Gimbernat as exceedingly important; for we then know, that cutting the lower and outer border of the external oblique muscle is quite erroneous. This proceeding is the more to be reprobated, because the lower pillar of the abdominal ring, in both sexes, will be divided by directing the incision upward, or upward and inward; and thus the abdominal and crural rings will be made into one common aperture, large enough to make the future occurrence of hernia very likely to happen. In the male there is also considerable danger of the spermatic cord being cut. Cutting Poupart's ligament obliquely outwards is attended with still more danger; for the epigastric artery will infallibly be divided at its origin; and with all these hazards, the incision must be quite useless, unless carried on to the internal edge of the crural arch. (*Gimbernat*, p. 16.)

The inclination, however, of several modern writers to refer the strangulation entirely to Gimbernat's ligament is not sanctioned by the most careful observers, like Hesselbach and Langenbeck. (*Neue Bibl.* b. ii. p. 132.) The former justly remarks, that a complete femoral hernia may be strangulated in two places, either at the outer or inner opening of the passage, through which the protrusion happens. Nay, says he, that the strangulation is sometimes caused by the outer opening was known to former surgeons, for they remarked that the constriction was removed by dividing the fascia (p. 53). And, in addition to these two modes of strangulation, is to be enumerated a third, in which the viscera are constricted by protruding through some weaker point, or accidental opening, in the anterior parietes of the crural canal (*Hesselbach*, p. 48; *Cloquet, Recherches Anat.* p. 85; also *Langenbeck*, op. cit. p. 132); or even through an aperture in the inner side of this passage, as we find depicted in the twentieth plate of Langenbeck's treatise, "De Structurâ Peritonæi."

When the dissection of the inguinal region is begun from within, the following circumstances are noticed: after the removal of the peritoneum from the abdominal muscles, and from the psoas, iliacus internus, and the great vessels, the inner surface of the transversalis still has an investment, which Sir Astley Cooper first described and named *fascia transversalis*, and which is always a white glistening aponeurosis. From the place where the femoral artery lies under Poupart's ligament, to the anterior superior spine of the ilium, the preceding fascia is extended in a strong fibrous form behind the inner surface of Poupart's ligament, and a strong continuation of it is extended over the iliacus internus and psoas muscles, where it is called by Sir A. Cooper and Cloquet, the *fascia iliaca*. In this situation the fascia of the transverse muscle closes the belly behind Poupart's ligament as completely as the peritoneum does, so that between the femoral artery and the anterior superior spine of the ilium none of the bowels can protrude, which occurrence is still farther prevented by the fascia lata, which, below Poupart's ligament, is closely attached to the muscles of the thigh. By the pelvis being thus shut up, the origin of a crural hernia on the outside of the femoral vessels is rendered quite impossible. (See *Langenbeck, Neue Bibl.* b. ii. p. 112, &c.) This part of the explanation very nearly resembles that delivered by Sir A. Cooper, except that the latter describes the iliac fascia, and not what Cloquet calls the transverse fascia, as closing the pelvis from the spine of the ilium to the crural vessels. But this difference is easily accounted for, by the circumstance of Sir A. Cooper extending the name fascia iliaca beyond the limits given it by Cloquet and Langenbeck.

"From that part of the crural arch extending from the anterior superior spinous process of the ilium, to the outer edge of the external iliac artery (says Sir Astley Cooper) a strong fascia will be found to arise, extending upwards over the iliacus and psoas muscles. It may be traced inwards behind the femoral vessels, as far as the linea ileo-pectinea, being attached at that line to the ligament of the pubes, and to the tendon of the psoas parvus, when that muscle is present. This fascia has been particularly described by Gimbernat, and should be called fascia iliaca. If the fascia iliaca be carefully traced, it will be found to arise from the outer half of the crural arch, in conjunction with the outer portion of the fascia transversalis; the latter ascending before the peritoneum, while the former passes up behind that membrane; they unite at the outer side of the transversalis muscle, and appear as one continuous production. By the union of these two fasciæ at Poupart's ligament, and their separation to enclose the viscera, the contents of the abdomen are thus received into a blind funnel, and are prevented descending on the outer side of the iliac vessels. If the latter vessels be raised, the fascia iliaca will be seen descending behind them, as far down the thigh as the origin of the profunda, thus forming the posterior part of the sheath. Thus a sheath is formed, enveloping the femoral artery, vein, and absorbent vessels, anteriorly by the descent of the fascia tranversalis, posteriorly by a similar process from the fascia iliaca; and by the union of these at the inner and back part of the sheath, the bag is rendered complete. At the upper part the sheath is broad, but, as it descends, it becomes more closely applied to the femoral vein and artery, giving it the appearance of a funnel. It is at the upper and inner part of this funnel, that the absorbent vessels enter the sheath, giving it, as has been already remarked, a cribriform appearance. This part of the sheath is much looser in its texture than the portion investing the artery and vein which is firm and unyielding on the fore part of the sheath, where the latter is united to Poupart's ligament.

"If the sheath be opened, the contents will be found separated by two membranous septa; one passing between the artery and vein, and a second, equally distinct, between the vein and the absorbents. The septum is formed by a process from the fascia tranversalis passing backwards to attach itself to the fascia iliaca." Sir Astley Cooper then proceeds to explain, that the artery and vein completely fill up the space in the sheath allotted to them, while the absorbents are loosely connected. (See *Sir A. Cooper, On Hernia*, p. 10, part i. ed. 2.)

Near the anterior superior spinous process of the ilium, Langenbeck remarks, that the fascia of the transverse muscle has some strong fibres, which proceed inwards under the internal opening of the inguinal canal, of which they form, as it were, the bottom, and are named by Hesselbach, the *internal inguinal ligament*. They go over the femoral artery and vein, are connected above with the fascia of the transverse muscle, and below are continued into the fascia of the psoas and iliac muscles. Where these fibres pass over the femoral vessels, they expand into a firm aponeurosis, which, passing downwards, is intimately attached at the inner side of the femoral vein to the horizontal branch of the os pubis, close to the symphysis, and then joins the aponeurosis of the recti muscles. The expanded portion of the foregoing tendinous fibres, thus continued along the crista (pecten) of the os pubis to the sheath of the rectus, forms the inner surface of *Gimbernat's*, or the *femoral* or *crural ligament*. The outer edge of this ligament is falciform and concave, the concavity being turned towards the femoral vein. Now where the fascia of the transverse muscle extends downwards, on the outer side of the crural artery, to the fascia of the psoas and iliac muscles, so as to close the pelvis between that vessel and the anterior superior spinous process of the ilium, it also forms, like Gimbernat's ligament, a falciform edge, the concavity of which lies close over the external convexity of the crural artery. Thus, partly by the concave edge of Gimbernat's ligament, directed towards the crural vein, and partly by the concave edge of the extension of the fascia of the transverse muscle to the fascia iliaca, which edge is turned towards the crural artery, an aperture is produced, through which the femoral vessels pass out of the pelvis. This opening is named by Cloquet the *upper opening of the crural canal*, or, as many English surgeons would say, of the *crural* or *femoral ring*. By Hesselbach, it is called the *internal opening for the femoral vessels*. However, as these vessels do not lie loosely and unconnectedly in this aperture, the opening itself is shut up as it were, and cannot be seen without dissection.

On the above described fasciæ, there is a considerable quantity of cellular tissue which covers the vessels in the pelvis, forms a sort of sheath for the crural artery and vein, and accompanies these vessels through the inner opening of the crural canal, or ring, which is itself accurately shut up by it (septum crurale). When this cellular tissue is removed, the white glistening fasciæ are plainly seen passing through the same opening, and coming nearer together in a funnel-like manner. (See also *Sir A. Cooper*, *On Hernia*, p. 10, part. i.) Where the fascia of the transverse muscle forms the outer falciform edge of this aperture, and is passing over the arteria circumflexa ilii to the psoas and iliac muscles, it sends off through the opening, a process which becomes connected with the outer side of the crural canal, or ring; while from the internal inguinal ligament which lies above this opening, and constitutes the upper edge of the inner aperture of the crural canal, a production is sent, which is connected with the anterior side of this canal. As for posterior and inner sides, they have a connection with the fascia covering the psoas muscle.

When the groin is externally dissected, in order to have a view of the crural ring or canal, on the outside of the pelvis, the following appearances present themselves:—after the removal of the common integuments, one finds below Poupart's ligament, a quantity of fat, glands, lymphatics, veins, and arteries, which vessels come out through small openings in the fascia lata. As soon as the outer surface of the external oblique muscle is cleared, its aponeurosis is found to become stronger at the anterior superior spinous process of the ilium, and its fibres to collect together, and assume the form of a band, which is Poupart's ligament, called by Hesselbach the *external inguinal ligament*, and by Gimbernat, Cloquet, and others, the *crural arch*. This ligament, as is well known, passes obliquely, inwards and downwards, towards the os pubis, and after forming the external pillar of the abdominal ring, is first closely inserted into the tuberosity of the os pubis, and then being continued inwards, or backwards, in the form of a firm fascia, is attached to the pectineal line on the horizontal ramus of that bone, making the *anterior or outer face of Gimbernat's ligament*, which is consequently produced by the junction of Poupart's with Hesselbach's internal inguinal ligament along the pecten of the os pubis. Thus, just as the internal inguinal ligament is a strengthened part of the fascia of the transverse muscle, the outer inguinal ligament (or, as it is here commonly called, Poupart's ligament) is produced by the strengthened fibres of the lower portion of the aponeurosis of the external oblique muscle, the fibres of it making the external pillar of the ring, being continued towards the pecten of the pubes, in the form of the outer surface of Gimbernat's ligament. (*Langenbeck, Neue Bibl.* b. ii. p. 120, 121.) Some English surgeons make the formation of Gimbernat's ligament more simple; thus Mr. Lawrence states, that when Poupart's ligament approaches the pubes, "it becomes suddenly broader; that it is fixed by this broad portion, along the whole length of the angle and crista" (*tuberosity and pecten*) "of the pubes; that it has a rounded and strong anterior edge, a thin and sharp posterior margin; and that the former of these is nearer to the surface, while the latter is comparatively deeply seated. The breadth of this part varies, in different subjects; it is generally from three quarters of an inch to an inch. Sometimes, as Gimbernat has stated, it measures more than an inch. Dr. Monro has observed, that it is broader in the male than in the female subject; and, from this structure, he explains in part the more rare occurrence of this rupture in the male" (p. 368, ed. 3).

The fascia lata, which is spread over the muscles of the thigh, proceeds downwards from Poupart's ligament, and is very closely attached to the muscles of the thigh, all the way from the anterior superior spinous process of the ilium to the femoral artery, drawing, as it were, Poupart's ligament downwards and inwards, or backwards, towards the cavity of the pelvis, so as to give to its external edge a convex appearance, and shut up the outside of the pelvis, from the anterior superior spine of the ilium as far as the crural nerve and artery, so firmly, that the formation of a femoral hernia at this part is all but impossible. And, if small apertures, filled with fat, be discernible in this portion of the fascia lata, still no hernia can here take place, because, as Langenbeck has already explained, here the interior of the pelvis is again shut up by fasciæ already described.

Under the fascia lata are situated the anterior crural nerve, the vein, and artery. The vena saphena magna lies superficial to it, and passes through an opening in it into the femoral vein. This aperture in the fascia lata is at the inner side of the groin, opposite the internal opening of the crural canal. It is named by Hesselbach *the external aperture for the femoral vessels*, and described by him as an oblique fissure about fifteen lines in length. He takes notice of its external semilunar edge, and two horns which are directed inwards; the parts first particularly described by Mr. A. Burns, of Glasgow, under the name of the *semilunar* or *falciform process of the fascia lata*. The lower horn bends rather inwards and upwards, and terminates in the production of the fascia lata spread over the pectineus muscle. The upper horn, which is less curved, buries itself under the external pillar of the abdominal ring. Over the lower horn of the opening, just now described, the vena saphena magna ascends into the femoral vein. Through the same aperture also pass nearly all the superficial lymphatics of the lower extremity. According to Cloquet, the fascia lata consists of two layers, of which the anterior superficial one is closely attached to the crural arch, extends over the femoral vessels, and forms the anterior side of the crural canal. The other layer near the pubes, quits the former, and, covering the pectineus muscle, constitutes the hinder side of that canal. The anterior layer of the fascia then forms an oval aperture, through which the vena saphena passes, and which is considered by Cloquet as the *lower opening of the crural canal*. This opening called by Hesselbach the *external foramen for the femoral vessels*, is well delineated both in his excellent work, and in the twenty-third plate of Langenbeck's book. (*De Structurâ Peritonæi, Testiculorum Tunicis, &c.* 8vo. Gött. 1817.)

According to Mr. Lawrence, "at the upper and anterior part of the limb, the fascia lata consists of two portions, an external and an internal, with distinct insertions. The former, which is the thickest and strongest, covers the sartorius and rectus femoris, and is inserted into Poupart's ligament, from the anterior superior spine of the ilium to the inner edge of the femoral vein. The latter thinner and weaker, covers the pectineus and adductor muscles, and is inserted into the pubes, in front of the origin of the former. It passes behind the femoral vessels, and is there continuous with the iliac fascia, while the external portion covers these vessels anteriorly, just below the crural arch, and the vessels themselves are consequently situated between these two divisions of the fascia." (*On Ruptures*, p. 391, ed. 4.)

Where the insertion of the fascia lata into Poupart's ligament ends internally, it forms what Mr. Burns of Glasgow calls the *falciform process*, the upper part of which is attached to the above ligament, while the lower proceeds farther down the thigh. The concavity of the falciform process is directed towards the pubes. This anatomical connection is one chief cause, why extending the thigh and rotating it outward, render the crural arch tense.

The hernia being situated in front of the pectineus, must of course be exterior to the pubic portion of the fascia lata. This part of the subject is rendered very clear in the works of Sir Astley Cooper, Lawrence, Hesselbach, Langenbeck, and Jones Quain.

Mr. Lawrence states, that "the upper end of the falciform process passes over the upper and outer part of the neck of the tumor; it is then folded under the crural arch, and continues into the thin posterior border. The iliac vein is placed on its outer side ; the pubes is directly behind it; and the upper and inner parts are bounded by the thin posterior edge of Poupart's ligament" (*Gimbernat's ligament*). "It is this part which forms the strangulation." (*On Ruptures*, p. 404, ed. 4.) While, however, the latter statement is made by this gentleman and others, Sir Astley Cooper as positively declares, that the stricture is never situated at Gimbernat's ligament, but at the crural arch, just where the viscera leave the abdomen. He also mentions, that he has known the stricture continue after the division of that ligament (Gimbernat's) and the patient die. The view taken of this part of the subject, by Hesselbach and Langenbeck, I have already explained.

The anterior and inner side of the crural canal, as already explained, is connected with the fascia of the transverse muscle. And, according to Langenbeck, below the part of the fascia lata, which forms the external foramen for the femoral vessels, the front side of the crural canal is sometimes formed by a continuation of the fascia of the transverse muscle, as he found was the case in both groins of one female subject. In some subjects there is a good deal of fat between the fascia lata, and the portion of the aponeurosis of the transverse muscle, and the two parts are easily separable. Langenbeck admits, however, that the same appearance may arise from a splitting of the layers of the fascia lata. Frequently the front side of the crural canal is so short that the opening cannot rightly be termed a canal, and it is always shorter than the posterior side. The outer side is extended across to join the inner over the space between the two horns, and is then connected with the aponeurosis of the pectineus muscle. In the anterior and inner sides of the crural canal, there are some small openings (*fascia cribriformis*). Doubtless this structure is referred to by Hesselbach, when he says, that in the male subject the outer opening for the femoral vessels is farther closed by a net-like web of tendinous fasciculi. The posterior side of the crural canal is derived from the part of the fascia of the psoas which enters its inner opening, and joins the aponeurosis of the pectineus muscle. The outer side of the canal lies under the fascia lata, and joins the anterior and posterior sides, where the aponeuroses of the transverse and iliac muscles proceed to the outside of the femoral artery. Langenbeck thinks the opening, by which the vena saphena passes over the lower horn of the falciform process of the fascia lata, might be named the *lower aperture of the crural canal.* (See *Langenbeck's Neue Bibl. für die Chirurgie*, b. ii. p. 126, 127, 8vo. Hanover, 1819.)

According to Hesselbach, when femoral hernia exists, the two openings of the passage now termed the crural canal, are one half larger than natural. The outer portion of the inner of these apertures is propelled more outward, and with it the epigastric artery. The femoral vein no longer lies at the external side of this opening, but rather at the back of the canal or passage. The external semilunar edge (the falciform process) of the outer opening is carried more outward and upward, and is tightly applied over the distended hernial sac. In this state of the parts the outer opening forms an oval, firm tendinous ring, the long diameter of which, like that of the inner opening for the passage of the femoral vessels, is transverse. The neck of the hernial sac is that portion of it, which lies within the canal between the two openings. The posterior side of this canal, or passage, now frequently named the crural canal, is longer than the anterior. In one large hernia, Hesselbach found it an inch and a half in length, but the anterior side of the passage more than one third shorter. The greatest diameter of the inner opening was one inch five lines, while that of the outer one was only one inch four lines. Most of the posterior part of the neck of the hernial sac, with the hinder side of the canal, lies upon the pectineus muscle, and towards the outer side upon the femoral vein. The neck of the hernial sac adheres more firmly to the anterior, than to the posterior side of the passage. At the outer opening of the passage, the neck terminates at almost a right angle forwards in the body of the sac, the upper portion of which lies upon Poupart's ligament, but the largest part of it is situated on the pectineal layer of the fascia lata. In the male subject, when the tendinous fibres, mixed with the cellular substance covering the outer opening of the passage (*fascia cribriformis*,) make great resistance at particular points, the hernial sac of a femoral hernia may be double, or even divided into several pouches, a preparation exhibiting which occurrence is in the anatomical museum at Würzburg. (*Hesselbach*, p. 48.) Except in a few cases, in which the origin and course of the epigastric artery are unusual, this vessel runs very close to the external side of the neck of the hernial sac, much nearer than it does in an internal inguinal hernia.

The sac of the femoral hernia is exceedingly narrow at its neck; and, where its body begins, it becomes expanded in a globular form: the sac of an oblique inguinal hernia is generally of an oblong pyramidal shape. The body of the sac of the femoral hernia makes a right angle with the neck, by being thrown forward and upward, a circumstance very necessary to be known in trying to reduce the parts by the taxis. Though the tumor formed by the body of the sac is oval and nearly transverse, it is found when attentively examined, to take the direction of the groin, which extends obliquely downwards and inwards, the outer rather smaller end of the swelling being somewhat higher than the inner. (*Hesselbach*, p. 50.)

The sac of the femoral hernia is said by Sir. A. Cooper to be covered by a kind of membranous expansion, consisting of condensed cellular substance (*septum crurale*), and named by him the *fascia propria*, which is thus described:—" A thin fascia naturally covers the opening through which the hernia passes, and descends on the posterior part of the pubes. When the hernia, therefore, enters the sheath, it pushes this fascia before it, so that the sac may be perfectly drawn from its inner side, and the fascia which covers it left distinct. The fascia which forms the crural sheath, and in which are placed the hole or holes for the absorbent vessels (*fascia cribriformis*), is also protruded forwards, and is united with the other, so that the two become thus consolidated into one. If a large hernia is examined, the fascia propria is only found to proceed upwards, as far as the edge of the orifice on the inner side of the crural sheath, by which the hernia descends; but, in a small hernia, it passes into the abdomen, as far as the peritoneum, and forms a pouch, from which the hernial sac may be withdrawn, leaving this, forming a complete bag over the hernia." (*On Hernia*, part 2, p. 6.)

The thin fascia, described by Sir Astley Cooper, as shutting up the crural canal, and protruded by the viscera, is the septum crurale of M. Cloquet; who observes, that it resists the finger when we endeavour to pass it from above downwards beneath the crural arch. It is always perforated by small apertures for the passage of lymphatics. One of these apertures, more considerable than the rest, is central, and sometimes occupied by an elongated absorbent gland. The sac of femoral hernia sometimes pushes before it the septum crurale; and, in other instances, protrudes through one of its apertures, which may then become a cause of stricture. (See *J. Cloquet*, *On Hernia*, p. 40, tr. by *McWhinnie*.)

By Sir Astley Cooper, M. Cloquet, and the generality of surgeons, femoral hernia is described as protruding into the sheath of the femoral vessels. The correctness of this description, however, Mr. Guthrie does not admit; but only because he will not consider the passage for the lymphatics, on the pubic side of the septum situated at the internal border of the femoral vein, as a portion of that sheath. " In all the dissections of femoral herniæ (says Mr. Guthrie) I have had an opportunity of making, the septum crurale of Cloquet, or the fascia propria of Sir Astley Cooper, formed a distinct sac, separated from the septum on the inside of the femoral vein, by a mass of condensed cellular structure, sometimes more than half an inch in thickness. The septum had been elongated into an outer sac for the hernia, and had gone down by the side of the sheath of the vein. The hernial sac, or peritoneum, is not then projected into the sheath of the femoral vessels, but into a separate sac, which it forms for itself by the side of them." (*On Inguinal and Femoral Herniæ*, p. 32.) Here the difference of opinion turns entirely upon the point, whether the passage for the absorbent vessels at the inner side of the septum, or the pubic edge of the vein, is a compartment of the femoral sheath or not.

In every dissection of femoral hernia performed by Mr. Todd, this thin fascia, the septum crurale, was sufficiently evident. It appears to him, however, that the fascia propria " is formed, not only of a portion of this internal fascia, but also, in many instances, of all the dilatable parts interposed between the hernial sac and the superficial fascia; and that its thickness will depend on the thickness and structure of these parts; on the alterations produced in them by inflammation and pressure; and on the perforated portion of the crural sheath, in some cases, composing a layer of this fascia; while, in others, the hernia dilates, and is protruded through one of the foramina, frequently pushing before it a large absorbent gland from the orifice of the sheath." (*C. H. Todd*, in *Dublin Hospital Reports*, vol. i. p. 248.)

As explained by Sir A. Cooper, a weak aponeurosis, derived from the superficial fascia of the bend of the thigh, covers the swelling, and lies immediately beneath the skin and adipose substance. Under this fascia is the condensed cellular substance or fascia propria joined with the expansion of the crural sheath, then some adipose substance, and lastly, the true peritoneal sac itself. It is of infinite use to remember these several investments in operating, lest the hernial sac should be supposed to be divided, while it is not so.

[The many elaborate descriptions given by different authors of the structures implicated in femoral hernia serve, it is to be feared, rather to confuse the practical surgeon than to enlighten him. Fortunately, the finger of the operator will guide him to the stricture, whatever may be its name, and however variously described. In like manner, his eye must direct him in dividing the coverings of the sac, whatever these structures may be, and however complicated their connections.

With regard to the parts which form the stricture in different cases of femoral hernia, they may be thus enumerated:—1st, the crescentic edge of the fascia lata; 2nd, Poupart's ligament and the deep crural arch; 3rd, Gimbernat's ligament; 4th, the neck of the sac. Of these the only structure not sufficiently described in the foregoing pages is the deep crural arch, or Hey's ligament. The fascial fibres composing this structure are situated in contact with and are adherent to the under surface of Poupart's ligament for its inner half. They cross therefore the upper part of the sheath of the femoral vessels to which they adhere. The fibres of the deep crural arch may be said to commence at the centre of the superficial surface of Poupart's ligament, to pass obliquely from without inwards, and from before backwards underneath it, to gain the deep surface of Gimbernat's ligament, where they may be said to terminate. They would consequently intervene between the neck of the sac of a femoral hernia and Poupart's ligament, and would be the first structure divided by the operator's knife in cutting upwards from the neck of the sac towards that ligament. With respect to the coverings of a femoral hernia in addition to the skin and superficial fascia, three are generally enumerated, namely—1st, the cribriform fascia; 2nd, the sheath of the femoral vessels; and 3rd, the septum crurale or fascia propria of Sir Astley Cooper. The first or cribriform fascia is simply that portion of the deepest layer of the superficial fascia which fills up the saphenic opening of the fascia lata and adheres to its margin. It is perforated by the superficial lymphatics as they pass to gain the interior of the femoral sheath; hence its name of cribriform fascia. Its surfaces are inseparable except by dissection, from the sheath of the vessels on the one hand, and from the superficial fascia on the other. The sheath of the femoral vessels and the fascia propria have been already sufficiently described.]

All late writers on hernia have remarked how very small the aperture is, through which the viscera protrude in the femoral rupture; how much greater the constriction generally is, than in inguinal hernia; consequently, how much more rapid the symptoms are; how much less frequently the taxis succeeds; and how much more dangerous delay proves. (See *Sir A. Cooper*, *Hey*, *Lawrence*, &c.)

Though the crural ring is almost always small, yet, in a few instances, in which the tumor is large, and of long standing, it becomes very capacious, just as the opening often becomes, through which the inguinal hernia protrudes. Dr. Thomson, of Edinburgh, Mr. Hey, and Mr. Lawrence, have related examples of this kind.

The remarks already made concerning the treatment of hernia, before having recourse to the knife, are all applicable to the present case, and need not be repeated. In attempting to reduce a femoral hernia by the taxis, the surgeon should recollect, however, that relaxing Poupart's ligament, and the femoral fascia, is of the highest consequence. Hence, the thigh should be bent, and rolled inwards. The pressure ought, also, to be first made downwards, in order to push the swelling off Poupart's ligament; and afterwards, the parts should be propelled backwards, and then upwards, so that they may return through the crural canal and ring. For the direction of the crural canal is vertical in the greater part of its extent; its superior aperture faces upwards and backwards towards the abdominal cavity, whilst its inferior (the opening for the vena saphena) is directed forwards. The canal, therefore, has three different axes, which by their union, represent the form of the small italic *s*; the superior branch of which, resting upon the pubes, would form the axis of the superior aperture of the canal, and which has a direction downwards and forwards. Its middle branch would represent that of the canal itself, which is more vertical; whilst the inferior would pass directly forwards, through the opening for the vena saphena, in a direction corresponding to the axis of this aperture (See *M. Jules Cloquet*, *On Inguinal* and *Femoral Hernia*, p. 37, tr. by *McWhinnie.*)

Operation for Femoral, or Crural Hernia.

Sir A. Cooper says, "The incision of the integuments is to be begun an inch and a half above the crural arch, in a line with the middle of the tumor, and extended downwards to the centre of the tumor below the arch. A second incision, nearly at right angles with the other, is next made, beginning from the middle of the inner side of the tumor, and extending across it to the outer side, so that the form of this double incision will be that of the letter T reversed." The angular flaps are, of course, to be next dissected off, and reflected. Dupuytren also makes the external wound of a similar shape, the first cut being always parallel to the femoral vessels. (*Breschet*, op. cit. p. 169.)

The making of two incisions, however, is not deemed necessary by the majority of surgeons; and, in all the numerous operations which I have seen performed in St. Bartholomew's Hospital during my apprenticeship there, and afterwards, and in eight cases, upon which I have operated myself, a transverse wound was not necessary. The division of the skin should begin about an inch above the crural ring, and be continued obliquely downwards and outwards. In this manner, we cut exactly over the place, where the incision of the stricture should be made. (See *Lawrence*, p. 425, ed. 4.)

"The first incision (Sir A. Cooper remarks) exposes the superficial fascia, which is given off by the external oblique muscle, and which covers the anterior part of the hernial sac; but, if the patient is thin, and the hernia has not been long formed, this fascia escapes observation, as it is then slight and delicate, and adheres closely to the inner side of the skin. When this fascia is divided, the tumor is so far exposed, that the circumscribed form of the hernia may be distinctly seen; and a person not well acquainted with the anatomy of the parts, would readily suppose that the sac itself was now laid bare. This, however, is not the case, for it is still enveloped by a membrane, which is the fascia, that the hernial sac pushes before it, as it passes through the inner side of the crural sheath. This membrane, the fascia propria, is to be next divided longitudinally from the neck to the fundus of the sac; and if the subject is fat, an adipose membrane lies between it and the sac, from which it may be distinguished, by seeing the cellular membrane passing from its inner side to the surface of the sac.

"This is, in my opinion, the most difficult part of the operation; for the fascia propria is very liable to be mistaken for the sac itself; so that, when it is divided, it is supposed, that the sac is exposed, and the intestine is laid bare: following upon this idea, the stricture is divided in the outer part of the sac, and the intestine, still strangulated, is pushed, with the unopened sac, into the cavity of the abdomen.

"The hernial sac being exposed, is to be next opened; and, to divide it with safety, it is best to pinch up a small part of it between the finger and thumb; to move the thumb upon the finger, by which the intestine is distinctly felt, and may be separated from the inner side of the sac; and then to cut into the sac, by placing the blade of the knife horizontally. Into this opening, a director should be passed, and the sac opened from its fundus to the crural sheath. (*On Crural and Umbilical Hernia.*)

Sometimes the contents of the hernia, thus exposed, admit of being returned, without the further use of the knife. When this object, however, cannot be readily effected, the protruded parts should never suffer injury from repeated manual attempts; and it is best to divide the stricture at once.

The merit of having first proposed the safest plan of cutting Poupart's ligament, even before surgeons were aware of the parts which really form the strangulation, is assigned by Gimbernat to Mr. B. Bell, who introduced his finger below Poupart's ligament, between the ligament and the intestine (an evident proof, says Gimbernat, that there was no strangulation there); he then made a very superficial incision from above downwards into the thickest part of the ligament to its lower edge; and, without cutting quite through it, he continued his incision about an inch. He rested the back of the scalpel upon his finger, which served as a guide to the instrument, and, at the same time, as a defence to the intestine. The incision, however, having been continued for an inch, would, as Gimbernat remarks, inevitably cut the internal edge of the crural arch. Now, cutting this, only for a few lines, gives sufficient room for the easy reduction of the parts, and there is no necessity to touch the ligament (Poupart's), as it never occasions the strangulation. (*Gimbernat*, p. 27.)

Gimbernat's method of dividing the stricture, in cases of femoral hernia, is now frequently regarded as the safest and most effectual. "Introduce, along the internal side of the intestine, a canulated or grooved sound with a blunt end, and a channel of sufficient depth. This is to be directed obliquely inwards, till it enter the crural ring, which will be known by the increased resistance; as also, when its point rests upon the branch of the os pubis. Then suspend the introduction; and keeping the sound (with your left hand, if you are operating on the right side, and *v. v.*) firmly resting upon the branch of the os pubis, so that its back shall be turned towards the intestine, and its canal to the symphysis pubis, introduce gently with your other hand, into the groove of the sound, a bistoury, with a narrow blade and blunt end, till it enter the ring. Its entry will be known, as before, by a little increase of resistance. Cautiously press the bistoury to the end of the canal; and employing your two hands at once, carry both instruments close along the branch to the body of the os pubis, drawing them out at the same time. By this easy operation, you will divide the internal edge of the crural arch (Gimbernat's ligament) at its extremity, and within four or five lines of its duplicature; the remainder continuing firmly attached by the inferior band, or pillar, of which it is the continuation. This simple incision being thus made, without the smallest danger, the internal border of the arch, which forms the strangulation, will be considerably relaxed, and the parts will be reduced with the greatest ease. (*Gimbernat*, pp. 45, 46.)

Mr. Lawrence thus executes Gimbernat's plan:— "It will generally be practicable (says he) to introduce the tip of the finger, or of the nail, under the edge of the tendon, the fibres of which should be carefully divided in succession, with the probe-pointed knife, until we have gained just sufficient room to replace the contents of the swelling. When the tightness of the stricture prevents the operator from using his finger as a guide, he will employ the deeply-grooved curved director, introducing it as near as he can to the pubes. In both cases, the blunt end only of the curved knife should be passed beyond the stricture, that the division may be effected without risk to the arteries, in case they should not follow their usual course." The intestine should be protected by the operator's left fore-finger, or, if that cannot be spared, it may be held aside by an assistant. (*On Ruptures*, p. 432, ed. 4.)

Mr. Todd has always found the division of a few fibres of Gimbernat's ligament effectual. (*Dublin Hospital Reports*, vol. i. p. 254.) The following are his directions: after the sac has been opened, "let the operator pass the fore-finger of his left hand (if the hernia be on the right side, and *vice versâ*) as far as can be, without using force, into the neck of the sac, the back of the nail being turned towards the pubes, and its extremity applied to the edge of Gimbernat's ligament. Sir Astley Cooper's bistoury is then to be introduced, the finger serving as a conductor for it, the bistoury being held so, that its edge shall look towards Poupart's ligament, and one of its sides be in contact with the nail of the conducting finger, between which, and Gimbernat's ligament, it is to be passed. Having ascertained, with the blunt extremity of the bistoury, that it is fairly introduced into the crural ring, the intestine being protected, as much as possible, by the left hand of the operator, the edge of the bistoury is to be turned towards the pubes, and being pushed a little further into the ring, the sharp portion of its edge will be brought into contact with Gimbernat's ligament, and will divide a few fibres of it. The operator is still to keep the conducting finger between the intestine and bistoury, as thus he will be enabled to perceive the dilatation of the ring, and to judge of the extent to which it may be necessary to enlarge it." (*C. H. Todd.*)

Sir Astley Cooper recommends the stricture to be divided "obliquely inwards and upwards, at right angles to the crural arch." In consequence of the very deep situation of the posterior edge of the crural arch, and the tight manner in which the protruded viscera are surrounded by the tendon, this excellent surgeon considers, that the intestine is in great danger of being wounded with the knife, or, if held aside sufficiently, of being torn. Hence, his custom is to divide the stricture on its anterior part, as far as the front margin of the crural arch, directing the edge of the knife upwards and inwards. If this is not sufficient, he afterwards cuts the thin posterior border of the tendon in the same direction.

After advising us to open the sac of a femoral hernia with particular care, on account of its being much thinner than that of inguinal hernia, and (as might be added) on account of its seldom containing any fluid, and often having no omentum in it covering the intestine, Mr. Hey remarks: "The stricture made upon the prolapsed parts is very great, as I have already observed; but if the tip of the finger can be introduced within the femoral ring, to guide the hernia knife, a small incision (for the ring is narrow) will be sufficient to set the parts at liberty. If the tip of the finger cannot be introduced at the proper place, a director with a deep groove must be used instead of the finger; but I prefer the latter. The finger or director should not be introduced very near the great vessels, but on that side of the intestine or omentum which is nearest to the symphysis of the ossa pubis. *The incision may then be made directly upwards.* The surgeon must take especial care to introduce his finger or director within that part where he finds the stricture to be the greatest, which, in this species of hernia, is the most interior part of the wound" (p. 155).

Gimbernat's mode is preferable to Mr. Hey's, because, were the operation done on a male, cutting directly upward would endanger the spermatic cord. In order to obviate this risk, Sir A. Cooper makes a small incision above Poupart's ligament, and draws the cord out of the way of the knife with a bent probe.

Mr. Lawrence has noticed that an "incision of the most interior part of the stricture is free from all danger in the ordinary course of the vessels. But that variety, in which the obturatrix artery, arising from the epigastric, runs along the inner margin of the sac, seems to preclude us from cutting even in this direction." Hesselbach met with a remarkable instance of such irregularity in the origin and course of the obturatrix artery in the body of a female, in whom there were two small crural herniæ. On the right side, the epigastric and obturatrix arteries arose, by a common trunk, from the crural artery below Poupart's ligament. They soon separated from one another; the epigastric taking its ordinary course upwards at the outer side of the neck of the hernial sac, while the obturatrix made a considerable turn, and ran transversely inwards over the strong fibres of the femoral ligament, and encircled the anterior and inner side of the neck of the hernia, whence it afterwards proceeded obliquely downwards and outwards, behind the horizontal branch of the os pubis, towards the obturator foramen. (*Hesselbach*, p. 52.) A mode of operating has been proposed (*Edin. Med. and Surg. Journal*, vol. ii. p. 205), with the view of avoiding this danger. We are directed to make an incision through the aponeurosis of the external oblique muscle, just above the crural arch, and in a direction parallel to that part; to introduce a director under the stricture from this opening, and to divide the tendon to the requisite extent by means of a curved knife passed along the groove. (*On Ruptures*, p. 430, ed. 4.) For reasons which Mr. Lawrence states, this plan is certainly not altogether eligible; and, upon the whole, Gimbernat's method of cutting the stricture is safer.

Dupuytren uses a curved probe-pointed bistoury, that cuts with its convexity. It is conducted flat on the left fore-finger, and with it, under the stricture, and then its edge is turned upwards, the incision being extended through the upper end of the falciform process to the margin of the crural arch. (*Breschet*, *Concours*, *&c.* p. 182.)

It is remarked by Mr. Guthrie that the falciform process, which lies over the femoral artery, and passes inwards to attach itself to Poupart's ligament, and to form the anterior part of Gimbernat's ligament, is inserted also into the os pubis, on a plane lower than the insertion of the inferior pillar of Poupart's ligament, so that "it forms an arch, exterior to the septum crurale, which, when it is forced to descend, is compelled to pass under it; *and it is this, and not Poupart's ligament*, which causes the greatest compression on the hernia, and is the seat of external stricture." (Op. cit. p. 32.) This gentleman has heard of more than one instance in which the obturatrix artery was wounded by dividing Gimbernat's ligament horizontally. He is therefore in favour of dividing directly upwards "that portion of the fascia lata which is attached to Gimbernat's ligament, and to the pubes, as well as the fascia propria." If this should be insufficient, he would then have recourse to the horizontal incision.

The industrious Cloquet examined 250 bodies, for the purpose of estimating the average number of cases, in which the origin and course of the obturatrix artery are different from what is most common. He found, that when this artery and the epigastric arise by one common trunk, they sometimes separate from each other above, and rarely below, the upper opening of the crural canal. In the first case, the longer their common trunk is, the closer do they lie to Gimbernat's ligament, and to the inner edge of the upper opening of the above canal. In the second case, the common trunk of these arteries arises within this canal, and the two vessels then return into the abdomen. In 160 bodies, of which 87 were male, and 73 female, the obturatrix artery arose on both sides from the hypogastric (internal iliac); and only in 56, of which 21 were male, and 35 female, did it originate on both sides from the epigastric. In 28, of which 15 were male, and 13 female, the obturatrix arose on one side from the hypogastric (internal iliac) and on the other from the epigastric. In six bodies, viz. two male, and four female, it originated from the crural. (*Rech. Anat. sur les Hernies*, 4to. Paris.)

When the obturatrix artery thus arises irregularly from the epigastric, it does not always take its course over and to the inside of the neck of the sac. Sir A. Cooper says, "In all cases, which I have myself dissected, where this variety existed with crural hernia, the obturator has passed into the pelvis, on the outer side of the neck of the sac, entirely out of the reach of any danger of the knife." (*On Crural Hernia*, p. 21.) Mr. Lawrence concludes, that the comparative number of instances, in which it is found on the opposite side, cannot be more than one in twenty, and consequently, if we admit that the obturatrix artery arises from the epigastric once in five times, it would only be liable to be wounded once in a hundred operations (p. 412, ed. 3).

[The latest and most reliable information on this subject will be found in Mr. Quain's valuable work on the anatomy of the arteries of the human body. Mr. Quain's tables show (*Commentaries on the Arteries*, p. 447) that out of 361 dissections, the obturator artery took origin from the internal iliac in 247, or about twice in three dissections, and from the epigastric in 103, or once in three and a half dissections. In five instances it arose by two roots, one from the internal iliac, and one from the epigastric; and in six instances from the external iliac trunk.

Again, in 101 cases (p. 451, op. cit.) where the obturator artery arose either from the epigastric, or from the external iliac, he found that 10 only were so situated as to render it certain that if a hernia occurred, the neck of the hernial sac would be surrounded above and internally by the artery; 54 were situated on the outer margin of the ring, and 37 crossed it, leaving it doubtful in these latter cases on which side of the artery the hernia would pass. It is evident that the artery associated with its veins and accompanying cellular tissue, when crossing midway the femoral ring, must offer an additional obstacle to the occurrence of a hernial protrusion at all in this situation. Mr. Quain, on attempting in the dead body to produce a protrusion where this position of the artery existed, found that it could be effected with greater facility on the inside than on the outside of the artery. In other words, that the attachment of the artery to the epigastric, rendered it more difficult to displace it in the inward than in the outward direction. It may therefore be fairly concluded that, in the majority of these 37 instances, a hernial sac would not be found with the obturator artery on its upper and inner side.

Mr. Allan Burns records an interesting case in which a double femoral hernia occurred where the obturator artery thus crossed the femoral ring. One of the hernial sacs was situated internal to the artery, the other external to it; and this latter was found to occupy the compartment of the sheath containing the femoral vein. It has generally been supposed, that when the obturator artery arises low down from the epigastric, it would be situated at the outside of the femoral ring, and that its origin high up from the epigastric would cause it to take its upper and inner margin. This opinion is combated by Mr. Quain; he found that the direction the obturator takes to gain the opening in the obturator fascia, is but little influenced by the level of its origin from the epigastric.]

When the origin and course of the epigastric artery differ from what is common, this vessel, as Hesselbach remarks, sometimes passes inwards along the horizontal branch of the os pubis, ere it ascends towards the rectus muscle; and when this variation exists in a case of femoral hernia, the artery does not pass over the outer side of the neck of the sac, but first under it, and then round its inner side. Hesselbach has seen only one instance of this irregularity of the epigastric artery in a female, and never in a male subject. (*Ueber den Ursprung, &c. der Leisten-und-Schenkelbrüche*, p. 52.)

It is observed by Professor Scarpa, that "the round ligament of the uterus, in passing through the abdominal muscles, follows precisely the same track as the spermatic cord. It is equally situated behind Poupart's ligament, with the difference, that it does not become so distinct from the internal extremity of this ligament, as the spermatic cord does, because it has not so far to run, in order to get from that ligament to the inguinal ring, the latter opening being situated lower in the female than in the male subject. The round ligament, like the spermatic cord, also crosses the epigastric artery, before reaching the inguinal ring. And as crural hernia always begins at the internal and inferior angle of the arch of this name, as well in the male as the female, it follows that, in the two sexes, the epigastric artery remains in its natural situation, and invariably corresponds to the external side of the neck of a crural hernia; whilst the spermatic cord in men, and the round ligament in women, pass over the extremity of the front of the neck of the hernial sac. In the operation for crural hernia, in females, the incision of the neck of the hernial sac, and of the crural arch, when directed upward towards the linea alba, cannot wound the epigastric artery, which it is of the most consequence to avoid; but it always divides, either totally, or partially, the round ligament of the uterus, which cannot lead to any dangerous hæmorrhage; for, except in the period of pregnancy, the arteries of the round ligament are very small; they are almost obliterated in women advanced in years; and, in general, they are quite capillary in the extremity of the ligament adjoining the ring. Hence, it cannot be surprising, that so many crural herniæ have been successfuly operated upon in women, by cutting the hernial sac and crural arch directly upward, while not a single instance can be cited of such an incision being made in man without mischief, although, in both sexes, the epigastric artery may have been avoided in operating by this process." (*Scarpa, Traité des Hernies*, p. 240.)

In operating upon crural hernia in males, Scarpa recommends us to follow a method, which he calls new, but which, in fact, is the same as that advised by Gimbernat. "I have found (says Scarpa) that, in man, the neck of the hernial sac may be divided without danger, by giving to the incision a direction exactly contrary to that which is practised in the female subject. After having opened the hernial sac, it is to be drawn outward by one of its sides sufficiently to allow the introduction of a small director between its neck and the strangulated intestine, *the groove of the instrument being turned downwards towards the internal and inferior angle of the crural arch. A probe-pointed bistoury, the edge of which is also to be directed downwards towards the point of insertion of Poupart's ligament to the pubes, is to be pushed along the groove. By this means the neck of the hernial sac will be divided its whole length, at its internal and inferior side, and Poupart's ligament will be cut close to its attachment to the top of the os pubis.* The epigastric artery will certainly be avoided, because it lies upon the opposite side of the hernial sac. As for the spermatic cord, I have demonstrated, that it is situated on the forepart of the neck of the hernial sac; consequently it cannot be touched by an incision made from above downwards, whilst it is constantly cut in the ordinary method, since the knife is carried from below upwards. In the first case, this part may be the more easily avoided, as it lies at some distance from the internal and inferior angle of the crural arch. In fact, it is at this place that it quits, as we have seen, the edge of Poupart's ligament, in order to ascend towards the inguinal ring. The incision that I propose (says Scarpa) not only has the advantage of slitting open the neck of the hernial sac its whole length, it also divides a part of the insertion of Poupart's ligament into the upper part of the os pubis, a thing that greatly contributes to relax the crural arch, and facilitate the reduction of the viscera; of those, at least, which are not adherent to the sac." (*Scarpa*, op. cit. p. 235.)

Hesselbach considers an incision through the anterior side of the crural ring safer than one through Gimbernat's ligament, and safer in women than men. In women he recommends the cut to be made through the middle of the fore part of the ring, nearly straight upwards, or a little inclined inwards, in which mode the epigastric artery cannot be hurt, whether it lie at the outer or inner side of the neck of the sac. In men this incision, directed obliquely upwards and inwards, he says, cannot be made, on account of the nearness of the spermatic cord. Therefore, in the male subject, he advises cutting the inner side of the opening, that is to say Gimbernat's or the femoral ligament, directly inwards towards the symphysis of the os pubis. (*Ueber den Ursprung der Leisten-und-Schenkelbrüche*, p. 54.) When the epigastric, or obturatrix, artery deviates from its usual course, and surrounds the inner side of the neck of the hernia (which variety can never be ascertained *a priori*), a wound of the vessel Hesselbach regards as unavoidable.

From the views taken of femoral hernia in this article, I consider the unrestricted direction always to cut Gimbernat's ligament in the operation to be erroneous. For, as Langenbeck has stated, the seat of strangulation may either be in the external aperture of the crural canal, or in an opening of the front or inner side of this passage, or in its inner opening, where indeed Gimbernat's ligament and the attachment of the falciform process of the fascia lata to it are truly concerned. When the strangulation is of the two first descriptions, he states, that only the fascia lata need be cut; but, in the third, most frequent case, the inner semi-lunar edge of the crural ring (Gimbernat's ligament) should be divided. In all cases, says Langenbeck, whether the strangulation be caused by the inner or external opening of the crural canal, or by an aperture in the front parietes of this passage, the stricture must be cut inwards, as directing the cut in the least outwards would injure the epigastric artery. When it is perceived in the operation that the neck of the hernial sac is strangulated close below and behind the external pillar of the abdominal ring, the inner opening of the crural canal must be divided inwards, with the knife directed along the horizontal ramus of the os pubis, under the external pillar of the ring, towards the symphysis of the pubes. If, in such a case, the knife were carried inwards and upwards, that part of Poupart's ligament forming the upper side of the crural canal might be cut and the spermatic artery injured. (*Neue Bibl.* b. ii. p. 133.)

Dr. Trüstedt has published some remarks in favour of employing dilatation, instead of an incision, in the operation for strangulated crural hernia. He observes that even when the common trunk of the obturatrix and epigastric arteries is short, the bowels may protrude under the first of these arteries, which will lie upon the upper and inner side of the hernia. In an operation performed upon a woman, in La Charité at Berlin, for a strangulated femoral hernia, the crural ligament was divided in Gimbernat's way by an incision exactly parallel to the horizontal ramus of the os pubis. The obturatrix artery was wounded, and the patient died eight days after the operation, having been previously attacked by trismus and opisthotonos. On dissection, about six ounces of putrid blood were found in the lesser cavity of the pelvis, and the above artery cut. The vessel arose from the epigastric, ran over the upper edge of the inner opening of the crural canal, or ring, and then descended along its inner edge, towards the obturator foramen. This occasional course of the obturatrix artery leads Dr. Trüstedt to suggest the following rules:—If, after the hernial sac is opened, the bowels cannot be returned, the outer opening of the crural canal should be cut directly inwards, in order to produce a considerable relaxation. But if the reduction should yet be impracticable (the strangulation being at the inner opening of the canal), then an attempt is to be made to insinuate the end of the finger through the constriction; a plan said to have answered very often in the practice of Surgeon-General Rust. Should the resistance be too great, however, for this method to succeed, Trüstedt advises the crural ligament to be forcibly drawn inwards and upwards towards the navel, with Arnaud's tenaculum, assisted by the introduction of the finger, or with two hooks. When this plan fails, he recommends Schreger's practice of dividing the anterior edge of Poupart's ligament with a pair of blunt-pointed scissors, and then the use of Arnaud's tenaculum again. (See *Rust's Magazin für die gesammte Heilkunde*, b. iii. h. 2.) The consideration, however, which will ever prevent the common adoption of Dr. Trüstedt's suggestion, is that fifty times more lives would be lost by the mischief done to the protruded bowels by the forcible introduction of the fingers and hooks, than by hæmorrhage from the obturatrix, or epigastric artery, when the course of the vessel is irregular.

Mr. Aston Key, who is an advocate for not opening the sac, makes the following remarks:— The inverted T incision, usual in the operation for femoral hernia, may be, in most cases, reduced to a single incision, either at right angles to Poupart's ligament, or in a transverse direction across the tumor. "I have not (says he) made trial of the perpendicular form of incision, but a single transverse one I have found sufficient, when the integuments have been loose, and the tumour not large. The superficial fascia adheres firmly to the common integuments, and is usually turned aside with them, especially when the latter are pinched up for the purpose of making the first incision. The fascia propria is therefore quickly exposed, and forms the first distinct covering of the tumor, being darker than the more superficial investment. It is under the outer layer of this fascia that the adipose structure is formed, which often assumes the appearance of omentum. The director easily makes its way under this fatty matter, as far as the neck of the sac, which lies deeper than the operator at first supposes. The point of the director should be applied rather to the inner than to the outer part of the neck of the sac, as it will be found to pass more easily under the stricture at this part. It should not at first be attempted to be thrust under the stricture, as the firmness of the parts forming the stricture would resist it. But the seat of stricture being felt, the operator should depress the end of the director upon the sac, which will yield before it, and then, by an onward movement, the director slides under the stricture." Mr. Key takes the opportunity of remarking, that the constriction, at the femoral aperture, is not entirely produced by a process from Poupart's ligament, but, in part, by a tendinous band on the forepart of the femoral sheath, where the fascia transversalis passes in a funnel-form behind Gimbernat's ligament to be inserted into the pubes. (See *Mem. on the Advantages of dividing the Stricture, &c. on the outside of the sac,* p. 142—145. 8vo. Lond. 1833.)

[Mr. Gay, who is also strongly in favor of division of the stricture in cases of strangulated hernia without opening the sac, published a work in 1848 on femoral rupture, in which he recommends a new mode of operating for this species of hernia. Some very useful statistical tables, bearing on the more interesting questions connected with femoral rupture, will be found in Mr. Gay's valuable monograph, a perusal of which will well repay the reader. His new operation, as described by himself, is here quoted:—

"For the first step of the operation, two imaginary lines should be drawn from the point directly over the inner side of the neck of the hernial tumor; one to the tuberosity of the pubis; the other down the thigh, along the inner side of the tumor. These two supposed lines will include an angular space, in which, and about mid-distance from either, the first incision is to be made. This incision should commence just within the angle formed by the meeting of these lines, and be carried inwards and rather downwards, for the extent of an inch or a little more; and should divide the integuments and superficial fascia over the femoral fossa.

"For the second part of the operation, the fore-finger of the left hand (if the hernial tumor is on the right thigh, and *vice versâ*) is to be passed through this wound, upwards and outwards, along and close to the side of the hernial tumor, to its neck. Should any of the deep laminæ of the superficial fascia which occupy the femoral fossa obstruct its passage these must be divided.

"The blunt point of a bistoury caché, guided by the tip of the finger still in the wound, is to be passed through the cribriform fascia (one of the sheath-like apertures in which it will readily enter), and the delicate vaginal sheath which alone intervenes between it and the crural canal. It is now to be directed upward, through the canal to the ring, where it usually meets with resistance from the seat of stricture. By the least amount of force, and with the aid of a little gentle compression of the inner side of the tumor by the finger, the point of the bistoury may be insinuated between the sac, and the pubic margin of the ring: the edge of the knife is then to be turned towards the pubes, and, by projecting the blade, the seat of stricture in that direction may be effectively divided. Should the surgeon, however, be disposed to direct his incision forwards, it may be done either before or after the incision of Gimbernat's ligament with equal facility. It will be obvious from a reference to the anatomical relations of the parts, that in its course from the femoral fossa through the cribriform fascia, crural canal and ring, the knife will pass successively behind the falciform process, the edge of the lower orifice of the canal, Hey's ligament, and the fibres of the inguinal ligament of Hesselbach; and thus be made to command whichever may happen to be the particular seat of stricture. By taking care not to keep the knife too close to the side of the hernial tumor, after its point has passed the cribriform fascia, its point would glide between the sheath and the deep layer of the iliac fascia lata; and in this way it would pass between the ring and the last portion of Hey's and Gimbernat's ligaments, and thus a division of these structures might be effected from the outside of the sheath or canal.

"If, after the division of the ring and parts on its pubic and front sides, the hernial tumor is not to be replaced without the employment of force, the stricture cannot have been dilated; and the surgeon would then have to contemplate the possibility of its being situated in the fibres of the septum crurale. The still constricted neck of the sac would in that case be felt, and it would be for the surgeon to get his knife cautiously behind the constricting fibres. This could be most easily done by a knife which has a beak flattened in the direction transverse to the edge,—by gently pressing the side of the tumor outwards, immediately below the seat of constriction, so as to gain room for its introduction.

"Should the seat of stricture be in the margins of one of the apertures of the cribriform fascia, which would in all probability be discovered at an early period of the operation, the means for dilating it would be analagous to those which have just been detailed.

"If, after the division of these various textures external to the sac, the hernial tumor should still remain constricted, the external wound would have to be enlarged, and the seat of stricture looked for either in the neck of the sac, or within the sac and amongst its contents.

"The operation just detailed is most simple and easy of execution; requires but few, and those small incisions; leaves the hernial tumor and its diseased coverings untouched; permits, if necessary, the immediate use of a truss; and in an otherwise healthy subject requires but a few days for the perfect recovery of the patient."]

Of late years, a fact of considerable interest has been ascertained in relation to femoral hernia; viz. that the constriction of the bowel by the smallness of the aperture and the sharp edge of Poupart's ligament (*Gimbernat's ligament*) is so great, that either a permanent contraction of the part, ulceration of the internal and muscular coats, or even that of the serous coat also may occur, followed by fatal extravasation, after the reduction of the hernia by the operation. (*Chevalier*, *in Med. Chir. Trans.* vol. iv. p. 324; *Breschet*, op. cit. obs. 2; *Lawrence*, p. 442, ed. 4.) Hence the latter gentleman is an advocate for gently drawing out the bowel, after liberating it from stricture: if no reason be found to apprehend perforation of the tube, he advises its reduction; but, in the opposite case, he directs it to be left out of the abdomen, rather than that the patient should be exposed to the danger of effusion into the abdomen (p. 444).

[Mr. Adams describes an interesting case of femoral hernia in a female forty-five years of age, which had assumed an unusual position, and which could not be distinguished by examination of the femoral region. The symptoms of strangulation, however, having become urgent, he determined to explore the femoral region by operative procedure. He found a hernial sac containing omentum, and about an inch and a half of small intestine in a gangrenous state. The woman died on the fourth day after the operation. On the post-mortem examination it was found that the hernia had left the abdomen by the femoral ring, that it had passed through an opening in the fascia covering the pectineus muscle, and that a few fibres belonging to the inner edge of this muscle had covered the hernial sac, and were divided during the operation. Mr. Adams drew the following inferences with respect to this case; 1st, that the hernia was of the femoral species; 2ndly, that the descent had not taken place in the sheath of the femoral vessels; 3rdly, that it had passed behind this sheath, and had made its way behind and internal to the femoral vein, through some unusual opening in the pectineal portion of the fascia lata; 4thly, that that part of the pectineus muscle on which the hernia lay was deprived of its immediate fascial investment, and that the innermost fasciculus formed a strong fleshy column over the hernial sac, beneath the pectineal portion of the fascia which covered it." (See *Med.-Chir. Trans.* vol. xliii. 1860, p. 27.)

Another case of this rare variety of femoral hernia was dissected by M. Cloquet, and is mentioned by Nélaton. (*Elémens de Pathologie chirurgicale*, t. iv. p. 358.) The hernia had passed through an irregular opening in the fascia, covering the pectineus muscle, and could not have been distinguished during life. A case is referred to by Mr. Gay where the hernia occupied the whole space under Poupart's ligament, between the anterior superior spine of the ilium and the tuberosity of the pubes. (*Gay*, *On Femoral Rupture*, p. 34.) Mr. Lawrence alludes to a case, described by Hesselbach, in which the hernial tumor was situated on the outside of the femoral vessels. It was covered by the iliac portion of the fascia lata, by the sartorius muscle, and by the fascia covering iliacus and psoas muscles below Poupart's ligament. He also mentions two dissections by Mr. Stanley, in which a femoral hernia was found to be situated in front of the femoral vessels. In one of these the obturator artery arose from the epigastric, and the common trunk and its divisions were placed in front of the sac. (*Treatise on Ruptures*, ed. 5, p. 486.) M. Demeaux (*Annales de la Chirurgie française*, t. i. p. 475) places on record two dissections of femoral hernia, in each of which two sacs existed, one in front of the femoral vessels, the other internal to the vein. The distance between the mouths of the two sacs, seen from within, was in the one case eight lines, in the other one inch. The internal of the two sacs in each dissection was bounded internally by Gimbernat's ligament, and externally by the epigastric artery. The external sac was situated in front of the femoral artery, and external to the epigastric. M. Laugier has described a case where the hernia passed altogether internal to the sheath of the femoral vessels through an opening in Gimbernat's ligament. A portion of Gimbernat's ligament separated the neck of the sac from the femoral ring. The sac below Poupart's ligament rested on the pectineus muscle and its fascia, having the sheath of the femoral vessels external to it. (*Archives générales de Médecine*, 1833, 2nd series, t. ii. p. 27.) M. Demeaux has dissected a similar case. The artery left the abdomen internal to the remains of the umbilical hernia, and passed through Gimbernat's ligament, appearing below Poupart's ligament internal to the femoral sheath. (Op. cit.)

These deviations from the usual course of a femoral rupture have induced Velpeau to admit three varieties of femoral hernia, which he would distinguish by the terms internal, middle, and external. The 1st, protruding through the fibres of Gimbernat's ligament; the 2nd, through the femoral ring; the 3rd, external to the epigastric artery, and in front of the femoral artery; the first and last being of very rare occurrence; the second or middle kind constituting the ordinary femoral hernia.]

UMBILICAL HERNIA, OR EXOMPHALOS.

"The exomphalos, or umbilical rupture (says Pott), is so called from its situation, and has (like other herniæ) for its general contents, a portion of intestine or omentum, or both. In old umbilical ruptures, the quantity of omentum is sometimes very great. Mr. Ranby says, that he found two ells and a half of intestine in one of these, with about a third part of the stomach, all adhering together. Mr. Gay and Mr. Nourse found the liver in the sac of an umbilical hernia, and Bohnius says that he did also. But whatever are the contents, they are originally contained in the sac formed by the protrusion of the peritoneum. In recent and small ruptures, this sac is very visible; but in old and large ones, it is broken through at the knot of the navel, by the pressure and weight of the contents, and is not always to be distinguished; which is the reason why it has by some been doubted whether this kind of rupture has a hernial sac or not.

"Infants are very subject to this disease in a small degree, from the separation of the funiculus; but in general they either get rid of it as they gather strength, or are easily cured by wearing a proper bandage. It is of still more consequence to get this disorder cured in females even than in males, that its return, when they are become adult and pregnant, may be prevented as much as possible; for at this time it is liable to occur from the too great distension of the belly, or from unguarded motion when the parts are upon the stretch. During gestation, it is often very troublesome, but after delivery, if the contents have contracted no adhesion, they will often return, and may be kept in their place by a proper bandage.

"If such bandage was always put on in time, and worn constantly, the disease might in general be kept within moderate bounds, and some of the very terrible consequences which often attend it might be prevented. The woman who has the smallest degree of it, and who, from her age and situation, has reason to expect children after its appearance, should be particularly careful to keep it restrained.

"In some the entrance of the sac is large, and the parts easily reducible; in others they are difficult, and in some absolutely irreducible. Of the last kind many have been suspended for years in a proper bag, and have given little or no trouble. They who are afflicted with this disorder, who are advanced in life, and in whom it is large, are generally subject to colics, diarrhœas, and, if the intestinal canal be at all obstructed, to very troublesome vomitings. Hence, patients are often supposed to labour under a stricture, when they really do not. It therefore behoves such to take great care to keep the intestinal tube as clean and free as possible, and neither to eat or drink any thing likely to make any disturbance in that part" (*Pott*, *On Ruptures*, vol. ii.)

The writings of Sir A. Cooper, Scarpa (*Traité des Hernies*, p. 327), and all the most accurate moderns, confirm the fact described by Pott, that in the umbilical rupture there is a hernial sac, just as in other instances of herniæ. Every anatomist knows that, behind the opening in the linea alba at the umbilicus, the peritoneum is complete, and consequently must protrude along with the viscera in cases of exomphalos. In the only two cases which Sir A. Cooper had seen of a deficiency of the sac, the membrane had been partially absorbed, or lacerated, so as to allow the protrusion of its contents, and threaten, from this cause, a double stricture. Similar appearances, less closely inspected, probably gave rise to the opinion so firmly maintained by Dionis, De la Faye, Garengeot, and J. L. Petit, that, in the umbilical hernia, the peritoneum was always lacerated, and there was no hernial sac. Early infancy is most subject to *umbilical* hernia, strictly so called, in which the parts protrude through the navel; while the other periods of life are more liable to false umbilical herniæ, or such as arise in the vicinity of the umbilicus. (*Œuvres Chir. de Desault*, t. ii. p. 315.)

Besides a true hernial sac, the exomphalos is also covered by a more superficial expansion, consisting of condensed cellular substance. In operating, however, a surgeon should always cut with great caution; for the integuments and hernial sac, in front of the tumor, are often inseparably adherent; and sometimes, in large cases, when an absorption of part of the sac has been caused by the pressure of the bowels, they are even found adherent to the integuments. [In stout persons affected with umbilical hernia of any size, notwithstanding there may be two inches of fat between the skin and abdominal muscles elsewhere, there will be none between the hernial sac and the skin, and the former, as above stated, will be found adherent to the latter.]

Pregnant women, and dropsical and corpulent subjects, are peculiarly liable to the exomphalos. In adults, when there is intestine in the sac, there is almost always omentum. The transverse arch of the colon is observed to be particularly often contained in umbilical herniæ, but the small intestines are not unfrequently protruded: and even the cæcum has been found in a rupture at the navel. (See *Lawrence, On Ruptures*, p. 454, 455, ed. 4.)

In the true umbilical hernia, the stricture is made by the tendinous opening in the linea alba. Let us next consider the umbilical hernia in the three particular forms, in which it has been noticed by the latest writers.

Congenital Umbilical Hernia.

Dr. Hamilton met with about two cases of this kind annually, for the space of seventeen years; and they strictly deserve the epithet *congenital*, as they appear at birth. The funis ends in a sort of bag, containing some of the viscera, which pass out of the abdomen through an aperture in the situation of the navel. The swelling is not covered with skin, so that the contents of the hernia can be seen through the thin distended covering of the cord. The disease is owing to a preternatural deficiency in the abdominal muscles, and the hope of cure must be regulated by the size of the malformation, and quantity of viscera protruded.

The plans of cure proposed, consist of the employment of a ligature, or of a bandage. The latter seems preferable, and was practised by Mr. Hey, as follows:—Having reduced the intestine, he desired an assistant to hold the funis compressed sufficiently near the abdomen, to keep the bowel from returning into the hernial sac.

"I procured (says he) some plaster spread upon leather; cut into circular pieces, and laid upon one another in a conical form. This compress I placed upon the navel, after I had brought the skin on each side of the aperture into contact, and had laid one of the lips a little over the other. I then put round the child's abdomen a linen belt; and placed upon the navel, a thick, circular, quilted pad, formed about two inches from one extremity of the belt.

"This bandage kept the intestine securely within the abdomen, and was renewed occasionally. The funis was separated about a week after birth; and at the expiration of a fortnight from that time, the aperture at the navel was so far contracted, that the crying of the child, when the bandage was removed, did not cause the least protrusion. I thought it proper, however, to continue the use of the bandage a little while longer. A small substance, like fungous flesh, projected, after the funis had dropped off, about half an inch from the bottom of that depression which the navel forms. A dossil of lint spread with cerat. e lapide calaminari, and assisted by the pressure of the bandage, brought on a complete cicatrisation." (P. 227.)

This gentleman has related another example, in which the intestines were quite uncovered and inflamed, the sac having burst in delivery. The parts were reduced, but the child died. (See also *G. A. Fried de Fœtu Intestinis plane nudis extra Abdomen propendentibus nato.* Argent. 1760.)

[M. Richet has devoted much time to the investigation of the anatomy of the umbilical orifice, before, and subsequent to, the separation of the cord, and has given an elaborate description of the mechanism by which it becomes closed. He especially draws attention to two fasciculi of fibres, arranged transversely in the form of a sphincter, which embrace the vessels of the cord. These fibres, which he describes as consisting of organic muscular fibre, are situated on the abdominal surface of the umbilical ring. These he considers to be the principal agents in closing the umbilical ring, and in constricting the umbilical vessels, upon which they act, after the manner of a ligature. He also describes a fascia, which he calls umbilical. It is situated on the deep surface of the umbilical vein, and joins laterally the fascia covering the abdominal muscles, and thus forms a sort of sheath for this vein. (*Archives générales de Médecine*, 1856, 5e série, tom. viii. p. 611.)

In congenital umbilical hernia, the abdominal wall is incomplete in the neighbourhood of the umbilicus. The protrusion takes place at the conflux of the umbilical arteries and vein, at the point at which the navel ought to be situated. It here separates these vessels from each other, where they would, otherwise, unite to form the umbilical cord. The hernia escapes, therefore, into the connecting tissue of the cord, separating its constituent parts in such a way as to have the vein above the sac, and the arteries below and on either side of it, forming three sides of a sort of triangle. These vessels meet again at the fundus of the sac, to constitute the proper umbilical cord. More correctly speaking, the viscera, from arrest of development, have never been situated within the abdominal cavity at all. The covering of the swelling is very thin, moist, and semi-transparent, through which the intestines can be more or less distinctly seen. It is formed, in fact, of the covering of the umbilical cord, which joins the common integument at the margin of the incomplete abdominal wall, instead of as usual, at the navel. The aspect of this semitransparent tumor contrasts strangely with the opaque integument covering the abdominal wall, and will always be recollected by those who have once seen it. The prognosis and treatment will depend upon the size of the tumor, and the extent of deficiency in the abdominal parietes. When these are considerable, no treatment will be of any avail, and death will ensue in from twelve to twenty-four hours. In all cases before reduction, the covering of the tumor should be kept moist and warm, otherwise evaporation will take place, and a sort of dry gangrene, such as that which affects the cord itself, will supervene. The principle upon which the treatment should be conducted is, to reduce the displaced viscera; to approximate the margins of the deficiency in the abdominal wall; and to endeavour to effect successfully the sloughing and separation of the hernial sac; which it will be remembered is formed of the covering of the cord and its vessels. Whether metallic sutures, hare-lip pins, quill sutures, or simply methodically arranged compresses and bandage are to be had recourse to, in order to effect these desirable objects, must be left to the judgment and ingenuity of the surgeon, in each individual case.]

UMBILICAL HERNIA IN CHILDREN.

The umbilical hernia, which is sometimes formed in the fœtus as above described, takes place, in other instances, at the moment of delivery; and then, as Sabatier remarks, should it be tied by mistake, with the funis, death would be the consequence. Most frequently, however, it is not till the second, third, or fourth month after birth, that the disease occurs; and the numerous cases, collected by Desault, prove that, of ten infants attacked with this hernia, nine become afflicted at the periods here specified.

The umbilicus, still open, now begins to contract, so as to close the cicatrix, which soon forms an obstacle capable of preventing a protrusion of the viscera. Sometimes, however, the repeated crying of the child propels the viscera through the opening, and thus the closure of the cicatrix of the navel is prevented. By degrees, the umbilical ring becomes more and more dilated, the quantity of protruded bowel increases, and thus a tumor arises, which, from being of trivial size at first, at length attains the size of an egg, or large walnut, and presents itself with all the characteristic marks of a hernia.

The presence of a piece of intestine and omentum in the tumor keeps the umbilicus open, and opposes the continual tendency which it has to close. Such tendency, however, being sometimes superior to the resistance of the protruded parts, forces them back into the abdomen, obliterates the opening through which they passed, and thus the spontaneous cure of the umbilical hernia in children is accomplished. Two cases illustrative of this fact, are related by Bichat. (*Œuvres Chir. de Desault*, t. ii. p. 318.)

Nature, however, does not effect many such cures; and when the case is left to her alone, she not only fails in bringing about a radical cure, but gradually renders it impossible. In short, the propensity of the opening to close diminishes, and is lost, as the subject grows older.

Thus, the umbilical hernia of children seems to be essentially different from that of adults, in the tendency of the aperture to contract. Hence the ease of effecting a radical cure in children, and the almost utter impossibility of doing so in adults. In the former, it is enough to keep the intestines from protruding, and the opening becomes of itself obliterated; in the latter, the opening always remains, whether the bowels continue in it or not. This indisposition of the aperture to contract in the adult, also frequently depends upon the protrusion not being through the umbilical ring itself, but through a fissure in the vicinity of it, not endued with the same natural tendency to close, which the umbilicus possesses in young subjects. In fact, it would appear from the observations of Scarpa, that, unless a grown up person has had the protrusion from infancy, it never occurs exactly through the umbilical ring itself.

The means of curing the umbilical hernia of children, are compression, and the ligature. The former is the most modern; the latter the most ancient treatment, being mentioned by Celsus. The design of both is the same, viz. to prevent the lodgement of the protruded viscera in the opening of the umbilicus, and thus facilitate the approximation of its sides. To accomplish this end, the ligature retrenches the hernial sac, and skin pushed before it; and, by the union of the cut parts, a cicatrix is produced, which hinders the protrusion of the viscera. At the same time the sides of the opening, obeying their natural tendency, compression closes the deficiency, or opening, in the parietes of the abdomen, hinders the protrusion of the bowels, and keeps these parts from resisting the contraction of the sac. Desault's method, which much resembled that of Saviard, is described by Bichat. The child must be placed on its back, with its thighs a little bent, and its head inclined towards the chest. The surgeon is to reduce the protruded parts, and to hold them so with his finger, at the same time that he raises the hernial sac, and rubs its sides between his fingers, so as to be sure that there is nothing contained in it. Being certain, that the parts, which he lifts up, are only the skin and sac, he is to direct an assistant to surround their base several times with a waxed ligature, of middling size, each turn being tied with a double knot, in such a manner as only to occasion little pain. The tumor, thus tied, is to be covered with lint, which is to be supported with one or two compresses, and a circular bandage, secured with a scapulary. By the following day, a slight swelling has commonly taken place in the constricted parts. On the second, or third day, the parts shrink, and then the ligature becomes loose, so that a fresh one must now be applied in the same manner as the first, taking care to draw it a little more tightly. The sensibility of the parts, increased by the inflammation, which the constriction of the ligature has already produced, usually renders this second ligature more painful. After the operation, the same dressings as at first are to be applied. The tumor soon becomes discoloured, livid, and smaller. A third ligature, put on in the same way as the preceding ones, entirely obstructs the circulation in it. The part turns black and flaccid, and commonly falls off on the eighth or tenth day. A small ulcer is left, which, being properly dressed, very soon heals, and leaves a cicatrix sufficiently strong to resist the impulse occasioned by coughing, or other efforts of the abdominal muscles. For two or three months, however, after the operation, the child should wear a circular bandage, in order to prevent, with still greater certainty, the viscera from being propelled against the cicatrix, so as to interrupt the process of nature, which is now producing a gradual closure of the umbilical opening.

Mr. Pott notices the plan of curing the exomphalos with the ligature, and expresses himself strongly against the practice in general. To adults the plan is not applicable. Mr. Pott was decidedly in favour of compression; and he observes, that in young subjects, and small herniæ, a bandage, worn a proper time, generally proves a perfect cure. (Vol. ii.)

Anxious that this work should be strictly impartial, I next proceed to relate what has been more recently urged against the employment of the ligature for the cure of umbilical hernia in children.

The incessant care that a bandage requires, either to keep it clean, or make it always keep up the proper degree of pressure, renders its employment difficult in the children of the poorer classes. Scarpa expresses his opinion, that this was what induced Desault to revive the operation for umbilical hernia by the ligature, nearly such as is described by Celsus; an operation (continues Scarpa), which a long while since, and for good reasons, was altogether abandoned. Desault himself has put some restrictions to the employment of the ligature, since he observes, that this method does not radically cure the umbilical hernia of children arrived at the age of four years; and, that, even in the youngest children, a radical cure cannot be effected by the ligature, unless a methodical compression of the navel, by means of a bandage, be kept up immediately after the operation, and for two or three months. It is perhaps to the omission of this last means that a relapse is to be ascribed in several of the children operated upon by Desault. "*Desault avoit remis en vigueur la ligature tombée en désuétude. Il s'abusoit sur sa valeur, et il n'est pas difficile d'en connoître la cause. Tous les enfans qu'il opéroit à l'Hôtel-Dieu sortoient guéris, et n'y revenoient plus: on regardoit alors comme radicale une guérison momentanée.*" (*Richerand, Nosographie Chir.* t. ii. p. 453.) "I have carefully watched (says Scarpa) the immediate effects, and the more or less remote consequences of tying the umbilical hernia, either simply, or by means of a needle and double ligature; and, after a considerable number of such cases, I believe I can assert, that *this operation, howsoever performed, is not always exempt from grave and sometimes dangerous accidents. I can also add, that it never procures a truly radical cure, unless the cicatrix, occasioned by it in the umbilical region, be submitted for some months to a methodical and uninterrupted compression. It is not so uncommon, as some surgeons pretend, to see arise, after the application of the ligature, a fever attended with symptoms of most violent irritation, and acute sufferings, which cause incessant crying, and sometimes convulsions. The ulcer, which is produced by the detachment of the swelling, is always very large and difficult to heal. Every now and then it becomes painful, and emits fungous granulations, even though dressed with dry applications.*

"Latterly, it has been explained by a celebrated surgeon (*Paletta Mémor. de l'Instituto*, tom. ii. part i.), that the umbilical vein and the suspensory ligament of the liver, being included in the ligature of the umbilical hernia, the inflammation, which originates in these parts, may perhaps, in certain cases, be communicated to the liver, so as to put the child's life in great danger. When, in consequence of the ligature, symptoms of violent irritation come on, they are ordinarily attributed to certain individual circumstances, such as extreme sensibility, or a particular disposition to spasm. Hence, it is believed, that they should be considered as exceptions, which do not exclude the general rule, and prove nothing against the utility of the operation. But how (says Scarpa) can the surgeon ascertain the existence or non-existence of these individual dispositions in the children upon which he is to operate? Assuredly, those subjects, in which I have had occasion to notice the above accidents, enjoyed, before the operation, perfect health in every respect.

"Whatever process be adopted for tying the umbilical hernia, it is evident, that the tumor can only be constricted as far as a little way on this side of the aponeurotic ring of the umbilicus; whence it follows, that the integuments must always remain prominent and relaxed, for a certain extent, at the front and circumference of this opening. Also, after the separation of the strangulated portion, there necessarily remains, under the cicatrix, a portion of the hernial sac, and of the loose integuments which covered it; and as the cicatrix itself never acquires sufficient firmness to resist the impulse of the viscera, which tend to insinuate themselves into the remains of the hernial sac, the hernia, sooner or later, reappears, and, in a short time, becomes larger than it was before the operation. If the subject is a little girl, it may be apprehended that the first pregnancy will cause a recurrence of the hernia; for, it is known, that during gestation the external cicatrix of the umbilicus is considerably distended, and much disposed to give way."

Scarpa then notices, that "after the separation of the tumor, there always remains, between the aponeurotic ring of the navel, and the integuments, a small cavity, formed by the neck of the hernial sac; a cavity into which the viscera begin to insinuate themselves after the operation, so as to hinder the complete contraction of the umbilical ring. The demonstration of what I have advanced is, in some measure, to be found in the old method of operating for inguinal hernia, not in a strangulated state by the ligature of the hernial sac and spermatic cord. Most of the herniæ operated upon by this barbarous process, were subject to relapses, because, in all probability, the cicatrix was not sufficiently firm to resist the impulse of the viscera, which entered the remains of the hernial sac. In the same manner, after the common operation for strangulated inguinal hernia, although the cicatrix is formed very near the ring, there is no prudent surgeon who does not advise the patient to wear a bandage the rest of his life; observation having proved that the hernia is still liable to recur.

"The experience of several ages leaves no doubt, that compression alone is an extremely efficacious method of radically curing the umbilical hernia of young subjects. It is attended with no risk; and, provided it be executed with the requisite caution, it is hardly ever necessary to continue it longer than two or three months for the purpose of obtaining a complete cure. On the other side, if it be clearly proved, by all that I have been observing, that the ligature never accomplishes a perfect cure without compression, it is manifest that it cannot be at all advantageous for the children of the poor, since a bandage cannot be dispensed with. It may be said, that in general it does not shorten the treatment; for, in the most successful cases, the ulcer caused by it is not healed in less than a month; and, in order to make the cure certain, an exact compression must be afterwards kept up, by means of a bandage, two months longer. It has already been stated that three months are ordinarily sufficient for obtaining a radical cure by the mere employment of a compressive bandage." (*Scarpa, Traité des Hernies*, p. 344—349.)

M. Girard published a Memoir on the Umbilical Hernia of Children, which was read to the Medical Society of Lyons, in May 1811; and the object of which was to recommend compression as an effectual means of cure. The arguments used were very similar to those adduced by Scarpa. In the course of the discussion, M. Cartier affirmed that he had seen many children operated upon by Desault, who were not cured of their herniæ. (See *Journ. Gén. de Méd.* t. xli. 1811.) The subject was afterwards taken up by the Medical Society of Paris, and the result of the debate was, that the employment of the ligature ought to be rejected. 1. Because the cure of umbilical herniæ is often accomplished by nature alone. 2. Because compression, either alone, or aided by tonic remedies, always succeeds. 3. Because the operation of the ligature deserves the triple reproach of being painful, and not free from danger, if unfortunately a piece of intestine should chance to be included in the ligature; of not succeeding in general, except with the assistance of compression; and of being sometimes uselessly practised, as Desault himself gives us instances of. According to M. Cayol, the insufficiency of the ligature was long since acknowledged by Sabatier, Lassus, Richerand, &c.

The treatment by compression is universally preferred by British surgeons.

Umbilical Hernia in Adult Subjects.

This case is to be treated on the principles common to all ruptures. When reducible, the parts should be kept up with a bandage or truss; which plan, however, in grown-up persons, affords no hope of a radical cure. Mr. Hey has described some very good trusses for the exomphalos, which are applicable to children, when compression is preferred, as well as to adult subjects.

When the exomphalos is irreducible and large, the tumor must be supported with bandages, or by a truss with a hollow pad.

It is observed by Scarpa, that umbilical herniæ, and those of the linea alba, are less subject to be strangulated than inguinal and femoral herniæ; but that, when they are unfortunately affected with strangulation, the symptoms are more intense, and gangrene comes on more rapidly, than in every other species of rupture. If the operation be performed, the event is frequently unfavourable, because it is generally done too late. This practical fact is proved by the experience of the most celebrated surgeons of every age. "*Il est certain* (says Dionis) *que de cette opération il en périt plus qu'il n'en réchappe.*" (*Cours d'Opérations*, p. 98, ed. 1777, *avec les notes de La Faye.*) He also adds, that they who have the misfortune to be afflicted with an exomphalos should rather dispense with their shirt than a bandage. Heister says nearly the same thing. (*Instit. Chirurg.* t. ii. cap. 94.)

When the omentum alone is strangulated in the exomphalos, or hernia of the linea alba, observation proves that the symptoms are not less intense than when the intestine is also incarcerated. There is this difference, however, that when the omentum alone is strangulated, only nausea occurs, and, if vomiting should likewise take place, it is less frequent and violent than when the bowel itself is strangulated. In the first case, the stools are hardly ever entirely suppressed. The proximity of the stomach is, no doubt, the reason why the strangulation of the omentum, in umbilical hernia, occasions far more intense symptoms of sympathetic irritation, than the strangulation of the same structure in inguinal, or crural hernia.

Here, the operation is not only always necessary, but urgently required. It is not materially different from that which is practised for strangulated inguinal and crural herniæ; but in general it demands greater circumspection, on account of the connection, or intimate adhesions, which frequently exist between the integuments and hernial sac, and also the adhesions which often prevail between the latter part and the omentum which it contains.

The situation of the intestine, which is frequently covered by, and enveloped in, the omentum, is another circumstance deserving earnest attention. (*Scarpa, Traité des Hernies*, pp. 361, 362.)

Mr. Pott is not such an advocate as Scarpa for the early performance of the operation in cases of exomphalos:—"The umbilical, like the inguinal hernia, becomes the subject of chirurgic operation, when the parts are not reducible by the hand only, and are so bound as to produce bad symptoms. But though I have, in the inguinal and scrotal herniæ, advised the early use of the knife, I cannot press it so much in this: the success of it is very rare, and I should make it the last remedy. Indeed, I am much inclined to believe that the bad symptoms which attend these cases are most frequently owing to disorders in the intestinal canal, and not so often to a stricture made on it at the navel, as is supposed. I do not say that the latter does not sometimes happen; it certainly does; but it is often believed to be the case when it is not.

"When the operation becomes necessary, it consists in dividing the skin and hernial sac, in such manner as shall set the intestine free from stricture, and enable the surgeon to return it into the abdomen." (*Pott, On Ruptures.*)

The rest of the conduct of the surgeon is to be regulated by the usual principles.

The division of the stricture is properly recommended to be made directly upward, in the course of the linea alba.

In consequence of the great fatality of the usual operation for umbilical hernia, I think the plan suggested and successfully practised by Sir A. Cooper, in two instances, should always be adopted whenever the tumor is large, and free from gangrene. It consists in making an incision just sufficient to divide the stricture, without opening the sac at all, or, at all events, no more of it than is inevitable; a plan that has also received the high sanction of that distinguished anatomist and surgeon, Professor Scarpa. (*Traité des Hernies*, p. 362.) Perhaps I might safely add, that when the parts admit of being reduced, without laying open the sac, this method should always be preferred.

In umbilical hernia, of not a large size, Sir A. Cooper recommends the following plan of operating:—"As the opening into the abdomen is placed towards the upper part of the tumor, I began the incision a little below it, that is, at the middle of the swelling, and extended it to its lowest part. I then made a second incision at the upper part of the first, and at right angles with it, so that the double incision was in the form of the letter T, the top of which crossed the middle of the tumor. The integuments being thus divided, the angles of the incision were turned down, which exposed a considerable portion of the hernial sac. This being then carefully opened, the finger was passed below the intestines to the orifice of the sac at the umbilicus, and the probe-pointed bistoury being introduced upon it, I directed it into the opening at the navel, and divided the linea alba downwards, to the requisite degree, instead of upwards, as in the former operation. When the omentum and intestine are returned, the portion of integument and sac which is left, falls over the opening at the umbilicus, covers it, and unites to its edge, and thus lessens the risk of peritoneal inflammation, by more readily closing the wound." (*On Crural and Umbilical Hernia.*)

Less frequent Kinds of Hernia.

The *ventral hernia*, described by Celsus, is not common; it may appear at almost any point of the anterior part of the belly, but is most frequently found between the recti muscles. The portion of intestine, &c., is always contained in a sac, made by the protrusion of the peritoneum. Sir A. Cooper imputes the disease to the dilatation of the natural foramina for the transmission of vessels, to congenital deficiencies, lacerations, and wounds of the abdominal muscles, or their tendons. In small ventral herniæ, a second fascia is found beneath the superficial one; but in large cases the latter is the only one covering the sac.

Herniæ in the course of the linea alba sometimes occur so near the umbilicus, that they are liable to be mistaken for true umbilical ruptures. They may take place either above or below the navel. The first case, however, is more frequent than the second; and the following is the reason of this circumstance, according to the opinion of Scarpa: —" The upper half of the linea alba, that which extends from the ensiform cartilage to the umbilicus, is naturally broader and weaker than the lower half, the recti muscles coming nearer and nearer together, as they descend from the navel to the pubes." (*Scarpa, Traité des Hernies*, p. 333.)

The hernial sac of ruptures at the upper part of the linea alba may contain a noose of intestine, and a piece of the omentum, though, in most cases, a portion of the latter membrane alone forms the contents. In some subjects, the linea alba is so disposed to give way, that several herniæ are observed to be formed successively in the interspace between the ensiform cartilage and the umbilicus.

M. Jules Cloquet has recorded a case of ventral hernia, reaching from the ensiform cartilage to the pubes. The skin covering it was so thin that the convolutions of the bowels were plainly visible. The cicatrix of the navel was perceptible rather towards the left side of the swelling. (See *Pathologie Chir.* p. 102.)

" With respect to the small hernia (says Scarpa) which is considered as formed by the stomach, and concerning which Hoin and Garengeot have written so much (without either of them having related, at least to my knowledge, a single example proved by dissection), it is at least unproved, that it was exclusively formed by this viscus. I do not see why the other viscera, particularly the omentum and transverse colon, might not also contribute to it. In my judgment, it only differs from other herniæ of the linea alba in being situated on the left side of the ensiform cartilage, a situation that must materially influence the symptoms of the case. In fact, whatever may be the viscera which form it, a sympathetic irritation of the stomach is occasioned, that is much more intense than that which ordinarily accompanies umbilical herniæ, those of the lower part of the linea alba, or, in short, all other herniæ, which are more remote from the stomach." (Op. cit. p. 334.)

The following are the circumstances by which the umbilical hernia may be discriminated from that which occurs in the linea alba near the navel.

The first, whether in the infant or the adult, has a roundish neck, or pedicle, at the circumference of which the aponeurotic edge of the umbilical ring can be felt. Whatever may be its size, its body always retains nearly a spherical shape. Neither at its apex nor its sides, is any wrinkling of the skin, or any thing like the cicatrix of the navel distinguishable. At some points of the surface of the tumor, the skin is merely somewhat paler and thinner than elsewhere.

On the contrary, the hernia of the linea alba has a neck or pedicle, of an oval form like the fissure, through which it is protruded. The body of the tumor is also constantly oval. If the finger be pressed deeply round its neck, the edges of the opening in the linea alba can be felt; and if the hernia be situated very near the umbilical ring, the cicatrix of the navel may be observed upon one side of it, which cicatrix retains its rugosity and all its natural appearance; a certain indication that the viscera are not protruded through the umbilical ring. (*Scarpa, Traité des Hernies*, p. 336.)

The distinction which Scarpa has established between the umbilical hernia, properly so called, and those of the linea alba, is not useless in regard to practice. Indeed, when the latter are left to themselves, they make much slower progress than the former. On account of their smallness, they frequently escape notice, particularly in fat persons, and when situated at the side of the ensiform cartilage. They occasion, however, complaints of the stomach, habitual colics, especially after meals; and, unfortunately for the patient, he may be tormented a very long time by these indispositions, before the true cause of them is discovered.

The umbilical hernia may be known from the earliest period of its formation, by the alteration which it produces in the cicatrix of the navel, and the rapidity of its increase.

In other respects, these two kinds of herniæ demand the same means of cure; but those of the linea alba, *cæteris paribus*, are more difficult to cure than ruptures at the umbilicus. This is probably owing to the natural tendency which, in children, the umbilical ring has to close, when the hernia is kept well reduced, whilst accidental openings in the linea alba have not the same advantage. (*Scarpa*, p. 340.)

When a common ventral hernia has been reduced, it should be kept in its place by means of a bandage or truss. When strangulated, it admits, more frequently than most other cases, of being relieved by medical treatment. If attended with stricture, which cannot otherwise be relieved, that stricture must be carefully divided.

[Under the head of ventral hernia may be mentioned a protrusion in the lumbar region, which is, however, of very rare occurrence. Mr. South in his *Notes on Chelius*, vol. ii. p. 84, narrates the following case from Cloquet: A man, seventy-five years of age, whilst lifting a heavy mattress felt a violent pain, with a sense of tearing in his loins, which gradually subsided in the course of six weeks. But, about a fortnight after, whilst getting up in his bed, he had a fresh attack of pain in the same spot. When seen the next day, he was much agitated, had violent colic, some nausea and vomiting, and his bowels were costive. The skin in the right lumbar region, without being discolored, was raised slightly by a rounded swelling, about five inches from the spine of the vertebræ. It was a little tender, and when grasped, was found to be somewhat elastic, crackling, deeply situated, or at least separated from the skin by a layer of fat. It had a broad pedicle; increased in bulk and dilated on coughing, sneezing, or making water. He had severe and constant pain deep in the right lumbar and iliac regions, in the course of the cæcum and ascending colon. The swelling was much larger when he stood up than when lying down, and when he turned on his face it disappeared, and left a hollow, readily distinguishable by the touch. He was treated by putting a pad upon the seat of the swelling, after its contents had been returned, and confining it with a circular bandage.]

Pudendal Hernia.—This is the name assigned by Sir A. Cooper to the hernia, which descends between the vagina and ramus ischii, and forms an oblong tumor in the labium, capable of being traced within the pelvis, as far as the os uteri. He thinks that this case has sometimes been mistaken for a thyroid hernia. When reducible, a common female bandage, or the truss used for a prolapsus ani, should be worn. A pessary, unless very large, could not well keep the parts from descending, as the protrusion happens so far from the vagina. Sir A. Cooper is of opinion that when strangulated, this hernia, in consequence of the yielding nature of the parts, may generally be reduced by pressing them, with gentle and regular force, against the inner side of the branch of the ischium. If not, the warm bath, bleeding, and tobacco clysters, are advised. [Chloroform would now be administered in preference to the adoption of these measures.] Were an operation indispensable, the incision should be made in the labium, the lower part of the sac carefully opened, and with a concealed bistoury, directed by the finger, the stricture should be cut directly inward, towards the vagina. The bladder should be emptied, both before the manual attempts at reduction and the operation. (*On Crural Hernia*, &c. p. 64.)

Vaginal Hernia. — A tumor occurs within the os externum. It is elastic, but not painful. When compressed it readily recedes; but is reproduced by coughing, or even without it, when the pressure is removed. The inconveniences produced are an inability to undergo much exercise or exertion; for every effort of this sort brings on a sense of bearing down. The vaginal hernia protrudes in the space left between the uterus and rectum. This space is bounded below by the peritoneum, which membrane is forced downwards towards the perineum: but being unable to protrude further in that direction, is pushed towards the back part of the vagina. In one case, Sir A. Cooper advised the use of a pessary; but the plan was neglected. Probably, these cases are always intestinal.

Some herniæ protrude at the anterior part of the vagina. (*Sir A. Cooper*, *On Crural Hernia*, p. 65, 66.)

Perineal Hernia. — In men, the parts protrude between the bladder and rectum; in women, between the rectum and vagina.

[This hernia in men forms a rounded projection in the perineum, on one side of the raphe, which is displaced from the median line to the opposite side. Sometimes it does not project so as to form an external tumor, and its existence can only be distinguished by examination per rectum. In women also the tumor is on one side of the median line; but if it enlarges it may occupy the lower part of the labium, and it then loses its rounded form. In this sex it may be felt both from the vagina, and from the rectum. In both sexes the hernia descends between the fibres of the levator ani and the viscera; the fascia on the inside of this muscle either gives way or is protruded before it.]

In case of strangulation, perhaps this hernia might be reduced by pressure from within the rectum. [Should the taxis not succeed and an operation become imperative, it may be performed without much difficulty on either sex, by carefully cutting down upon the tumor, opening the sac, and introducing the finger to the seat of stricture to serve as a guide to the hernia knife. The stricture and neck of the sac must be divided together in the direction away from the vagina or rectum.] An interesting case of perineal hernia, which took place from the peritoneum being wounded with the gorget in lithotomy, is related by Mr. Bromfield. (*Chirurgical Obs.* p. 264.)

The reducible perineal hernia in women may be kept from descending by means of a large pessary. Both this kind of rupture and the vaginal may prove very dangerous in cases of pregnancy. (See *Smellie's Midwifery*, case 5.) [A spring truss may be worn with advantage in either sex. It should be provided with a curved portion, having the pad attached, and which should descend from the posterior part of the circular spring to reach the perineal tumor.]

Sacro-rectal Hernia. — In a young infant, where the ossification of the sacrum was incomplete, a protrusion is said to have been met with through an opening in that bone. The possibility of such a case should be remembered, in order that the disease may not be mistaken for spina bifida. (See *Journ. of Foreign Med.* No. 16, p. 616.)

Thyroid Hernia.— In the anterior and upper part of the obturator ligament, there is an opening, through which the obturator artery, vein, and nerve proceed, and through which, occasionally, a piece of omentum, or intestine, is protruded, covered by a part of the peritoneum, which constitutes the hernial sac.

In the case which Sir A. Cooper met with, the hernia descended above the obturatores muscles. The os pubis was in front of the neck of the sac; three-fourths of it were surrounded by the obturator ligament; and the fundus of the sac lay beneath the pectineus and adductor brevis muscles. The obturator nerve and artery were situated behind the neck of the sac, a little towards its inner side. This species of hernia can only form an outward tumor, when very large. Garengeot, however, met with an instance, in which there was not only a swelling, but one attended with symptoms of strangulation: he reduced the hernia, which went up with a gurgling noise; the symptoms were stopped, and stools soon followed.

M. Jules Cloquet gives the particulars of a thyroid hernia, met with in the dead body of a woman, aged about fifty. It formed a slight roundish tumor in the lower part of the left groin; and the skin over it was of a purple colour. On opening the abdomen all the upper portion of the small intestines was inflamed, and enormously distended with liquid fæces and gas. A noose of the bowel, which was strangulated in the thyroid foramen, had given way at two points just above the stricture, and the intestinal matter had escaped freely into the cavity of the peritoneum. A piece of omentum also protruded at the upper part of the thyroid foramen, together with the intestine. On dissection, M. Cloquet found the hernia covered successively by the skin and superficial fascia, the fascia lata, and the middle adductor and pectineus muscles, which were raised up by the protrusion which had passed between the fibres of the adductor brevis. There were two saphenal veins, which, as well as the crural vessels, were somewhat displaced outwards by the tumor. The tumor was oblong, with an oblique direction, from above inwards, and it was divided by a constriction into two portion; the larger above, the smaller below. The upper portion ascended towards the spine of the pubes, in front of the obturator externus, and behind some fibres of the adductor brevis. This part of the sac was higher up than the opening by which the hernia had escaped. The obturator vessels and nerve lay to the outer side and behind the neck of the sac, below which the artery divided into two branches. The lower of these passed behind the sac, to be distributed to the obturator externus and adductor brevis; while the other passed also behind the sac, and then turning round its inner side, on a level with the neck, proceeded in front of it to the pectineus. The sac rested posteriorly on the obturator externus muscle, which it had separated from the ligament. (See *Jules Cloquet, Pathologie Chir.* p. 107.)

[M. Vinson has collected fifteen cases of thyroid hernia, in which the position of the obturator vessels and nerve with regard to the neck of the sac had been determined. In six of these the vessels were situated on the inside of the neck of the sac, and in six on the outside. In the remaining three the vessels were behind the sac. (*Nélaton, Elémens de Pathologie Chirurgicale*, t. iv. p. 403.)]

Thyroid hernia, when reducible, must be replaced and kept up with a suitable truss; and if it were strangulated, and not capable of relief from the usual means, an operation would be requisite, though attended with difficulties.

[In vol. xxxiv. of the *Medico-Chirurgical Transactions*, p. 232, will be found a case of obturator or thyroid hernia which had become strangulated, and was operated on by Mr. Obré. The patient, a female, was fifty-five years of age. She laboured under the ordinary symptoms of strangulated hernia, but no swelling could at first be discovered. On the third day, however, on comparing the two thighs, a greater fulness was noticed in Scarpa's triangle on the right side, and on using firm pressure with the fingers in this situation a distinct hardness could be felt. An incision was made so as to expose the saphenic opening of the fascia lata, and the finger then detected the hardened structure, which was exposed by dividing the fascia lata and some fibres of the pectineus muscle. The hernial sac now came distinctly into view, an opening was made into it, and the stricture divided. The patient rapidly recovered. Mr. Bransby Cooper also operated on a case of thyroid hernia, in Guy's Hospital, in 1853. The case in many respects resembled that of Mr. Obré. The pressure of the pectineus muscle on the hernia by displacing the sac appeared to cause the strangulation, for on dividing the fibres of this muscle transversely as they covered the sac, the hernia together with its sac slipped spontaneously into the abdominal cavity. The peritoneal sac therefore was not opened, nor was the stricture divided. The patient recovered completely from the operation, but died three weeks after in consequence of a severe attack of bronchitis. (See *Medical Times*, vol. i. 1853, p. 113, 142, 216.)]

Cystocele.—As Mr. Pott observes, "The urinary bladder is also liable to be thrust forth from its proper situation, either through the opening in the oblique muscle, like the inguinal hernia, or under Poupart's ligament, in the same manner as the femoral.

"This is not a very frequent species of hernia, but does happen, and has as plain and determined a character as any other.

"It has been mentioned by Bartholin, T. Dom. Sala, Platerus, Bonetus, Ruysch, Petit, Mery, Verdier, &c. In one of the histories given by the latter, the urachus, and impervious umbilical artery on the left side, were drawn through the tendon into the scrotum, with the bladder. In another he found four calculi.

"Ruysch gives an account of one complicated with a mortified inguinal hernia. Petit says he felt several calculi in one, which were afterwards discharged through the urethra. (See also *J. G. F. John de insolitâ Calculi Ingentis per Scrotum exclusione.* Wittenburg, 1750.)

"Bartholin speaks of T. Dom. Sala as the first discoverer of the disease, and quotes a case from him, in which the patient had all the symptoms of a stone in his bladder. The stone could never be felt by the *sound*, but was found in the bladder (which had passed into the groin) after death." (*Pott.*)

According to Sir Astley Cooper, the increase or diminution of the size of the tumor is not much affected by the position of the patient's body, but depends more upon the accumulation or evacuation of urine. "This variation of size, however, is not always observable, as the bladder does not always discharge the whole of its contents when the patient makes water; that part of the viscus within the pelvis completely emptying itself, while the portion within the scrotum remains distended, as before the attempt to void the urine. Persons, therefore, labouring under this complaint are sometimes under the necessity of raising the scrotum, and pressing upon it, in order to force its contents into the pelvic portion of the bladder, by which means the whole volume of water is discharged by the urethra." Another troublesome symptom is frequent desire to make water, caused by its imperfect evacuation. The fluctuation might lead to a suspicion of hydrocele; but, in the two cases seen by Sir Astley Cooper, there was no transparency. (*On Hernia*, part ii. p. 63.)

This circumstance, together with the return of the urine into the bladder in the pelvis, and the consequent desire to make water, on the tumor being compressed, will prevent such a mistake. But Bertrand met with a case, in which such recession of the urine could not be made to take place by pressure. Verdier gives a case, in which a calculus in the protruded part of the bladder was mistaken for a bubo, and caustic was applied, by which an urinary fistulous opening was produced.

As the bladder is only covered in part by the peritoneum, the hernia cystica has no sac; and when complicated with an inguinal hernia, that portion of the bladder which forms the cystic hernia lies between the intestinal hernia and the spermatic cord, that is, the intestinal hernia must be anterior to the cystic.

The vesical hernia is believed by Sir Astley Cooper to have its origin in a relaxed state of the bladder, and he suspects, that the protrusion may also be promoted by neglect to empty the bladder at the time required. The bladder thus becomes distended laterally; and then reaches the superior opening of the inguinal canal, through which it is forced by the pressure of the superincumbent viscera, and the action of the diaphragm and abdominal muscles. "As the anterior and lateral parts of the bladder are, in some degree, devoid of peritoneal covering, the bladder at first enters the inguinal canal, without bringing that membrane with it; but, as soon as the fundus begins to descend, the peritoneum accompanies it; and with the sac, thus formed, intestine and omentum afterwards protrude." (See *Sir A. Cooper*, *On Hernia*, part ii. p. 64, ed. 2.)

While recent, this kind of hernia is reducible, and should be kept up with a truss. When it is of any date, or has arrived to any considerable size, as Pott remarks, the urine cannot be discharged without lifting up and compressing the scrotum: the outer surface of the bladder is now become adherent to the cellular membrane, and the patient must be contented with a suspensory bag.

"In case of complication with a bubonocele, if the operation becomes necessary, great care must be taken not to open the bladder instead of the sac; the latter will always be found to be posterior."

Verdier and Sharp have accurately described the cystocele. Pott has recorded two cases, which fell under his observation (vol. iii.) Pipelet mentions a cystic hernia in perinæo; and several cases of its occurrence in the female. (*Acad. de Chir.* t. iv.) Pott cut into one cystocele by mistake. Mention is made (*Edin. Surg. Journ.* vol. iv. p. 512) of a cystic hernia, which protruded between the origins of the levator ani and obturator internus muscles: the tumor made its appearance in the pudendum of an old woman. A similar case is published in Sir Astley Cooper's work, as communicated to him by Mr. Burns, of Glasgow. Sir Astley has also recorded the particulars of the dissection of two inguinal cystoceles.

An instance of protrusion of the bladder through a wound, caused by a bullock's horn, is recorded by Larrey. (*Mém de Chir. Mil.* t. iv. p. 289.)

[There is a preparation of a very large cystocele in the Museum of St. Mary's Hospital. It formed during life a tumor in the scrotum, as large as a child's head, concealing the penis. The hernia was of the direct kind, and had existed for twenty years. The man, who was seventy years of age, explained that to empty his bladder he was obliged to press the tumor with his hands. Latterly he had suffered occasionally from retention of urine. The Editor was called to see him on one of these occasions. It required a very long flexible catheter to reach the bladder. He died, worn out by repeated attacks of retention of urine and prostatic disease. On a *post-mortem* examination, the bladder was found divided by the external abdominal ring into an intra-pelvic and an extra-pelvic portion. The intra-pelvic portion was the smaller of the two. It would hold about half-a-pint of water, and was held down in its position by the fasciæ surrounding the prostate gland and neck of the bladder, so that these parts were but little displaced. There was no hernial sac and no protrusion of other viscera. The scrotal portion of the bladder would readily hold a pint of fluid; it communicated with the pelvic portion by an opening nearly an inch in diameter. The epigastric artery was in contact with the outer side of the neck of the sac.]

Ischiatic Hernia.—This disease is very rare. A case, however, which was strangulated, and undiscovered till after death, is related in Sir A. Cooper's second part of his work on hernia. It was communicated by Dr. Jones, so celebrated for his book on hemorrhage. The disease happened in a young man, aged 27. On opening the abdomen, the ileum was found to have descended on the right side of the rectum into the pelvis, and a fold of it was protruded into a small sac, which passed out of the pelvis at the ischiatic notch. The intestine was adherent to the sac at two points: the strangulated part, and about three inches on each side, were very black. The intestines towards the stomach were much distended with air, and here and there had a livid spot on them. A dark spot was even found on the stomach itself, just above the pylorus. The colon was exceedingly contracted, as far as its sigmoid flexure. A small orifice was found in the side of the pelvis, in front of, but a little above, the sciatic nerve, and on the forepart of the pyriformis muscle. The sac lay under the glutæus maximus muscle, and its orifice was before the internal iliac artery, below the obturator artery, but above the vein. Sir A. Cooper remarks, that a reducible case might be kept up with a spring-truss, and, that if an operation were requisite, the orifice of the sac should be dilated directly forwards. (*On Crural Hernia, &c.* p. 73.)

Phrenic Hernia.—The abdominal viscera are occasionally protruded through the diaphragm, either through some of the natural apertures in this muscle, or deficiencies, or wounds, and lacerations in it. The second kind of case is the most frequent:—Morgagni furnishes an instance of the first. Two cases, related by Dr. Macauley, in *Med. Obs. and Inq.* vol. i.; two more detailed in the *Medical Records, and Researches*; and two others published by Sir A. Cooper, are instances of the second sort: and another case has been lately recorded by the latter gentleman, affording an example of the third kind. A laceration of the diaphragm by fractured ribs has produced a hernia. A case of this kind was dissected by Mr. Travers, at Guy's Hospital. (*Med. Chir. Trans.* vol. vi. p. 375.) In this last volume may also be found the particulars of an interesting example, in which a considerable part of the large curvature of the stomach was protruded through a fissure of the diaphragm. The accident was unattended with any fracture of the ribs, and was caused by the upsetting of a stage-coach, on which the patient was an outside passenger. Before death, he vomited up a large quantity of blood, and a small semicircular aperture was discovered on dissection in the lower part of the strangulated portion of the stomach (p. 378, 379). See also *B. Stehelin, Tentamen, Med. quod ventriculum, qui in thoracem migraverat, &c. describit*, 1721 (*in Halleri Disp. Anat.* tom. vi. p. 675). Hildanus, Paré, Petit, Schenck, &c., also mention cases of phrenic hernia. The disease is quite out of the reach of art.

Mesenteric Hernia.—If one of the layers of the mesentery be torn by a blow, while the other remains in its natural state, the intestines may insinuate themselves into the aperture, and form a kind of hernia. The same consequence may result from a natural deficiency in one of these layers. Sir A. Cooper records a case, in which all the small intestines, except the duodenum, were thus circumstanced. The symptoms during life were unknown. (*On Crural Hernia, &c.* p. 82.)

Mesocolic Hernia.—So named by Sir Astley Cooper, when the bowels glide between the layers of the mesocolon. A specimen of this disease is preserved at St. Thomas's Hospital.

Every surgeon should be aware, that the intestines may be strangulated within the abdomen from the following causes:—1. Apertures in the omentum, mesentery, or mesocolon, through which the intestine protrudes. 2. Adhesions, leaving an aperture, in which a piece of intestine becomes confined. 3. Membranous bands at the mouths of hernial sacs, which becoming elongated by the frequent protrusion and return of the viscera, surround the intestine, so as to strangulate it within the abdomen, when returned from the sac. (See *Sir A. Cooper, On Crural Hernia, &c.* p. 85.)

Pott remarks, that "Ruysch gives an account of an impregnated uterus being found on the outside of the abdominal opening; and so do Hildanus and Sennertus. Ruysch also gives an account of an entire spleen having passed the tendon of the oblique muscle. And I have myself seen the ovaria removed by incision, after they had been some months in the groin." (vol. ii.)

[REDUCTION EN MASSE.]

[There is one point of considerable importance, which, though mentioned casually in the preceding pages, has not perhaps received sufficient consideration, — namely, the reduction of a strangulated hernia together with its sac, called by French surgeons *réduction en bloc*, or *réduction en masse*. Le Dran first drew attention to the subject. Cloquet proved the possibility of the occurrence in twenty cases in the dead body. Dupuytren operated on several cases where this complication existed. Mr. South, in his translation of Chelius, enters fully into the subject (vol. ii. p.16). And Mr. Luke has contributed a valuable paper on it in the Medico-Chirurgical Transactions, entitled *Cases of Strangulated Hernia reduced en masse, with Observations*, vol. xxiv. p. 159.

Every surgeon has witnessed the reduction of a recent hernia, together with its sac, when not strangulated; but, in a *reducible* hernia of any standing, generally the adhesions contracted by the sac to the orifices through which it passed, and to the tissues surrounding it, will prevent the latter from receding with its contents into the abdominal cavity. Some few cases of hernia, which have been *irreducible* for years, have been replaced, together with the sac, after some months' treatment by pressure, in the horizontal position. In *strangulated* hernia, the case now under consideration, the circumstances which favour the reduction *en masse*, are,—1st, the shortness of the canal through which the hernia has protruded, as in a femoral or a direct inguinal hernia; 2nd, the large size of the opening through which it has escaped, and the smallness of the body of the sac, relatively to the neck; 3rd, the looseness of the connection between the sac and the structures which surround its neck and body; 4th, the existence of firm adhesions between the hernial contents and their containing sac. Under a combination of such predisposing circumstances, it will be readily understood that repeated and forcible attempts by the patient and the surgeon to reduce by the taxis the strangulated rupture, may result in its sudden return *en masse* into the abdominal cavity. The cases now placed on record of this untoward accident by various authors, no longer admit of any doubt as to the fact of its occasional, though very rare, occurrence. The hernia under these circumstances will be found situated between the abdominal muscles and the peritoneum, in the immediate vicinity of the orifice by which it had been made to enter the abdomen. It will of course be contained in its sac, by the neck of which it will be still subjected to pressure. The symptoms by which the reduction of a strangulated hernia *en masse* may be recognised, are,—1st, the recent sudden reduction of a strangulated hernia; 2nd, the persistence of the symptoms of strangulation notwithstanding; 3rd, the presence of a painful swelling to be distinguished on careful examination in the abdominal cavity, in close proximity to the opening by which the hernia had escaped from and into the cavity; 4th, an impulse on coughing communicated sometimes to the finger introduced through the ring. The last two signs are not always present. A case has been known to occur, where, in a femoral hernia, the tumor formed by the sac and its contents was situated between the pubes and the bladder, and therefore not to be felt by the finger introduced into the ring, or by the hand placed on the abdominal wall.

In the treatment of these cases the surgeon should endeavour to obtain the descent of the hernia, by inducing the patient to make efforts by coughing, or otherwise straining. Should these efforts prove successful, the operation should be immediately performed with great caution, and with as little pressure as possible on the sac, lest it should again escape out of view. If, however, the efforts made by the patient fail, which will most probably be the case, the surgeon must cut down upon the structures overlaying the position formerly occupied by the hernia; he must introduce his finger into the canal by which the hernia had protruded, and by which it had passed back into the abdomen. His next endeavour should be to draw down the sac, which he would find lodged between the peritoneum and abdominal wall; this he must do either with his fingers or by the aid of a pair of forceps. Having effected this object, the sac should be retained by an assistant, while the surgeon proceeds to open it and divide the stricture formed by its neck. Six operations, performed by Dupuytren on strangulated herniæ, reduced *en masse*, will exemplify the difficulties which may be met with and overcome in these cases. These cases are described by M. Sanson. (*Dictionnaire de Médecine et de Chirurgie pratiques*, tom. ix. p. 390.) "In two (of the six cases) the efforts which he caused the patient to make brought the swelling down again in a mass, as it had gone up, and the operation was performed in the usual manner. The tumor could not be brought out again in the four others. In two of these, where there was hernia on one side only, an incision was made over the ring, which enabled the operator to seize the swelling and draw it down, when the operation was completed. In the two others there was a hernia on each side. Both had been returned, and it could not be determined which of them had been strangulated. On one of these the operation was performed on the side where there was no strangulation; it was then repeated on the other side. The tumor was drawn out, and the operation finished. On the other the operation was fortunately performed, at first, on the side where the strangulation existed." (*Lawrence, Treatise on Ruptures*, 5th ed. p. 152.)

In *oblique inguinal* hernia, from the length of the canal the sac has to traverse, more especially when it descends into the scrotum, and the extent of the surfaces with which it is in contact, and to which it contracts adhesions, this complication of the reduction *en masse* of the strangulated rupture, as might be expected, occurs much less frequently. The hernial tumor may be made, it is true, in some instances, to leave the upper part of the scrotal region when the external abdominal ring is large, and when the stricture is situated at the internal ring; but under such circumstances the swelling is evidently located in the inguinal canal, and not in the abdominal cavity, forming simply an increased bulging of the space between the two rings. Mr. Birkett, who has devoted much attention to this particular question, goes so far as to doubt the possibility of reducing *en masse* a strangulated hernia of the oblique kind. In an elaborate paper on this division of the subject, evincing considerable research (*Medico-Chirurgical Transactions*, vol. xlii. p. 247), he endeavours to show that in these cases of so-called reduction *en masse* in oblique inguinal hernia, the tumor, when it has fairly disappeared from the inguinal canal, and has entered the abdominal cavity, consists of the contents of the sac only, which, by the force exerted during the application of the taxis, have been thrust through a rent in the upper part of the sac, and will be found lodged outside the sac, between the peritoneum and the abdominal wall, in the immediate neighbourhood of the internal ring. The sac, he maintains, will be found in the scrotum and inguinal canal, retaining its usual attachments to the surrounding structures, and that, if examined by the finger, an opening will be discovered, which may be readily mistaken for the mouth of the sac, but which in reality is the laceration, through which the intestine will be felt.

The practical application of this view of the subject, should after experience prove it to be correct, will be best collected from Mr. Birkett's own words. "Should there be," he observes, "even the slightest indications of the complication described in this paper, the operator must proceed to examine the inguinal region, for delay is inadmissible. In this operation he should first search for the hernial sac. Having opened this, upon passing the finger upwards to the internal ring, he will, very probably, pass it through the laceration in the sac, and feeling the intestine, he will suppose he has reached the peritoneal cavity. This, however, he has not yet accomplished. He must next draw the bowel into the inguinal canal, and then, by passing the finger along the *anterior* surface of the mesentery he will reach the *orifice* of the hernial sac, which firmly constricts the protrusion. The orifice of the sac must now be divided, and in the reduction of the hernia into the peritoneal cavity, great care is required to prevent its gliding through the laceration. The division of the constriction, or orifice, of the hernial sac is accomplished with greater facility, if an assistant steadily draws the sac downwards, whilst the operator introduces the bistoury on his index finger." Mr. Birkett has carefully collected thirty-seven cases of strangulated oblique inguinal hernia, said to be reduced *en masse*, and has given a tabulated view of their peculiarities under three heads. His first table comprises 8 cases of inguinal hernia reduced *en bloc*, where no operation was performed, and death resulted. In his second table are included 13 cases in which the operation was performed, and the patients recovered. In his fourth table are contained 16 cases in which the operation was performed, and death ensued.

There can be no question, if Mr. Birkett can establish his view of the nature of the accident which has taken place in these cases, that he will have earned the credit of having elucidated one of the many complications that the practical surgeon has to encounter, in his operations for strangulated hernia. At any rate, a perusal of his paper cannot fail to place the surgeon on his guard in these obscure cases, and will afford him all the information at present attainable on the subject.]

[The following tables are transcribed from Mr. Lawrence's valuable work on Ruptures. They shew the comparative numbers of the different kinds of ruptures, and the relative frequency of the complaint generally, as well as that of its various forms in the two sexes. The first is extracted from the register of the patients relieved by the City of London Truss Society, within twenty-eight years. The second is from M. Cloquet's work:—

"In 83,584 patients, 67,798 were males, 15,786 were females.

Males.	Females.			
14,006	511	left inguinal	39,419 inguinal	45,629 single.
24,316	586	right inguinal		
278	2,255	left femoral	6,210 femoral	
421	3,256	right femoral		
24,966	286	double inguinal		double 27,029
169	1,608	double femoral		
664	2,775	umbilical		4,063
209	415	ventral		
1	3	peritoneal		4
1	4	obturator		5
26	46	have undergone operations		72

Males.	Females.		
2,289	1,401	with umbilical and inguinal hernia have been cured . . .	3,690
446	243	with prolapsus ani . . .	689
	2,196	with prolapsus uteri	. . 2,392
	37	with prolapsus vaginæ	
	159	with prolapsus vesicæ	
6	5	with varix of the abdominal veins	11
67,798+15,786=83,584			83,584

In addition to the above statement, the following varieties in the situation of this malady have been noticed, viz.:—

"In 801 Males.

184 left inguinal and right femoral hernia.
82 left inguinal and left femoral hernia.
13 left inguinal and double femoral hernia.
10 left inguinal and ventral hernia.
13 left inguinal and umbilical hernia.
3 left inguinal hernia and prolapsus ani.
3 left inguinal, umbilical and ventral hernia.
135 right inguinal and left femoral hernia.
27 right inguinal and right femoral hernia.
25 right inguinal and double femoral hernia.
16 right inguinal and ventral hernia.
26 right inguinal and umbilical hernia.
7 right inguinal and prolapsus ani.
1 right inguinal, umbilical, and ventral hernia.
87 double inguinal and right femoral hernia.
54 double inguinal and left femoral hernia.
27 double inguinal and double femoral hernia.
1 double inguinal and double femoral hernia outside of the femoral vessels.
12 double inguinal and ventral hernia.
1 double inguinal and double ventral hernia.
48 double inguinal and umbilical hernia.
18 double inguinal hernia and prolapsus ani.
2 double inguinal, umbilical, and ventral hernia.
1 left femoral and umbilical hernia.
1 right femoral and ventral hernia.
1 right femoral and umbilical hernia.
1 right femoral hernia, outside of the femoral vessels.

"In 367 Females.

13 left inguinal and left femoral hernia.
40 left inguinal and right femoral hernia.
1 left inguinal and double femoral hernia.
2 left inguinal and umbilical hernia.
6 left inguinal hernia and prolapsus uteri.
1 left inguinal hernia and prolapsus ani.
20 right inguinal and left femoral hernia.
5 right inguinal and right femoral hernia.
1 right inguinal and double femoral hernia.
9 right inguinal and umbilical hernia.
3 right inguinal and ventral hernia.
3 right inguinal hernia and prolapsus uteri.
1 double inguinal and right femoral hernia.
8 double inguinal and umbilical hernia.
5 double inguinal and ventral hernia.
1 double inguinal hernia and prolapsus uteri.
28 single femoral and umbilical hernia.
10 single femoral and ventral hernia.
1 left femoral and double ventral hernia on the right side.
1 left femoral and right obturator hernia.
3 left femoral hernia on the outside of the femoral vessels.
14 single femoral hernia and prolapsus uteri.
2 right femoral hernia on the outside of the femoral vessels.
1 right femoral hernia on inside and outside of the femoral vessels.
2 right femoral hernia, prolapsus uteri, and prolapsus vesicæ.
12 double femoral and umbilical hernia.
3 double femoral and large ventral hernia.
8 double femoral hernia and prolapsus uteri.
2 double femoral hernia and prolapsus ani.
22 umbilical and ventral hernia.
5 umbilical hernia and prolapsus uteri.
1 umbilical hernia, prolapsus uteri, and prolapsus vesicæ.
1 ventral hernia and prolapsus uteri.
5 prolapsus uteri and prolapsus ani.
109 prolapsus uteri and prolapsus vesicæ.
8 prolapsus uteri and prolapsus vaginæ.
10 prolapsus uteri, prolapsus vesicæ, and prolapsus vaginæ.

5,448 patients had congenital hernia.

7,299 patients were relieved with trusses under 10 years of age.

4,551	between	10	and	20
8,715	,,	20	,,	30
13,614	,,	30	,,	40
15,627	,,	40	,,	50
14,169	,,	50	,,	60
9,761	,,	60	,,	70
3,866	,,	70	,,	80
442	,,	80	,,	90
23	,,	90	,,	100
78,067				

"Of 457 herniæ examined by M. Cloquet, 307 occurred in the male, 150 in the female sex; 246 on the right, 187 on the left side, and 24 on the middle line of the abdomen.

"The numbers of the different kinds were as follows:—

Males.	Females.			
94	11	right external inguinal	203 external	289 inguinal.
79	19	left ,, ,,		
39	8	right internal	86 internal	
35	4	left ,,		
33	54	right femoral	. . .	134 crural.
22	25	left ,,		
3	21	umbilical and linea alba	. . .	24
2	5	right obturator	. . .	10 obturator.
0	3	left ,,		

Recherches sur les Causes et l'Anatomie des Hernies abdominales (p. 9, *note*)."

From the register of the Truss Society, it may be deduced that the relative frequency of hernia in the two sexes is as follows:—

Of all kinds—in males to females	as about	4½ to 1
Of inguinal—in males to females	,,	45 to 1
Of femoral—in females to males	,,	8 to 1
Of umbilical—in females to males	,,	4 to 1
Of inguinal to femoral—in both sexes	,,	8 to 1]

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des Sciences, 1717. *Verdier*, Recherches sur la Hernie de la Vessie; Mém. de l'Acad. de Chir. t. ii. *Divoux*, Disp. de Herniâ Vesicæ Urinariæ, Argent. 1732. *Levret*, Obs. sur la Hernie de la Vessie; Mém. de l'Acad. de Chir. t. ii. *P. Petit* (le jeune), Sur les Hernies de la Vessie, et de l'Estomac; Acad. de Chir. t. iv. Vater de Lienis Prolapsione, 1746. *M. Mondiere*, in Archiv. générales, Sept. 1834; an interesting Memoir. *M. G. Pfannius*, De Entero-Oscheocele antiquâ, Restitutione Sacci Herniosi feliciter peractâ, absque Bracherio et Sectione curatâ. Erlângæ, 1748. *La Peyronie*, Sur un Etranglement de l'Intestin; causé intérieurement par l'Adhérence de l'Epiploon au-dessus de l'Anneau; Mém. de l'Acad. de Chir. t. i. *Tenon*, in Acad. des Sciences, 1764. *Richter*, Von den Brüchen, in 2 vols. 1778, 1779: or the French transl. by Rougement, 4to. Bonn, 1788. *A. G. Richter*, De Herniâ Incarceratâ una cum Sacco suo reponi per Annulum Abdominalem posse monet, 4to. 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HERNIA CEREBRI. (*Fungus Cerebri. Encephalocele.*) There are two principal kinds of hernia cerebri: one presents itself in young infants, before the ossification of the skull is completed; the other takes place after the destruction of a part of the skull by the operation of the trephine, accidental violence, or disease.

[The latter kind of hernia cerebri has already been fully treated of in article HEAD, INJURIES OF (see this article): the former will be alone considered here.]

The congenital hernia cerebri of infants occurs in two very different forms: in one, it is covered by the scalp; in the other, the corresponding integuments of the head, and sometimes even the dura mater, are deficient.

The common encephalocele, met with in new-born children, seems to originate from the imperfect ossification of the skull, especially in the situation of the fontanella, and sutures. This case is characterised by a soft swelling, of an equal round shape, which is attended with a pulsation corresponding with that of the pulse: it yields and disappears under pressure, offers no alteration in the colour of the skin, and is circumscribed by the margin of the defective portion of the scull. (*Ferrand, in Mém. de l'Acad. de Chir.* t. xiii. in 12mo. p. 102.) In general, the mental faculties are not affected; and we read of one example, in which a patient had such a hernia cerebri thirty-three years, without his intellects ever having been impaired during the whole of that period. (Op. cit. t. v. in 4to. p. 863.)

It is tolerably well established, that the congenital hernia cerebri, which arises from the incomplete ossification of the skull, and is covered by the scalp, ought to be treated by the application of constant, yet moderate, pressure. M. Salleneuve communicated to the Royal Academy of Surgery in France an example of the good effects of this treatment, which reduces the size of the tumor, and accomplishes a perfect cure as soon as the ossification is completed. M. Salleneuve put a piece of thin sheet lead, properly covered with soft linen, under the child's cap, to which it was sewed in a suitable situation, and the degree of pressure was increased, or lessened, according as circumstances required, by tightening or loosening the cap. (Op. cit. p. 103, t. xiii. ed. 12mo.)

The experience of Callisen also confirms the fact that hernia cerebri, when of moderate size, may be cured by the foregoing method, the aperture becoming gradually closed. But he adds that large tumors of this description, especially when situated about the occiput, scarcely admit of any means of relief, except the employment of some contrivance to protect them from external injury. (*System. Chir. Hodiernæ*, vol. ii. p. 513, 514, ed. 1800.)

When the ossification of the sutures in children is late, the cerebellum, as well as the cerebrum, is liable to protrusion. In 1813, two such cases occurred at Paris. In one, Professor Lallement mistook the disease for a common tumor, and commenced an operation for its removal, when, after making some of the necessary incisions, his proceedings were stopped by his seeing the white silvery colour of the dura mater, and that the swelling came out of an aperture in the occipital bone. The day after the operation the child was seized with violent pain in the head, had a hard pulse, prostration of strength, vomiting, &c., and died in the course of a week. On dissection, a part of the tentorium, and an elongation of the two lobes of the cerebellum, about as large as a nut, were found in the protruded sac of the dura mater. Several abscesses were also discovered in the substance of the cerebellum. The other example fell under the observation of M. Baffos: upon the death of the child, the dissection evinced similar appearances. (*Richerand, Nosographie Chir.* t. ii. p. 319, ed. 4.)

Such facts should teach the surgeon to be particularly cautious in ascertaining the nature of tumors about the back part of the head, before he ventures to attempt their removal.

The second kind of congenital encephalocele is that in which not only large portions of the cranium, but also more or less of the integuments of the head, are deficient. It is rather to be regarded as a malformation than a disease; and, indeed, in most instances, the infants are still-born. The case sometimes consists of the protrusion of most of the brain through the inferior and posterior fontanellæ, so that the child is born with a largish bag, on the back of its head, hanging down over the posterior part of the neck. Several specimens of these malformations, taken from infants born in the Hospice de la Maternité, are preserved in the museum of the Faculté de Médecine at Paris. (*Richerand, Nosogr. Chir.* t. ii. p. 316, ed. 4.) In the year 1810, a remarkable case of this last description of congenital hernia cerebri was published by Dr. Burrows. "The whole of the forehead, summit, and a great part of the occiput, were deficient; and in lieu of them a substance projected of a light mulberry colour, and of the mushroom form, except that it was proportionably broader. From the deficiency of bone, the eyes appeared to project much more than usual. The child lived six days without either taking sustenance, or having any evacuation." On dissection, the scalp, the os frontis, the parietal, and a great part of the occipital bones, were wanting. Through the parts, at which these bones were deficient, the cerebrum projected, exhibiting its usual convolutions. It was covered with the pia mater; was of a mulberry colour; appeared to be more vascular than the pia mater usually is; and the edge of the scalp adhered to the neck of the tumor. The cerebellum was not more than one-fourth of its usual size, for the posterior part of the os occipitis was much nearer to the sella turcica than natural. The child was destitute of the power of voluntary motion, and all the secretions appeared to be stopped. (See *Med. Chir. Trans.* vol. ii. p. 52.)

HERNIA HUMORALIS. *Orchitis.* Inflammation of the testicle, especially when produced by irritation in the urethra, gonorrhœa, the use of bougies, &c. As the term is founded upon the exploded doctrine of the translation of humours from one part to another, the sooner its employment is abandoned the better. The case is considered under the word *Testicle.*

HERPES. (From ἕρπω, to creep.) The appellation, *herpes*, is limited "to a non-contagious vesicular disease, which, in most of its forms, passes through a regular course of increase, maturation, and decline, and terminates in about ten, twelve, or fourteen days. (See SKIN, *Diseases of.*)

[HETEROCHYMEUSIS. (From ἕτερος and χύμευσις.) A foreign substance in the blood, or an excess of one or more of its normal constituents. This term is employed by F. Simon to designate morbid conditions, in which materials, not belonging to the class of poisons, as sugar, oil, biliary pigment, blood pigment, amylaceous matter, and the like, are present in the blood, such substances being absent, or occurring in inappreciable or very minute quantities in health. (*Animal Chemistry.*) The term includes many of those diseases referred by the elder humoral pathologists to an acrimony in the blood.

Heterochymeusis may arise — 1. From the ingestion of substances foreign to the nutrition of the body, or of an excess of assimilable materials. In this case, for the most part, only minute portions, or only a small quantity in excess, is absorbed; the greater part being carried off by the intestinal canal. 2. From substances developed during primary or secondary digestion, assimilation, and disintegration. Many pathologists believe that sugar in glucohæmia is produced in the alimentary canal. Salts of lime are furnished to the blood in excess in caries. 3. From substances engendered in the blood itself, or in the blood-forming and transposing organs. Blood pigment, bile pigment in excess, and excess of white corpuscles have this origin. Thus acrimonies in the blood may be derived either from within or from without the body. The portions received into the blood are in some instances wholly or in part assimilated, neutralised, or oxidised, or they percolate in solution through the secreting organs. Totally unassimilable colouring and odorous principles of numerous articles of food and of beverages, and various medicines, percolate the kidneys, skin, and lungs, and are rapidly removed without producing any injurious effects. Grape sugar and glucose are destroyed in the blood, unless in excess, when they are eliminated by the kidneys; cane sugar, on the other hand, is never destroyed, but always eliminated. When from any cause such substances are neither eliminated nor destroyed, they remain as acrimonies, their effect on the organisation and functions of life depending on their mechanical and chemical qualities, and their relations to the vital fluids and structures. "The continuous ingestion of injurious articles of diet, or persistent diseases in definite organs, produce permanent faulty conditions of the blood." (*Virchow.*) Such conditions may affect the morphological elements, as where the red corpuscles are broken up and the pigment diffused, or they may affect the liquor sanguinis chemically.

In illustration of the surgical importance of these acrimonies in the blood, numerous examples might be cited. Minute particles of insoluble substances, as of charcoal, taken into the alimentary canal, are said to be capable of passing into the circulation and of blocking up the minute capillaries in the brain. *Oerstenlin.*) Blood pigment from fragments of thrombi or emboli crumbling down and decomposing, and pigment cells, or coloured elements which do not belong to the blood, believed by Virchow to be derived from the spleen, have similar effects; and a most important principle enunciated by the pathologist just quoted is, that when such thrombi or emboli are altered in character, as when they proceed from a gangrenous wound, they modify the nature of the process arising from the obstruction, just as if gangrenous matter had been inoculated. Other substances received into the blood alter its density, pressure, and viscidity; and thereby influence the rapidity of its circulation in the tissues, and the processes of endosmose and exosmose — oily substances for instance. (See *Art.* BLOOD, COAGULATION OF, DURING LIFE ; BLOOD, PIGMENT GRANULES IN; HYPERÆMIA ; THROMBUS.)

Many substances have a specific action on the elements of the tissues and in the parenchymatous fluids. Chemical affinities exist between definite tissues and the fluids they contain, and definite substances, whether those substances may have been conveyed to the part by the blood or applied more directly. By virtue of this elective affinity, certain parts attract particular substances from the blood. Thus, free fat in the blood is attracted by the hepatic cells. The crystalline lens has an attraction for some of the constituents of glucogenic blood, in consequence of which cataract is produced. (See *Dr. W. Budd, On Diseases which affect corresponding parts of the Body ; Med. Chirur. Trans.* 1842, p. 100.)

Amyloid substance, the basis of those affections of the kidney, liver, spleen, and lymphatic glands, termed lardaceous or "waxy," has rarely if ever been detected in the blood, but all the circumstances of the amyloid degeneration lead to the conclusion that the fluid constituents of the blood are modified by some acrimony, and that the materials of this substance, or of the starch granule, are furnished direct from the blood by elective affinity to the tissues. The amyloid substance has been found in almost every tissue; the cerebrum, cerebellum, liver, spleen, lung, kidney, striped muscular substance, and areolar tissue. In one case Virchow found it in every organ examined, and it usually occurs in many parts of the body simultaneously. The earliest seat of the change is the walls of the minutest arteries, after which the change extends to the surrounding parenchyma. The parts which are its seat of election, as the vessels and gland cells, become totally incapable of discharging their functions, and frequently form a mechanical impediment to the circulation of the blood; or by obstructing the lymph vessels and glands produce ulterior changes in the blood. General cachexia, dropsy, and marasmus are its concomitants. There are cases in which every minute artery in the digestive track from the mouth to the anus is affected.

Acrimonies in the blood are frequently conveyed from one part of the body to another, and are thus the causes of a true metastasis. In gout, when the kidneys fail to excrete the excess of uric acid, this acrimony accumulates in the blood, and by elective affinity is deposited at definite points. Virchow has pointed out a very remarkable metastasis of this nature. In cases of great destruction of bone, the earthy salts are absorbed and received into the blood; if at the same time there is an impeded elimination of the salts of lime by the kidney, they may be deposited in other parts of the body as "a fine incrustation or infiltration." Carbonate and phosphate of lime has thus, in diseases of the bones, been found deposited in the lungs, the mucous membrane of the stomach, and the vessels of the medullary substance of the brain. These metastases sometimes produce the pains of rheumatism. It becomes a question also whether the ossification of the tissues of the heart and blood vessels, the lens, &c., occurring in old age, is not connected with senile wasting of the bones.

The effects of foreign substances in the blood have been most studied in relation to poisons. (See TOXÆMIA.)]

Henry Ancell.

HORDEOLUM. (dim. of *hordeum*, barley.) A little tumor on the eye lid resembling a barleycorn. A *stye.* As Scarpa remarks, the stye is strictly only a little boil, which projects from the edge of the eye-lids, frequently near the great angle of the eye. Like the furunculus, it is of a dark-red colour, much inflamed, and a great deal more painful than might be expected, considering its small size. The latter circumstance is partly owing to the vehemence of the inflammation, and partly to the exquisite sensibility and tension of the skin covering the edge of the eyelids. On this account, the hordeolum very often excites fever and restlessness in delicate irritable constitutions ; it suppurates slowly and imperfectly ; and, when suppurated, has no tendency to burst.

The stye, like other furunculous inflammations, forms an exception to the general rule, that the best mode in which inflammatory swellings can end is resolution. For, whenever a furunculous inflammation extends so deeply as to destroy any of the cellular substance, the little tumor can never be resolved or only imperfectly so. This event, indeed, would rather be hurtful, since there would still remain behind a greater or smaller portion of dead cellular membrane ; which, sooner or later, might bring on a renewal of the stye in the same place as before, or else become converted into a hard indolent body, deforming the edge of the eyelid, and termed *grando.*

The resolution of the incipient hordeolum may be effected in that stage of it in which the inflammation only interests the skin, and not the cellular substance underneath, as is the case on the first appearance of the disease. Now repellent, cold applications are useful, particularly ice. But when the hordeolum has affected and destroyed any of the cellular membrane underneath, every topical repellent application is absolutely useless, and even hurtful; and the patient should have recourse to emollient anodyne remedies. The hordeolum and eyelids should be covered with a warm soft bread and milk poultice, which ought to be renewed very often. When a white point makes its appearance on the apex of the little tumor, Scarpa says the surgeon should not be in a hurry to let out the small quantity of serous matter which exists between the skin and dead portion of cellular membrane. It is better that he should wait till the skin, within this white point, has become somewhat thinner, so as to burst of itself, and give ready vent, not merely to the little serous matter, but to all the dead cellular membrane, which constitutes the chief part of the disease. When the contents of the little tumor are slow in making their way outward, through the opening, the surgeon, gently compressing the base of the stye, ought to force them out. After this all the symptoms of the disease will disappear, and the cavity, left by the dead cellular membrane in the centre of the little tumor, will be found quite filled up, and healed in the course of twenty-four hours.

Sometimes, though seldom, this process of nature, destined to detach the dead from the living cellular membrane, only takes place incompletely, and a small fragment of yellow dead cellular substance still continues fixed in the cavity, and hinders the cure. In this circumstance, the further employment of emollient poultices is of little or no service. The surgeon should now touch the cavity with nitrate of silver scraped to a point, or dip the point of a camel-hair pencil in sulphuric acid, and touch the inside of the stye with it, one or more times, until the sloughy cellular membrane comes away. After this, the small cavity remaining will soon close. Should the eyelid continue afterwards a little swollen and œdematous, this affection may be removed by applying the lotio plumbi acet. containing a little spirit of wine. Some persons are often annoyed with this disease. This is most frequent in persons who live on acrid irritating food, and drink spirits. The stye, which occurs and relapses so frequently in scrofulous children, is readily curable by means of sulphate of quinine, and rubbing the tumor, when not inflamed, with any smooth hard body, like a plain gold ring; [and also by the internal use of chlorate of potash, in doses of from five to fifteen grains three times a day.] (See *R. Middlemore*, *On Dis. of the Eye*, vol. ii. p. 772.) Chronic styes may occasionally be made to suppurate, by applying to them stimulating salves. (See *W. Mackenzie*, *On Dis. of the Eye*, p. 158, ed. 2.) (See *Scarpa*, *Sulle Malattie degli Occhi*, cap. ii. *Guthrie's Operative Surgery of the Eye*, p. 107. *R. Middlemore*, *On Dis. of the Eye*, vol. ii. p. 770. 8vo. Lond. 1835. [*Dixon*, *on Dis. of the Eye*, 1855. *Desmarres' Traité*, *&c.* 2d edit. Paris, 1855. *Mackenzie*, *on Dis. of the Eye*, 4th edit. 1854.)]

HOSPITAL GANGRENE. (*Phagedæna Gangrenosa*; *Hospital Sore*; *Putrid or Malignant Ulcer*; *Pourriture d'Hôpital.*) [The term *gangrene* is not well applied to this affection, as we shall presently show. The real nature of it is that of sloughing phagedæna, or diphtherite; a condition in which certain morbid exudations are poured out in or upon a wounded or diseased part, and there undergo decomposition together with the tissues they involve.] It is particularly characterised by its contagious or infectious nature; its disposition to attack wounds, or ulcers, in crowded hospitals, or other situations, where many of these cases are brought together; and its tendency to convert the soft parts affected into a putrid, glutinous, or pulpy substance, in which no trace of their original texture is discernible. (*Delpech*, *Précis Elém. des Mal. Chir.* t. i. p. 123.)

[Rousseau has well said that "man of all animals is the least able to live in herds." Under no circumstances can human beings be crowded together with impunity. Towns ill placed and arranged, fortresses during sieges, and most hospitals and prisons, are true death places for the human race. Out of the air which has served for respiration, and the animal exhalations, are engendered a crowd of miasmata, capable of producing diseases, and of these none more remarkable than the hospital gangrene.

"For a long time this malady was confounded with *gangrene* (=*mortification*); yet the diagnosis is easy. Gangrene is the extinction of life in a part more or less extensive; hospital gangrene, the decomposition of a surface. Gangrene is usually the consequence of intense inflammation, of contusion, pressure, ligature, strangulation, burns, or infiltration; hospital gangrene has its source in foul air, loaded with animal exhalations. Gangrene attacks without regard to dwelling or condition; is not epidemic; and once arrested, seldom relapses. Hospital gangrene is more insidious, more deadly; it only attacks wounded or ulcerated surfaces: it may make the simplest wound a focus of putrefaction; it is developed *par excellence* in ships, prisons, and hospitals; it may attack the same individual many times; if he have many wounds, it may affect one singly, or more than one; on a large wound it may affect only a part of the surface, whilst the remainder proceeds in suppurating and cicatrising favorably."—(*Aubry, F. J.*, *Dissertation sur la Complication des Plaies, et des Ulcères*, Paris, 1815.)

In revising the present article, it is proposed to follow strictly the style and purpose of the original, and to present a kind of bibliographical or literary history of the subject. We shall therefore allow each author quoted to speak, for the most part, in his own words, and shall give extracts from the chief writers from the time of the Peninsular War to the Crimean; for it needs scarcely be said, that it is in the crowded hospitals attached to armies in the field that hospital gangrene displays itself in its true malignity. But, first, we crave attention to the following propositions, which will enable the student to grasp the leading ideas in the paragraphs which follow.

1. Hospital gangrene is the result of a poison generated by crowding the wounded together, with insufficient ventilation. This poison may act, first, by direct inoculation, or application of the matter from one patient's wound to another's; or, secondly, it may act through the medium of its vapour, on wounded surfaces. In either of these cases the first symptoms are local, and the disease produced is at first local.

In a third set of cases, the poison acts through the reception of its vapour into the blood; and in this case shivering and other constitutional symptoms come first. If the patient have a wound, it may be affected with the gangrene; if he have not, the effect of the poison may be evidenced by a gangrenous carbuncle or by bilious fever, diarrhœa, or dysentery.

The poison is extremely permanent, and adheres to linen, and other organic substances, even after cleansing.

2. When the disease begins locally, the first symptom is usually pain, the next a diphtheritic exudation. The writer claims that he first pointed out the analogy between the exudation of diphtherite and that of hospital gangrene. The course of the disease is, that the exudation, and the parts

which it infects, slowly decompose, and the products of decomposition spread and infect the sound parts adjoining. Meanwhile the lymphatics inflame; the blood becomes contaminated; feverish symptoms come on, if they did not at first; the blood loses its healthy properties; hæmorrhages occur, and diarrhœa follows. The connection of secondary hæmorrhage with hospital gangrene, and with other less conspicuous unhealthy states of wounds, produced through hospital air, is well worthy of notice.

3. The treatment of the disease has gradually advanced from a state of confusion and uncertainty to one that is definite and rational. The application of caustic and antiseptic substances to the wound; the most entire cleanliness and pure air; tonics, and good diet, are the remedies now universally sanctioned. Yet the reader will notice that some military surgical authorities at one time advocated bleeding largely! and believed that great good resulted from it, and describe the patients as imploring to be bled! and this, in a disease caused by a putrid poison, and tending to destroy life by debility. In the article Inflammation, *Treatment of*, we hope to explain why bleeding was formerly employed in the very cases in which it is now considered pernicious, and was then equally pernicious in reality.]

Literary History. From the researches of Mr. Blackadder it appears probable that several of the ancient writers, in their descriptions of foul gangrenous bleeding ulcers, must have alluded to the same kind of disease, which is now usually denominated hospital gangrene.

Besides the use of the actual cautery, which, according to the modern French writers, is the surest means of arresting this distemper, several of the ancients appear also to have employed for its cure arsenical applications; as, for instance, Ætius, Paulus, Rolandus, Avicenna, Guido, &c. The only doubt, whether these authors actually referred to hospital gangrene, depends upon their not having generally described its contagious nature.

Although La Motte made cursory mention of hospital gangrene in 1722, under the name of *pourriture*, and stated, that it had occurred in the Hôtel Dieu at Paris, the first distinct modern account of this disease is contained in the 3rd vol. of the posthumous works of Pouteau, published in 1783. In the year 1788, Dussassoy, who succeeded Pouteau as chief surgeon of the Hôtel Dieu at Lyons, also published a short treatise on the disorder. The first very accurate description of hospital gangrene in the English language, appeared in the 6th vol. of the *London Medical Journal*, printed in 1785. The account is entitled, "Observations on the Putrid Ulcer, by Mr. Gillespie, surgeon of the Royal Navy." In the edition of Dr. Rollo's work on Diabetes, published 1797, there is a section on this subject, entitled, "A short account of a morbid poison, acting on sores; and of the method of destroying it." In 1799, Sir Gilbert Blane, in the 3rd edit. of his book on the Diseases of Seamen, gave an account of hospital gangrene under the name of malignant ulcer; and Dr. Trotter, in the 2nd vol. of his *Medicina Nautica*, published in the same year, described that affection by the same appellation. In the third vol. of the same work, Dr. Trotter added to his first account several valuable communications relating to this disease, received from surgeons of the royal navy. Mr. John Bell also made hospital gangrene the subject of particular remark, in the 1st vol. of his *Principles of Surgery*, published in 1801. According to Dr. Thompson, two excellent theses were likewise published on it in the University of Edinburgh: the first entitled, "De Gangrænâ Contagiosâ," by Dr. Leslie, in 1804; the second by Dr. Charles Johnson, in 1805, under the title of "De Gangrænâ Contagiosâ Nosocomiali." (See *Lectures on Inflammation*, p. 456—458.)

Professor Thompson's account of the subject, published in 1813, contained the fullest history of the disease at that time collected. Boyer afterwards gave a very fair account of the distemper. (See *Traité des Mal. Chir.* t. i. p. 320, 8vo. Paris, 1814.)

These descriptions were followed by the valuable essay of Delpech, entitled "Mémoire sur la Complication des Plaies et des Ulcères connue sous le nom de Pourriture d'Hôpital," 1815; some interesting observations by Dr. Hennen, in the *London Medical Repository for March*, 1815; a Paper by Professor Brugmann, of Leyden, in the *Annales de Littérature Méd.* vol. xix. 1815; and the treatise of Mr. Blackadder, which contains some of the best remarks ever made concerning this affection, and is entitled "Observations on Phagedæna Gangrænosa, 8vo. Edinb. 1818." To these publications are to be added the interesting remarks of Mr. R. Welbank, On Sloughing Phagedæna, contained in the 11th vol. of the *Med. Chir. Trans.*; and those of Dr. Boggie, recorded in the 3rd vol. of the *Edin. Med. Chir. Trans.*, [and reprinted at Edinburgh, 1848; the lectures of Guthrie, published in the Lancet, 1848, vol. ii., and in his Commentaries on Military Surgery, 6th ed.; lectures by Velpeau, "On the Wounded during the Revolution of 1848," in the same vol.; Macleod, "On the Surgery of the Crimean War;" besides other cases, and memoirs, which we shall refer to as we proceed.]

Descriptions by various Military Surgeons.

According to Mr. Blackadder, when the morbific matter, which produces the disease, has been applied to some part of the surface of the body, from which the cuticle has been removed, as by a blister, one or more small vesicles first appear, which are filled with a watery fluid, or bloody serum of a livid, or reddish-brown colour. The situation of the vesicle is generally at the edge of the sore. Its size is not unfrequently that of a split garden pea, and it is easily ruptured, the pellicle which covers it being very thin. When the vesicle is filled with a watery fluid, and has not been ruptured, it assumes the appearance of a greyish-white, or ash-coloured slough; but when it contains a dark-coloured fluid, or has been ruptured, it puts on the appearance of a thin coagulum of blood, of a dirty, brownish-black colour. During the formation of the vesicle, there is generally a change in the sensation of the sore, accompanied with a painful feel like that of the sting of a gnat.

After a slough is formed, it spreads with more or less rapidity, until it occupies the whole surface of the original sore; and, when left to itself (which seldom happens), there is little or no discharge, but the slough acquires daily greater thickness.

"When the formation of the slough has been interrupted, the stinging sensation becomes more frequent and acute; phagedænic ulceration quickly commences; and such is frequently the rapidity of its progress, that even in the course of a few hours a very considerable excavation will be formed, while the parts in the vicinity retain their usual healthy appearance." The cavity, the edges of which are well defined, is filled with a thick glutinous matter, which adheres strongly to the subjacent parts. When this matter is removed, the surface underneath presents itself of a fine granular texture, which, in almost all instances, is possessed of extreme sensibility, and is very apt to bleed, when the operation of cleaning is not performed with great delicacy. At each dressing the circumference of the cavity is found enlarged, and if there are more than one, they generally run into each other. The stinging pain gradually becomes of a darting or lancinating kind; and *either about the fourth, or sixth day, from the time when the morbific matter had access to the sore, or afterwards, at the period of what may be termed secondary inflammation, the lymphatic vessels and glands are apt to become affected.*

"The soft parts, in the immediate vicinity of the sore, daily become more painful, tumefied, and indurated; and, in a great number of cases, particularly in those of plethoric and irritable habits, an attack of acute inflammation speedily supervenes, and is accompanied by a great increase of pain, the sensation being described to be such as if the sore were burning. The period at which this inflammation begins to subside is by no means regular. Sometimes it subsides in the course of two days, and sometimes it continues upwards of five; depending very much on the constitution and previous habits of the patient, as well as the treatment that has been adopted. During its progress, the thick, putrid-looking, and frequently spongy slough which is formed on the sore, becomes more and more moist, and of a *pulpy* consistence. (Hence this form of disease is actually named by Gerson, *pulpy gangrene.*) In the course of a few days, a very offensive matter begins to be discharged at its edges. The slough then begins to separate; by and by, it is thrown off; but only to prepare the way for an extension of the disease by a continued process of ulceration, and by a recurrence of the last-mentioned symptoms." (*Blackadder*, *On Phagedæna Gangrænosa,* p. 28—30.)

According to other observers, the first symptoms which indicate hospital gangrene in a wound, or ulcer, are, a more or less acute pain, and a viscid whitish exudation on the surface of the granulations, which lose their vermilion colour, and present at several points, spots of a greyish or dirty-white hue, resembling venereal ulcers, or aphthæ. These ulcerated points, thus engrafted (as it were) upon the original ulcer, soon spread, and join together, so as to give to the whole surface of the solution of continuity a grey ash-colour. The surface also becomes more or less indurated, and sometimes bleeds. A red, purplish œdematous circle of a greater, or lesser extent, is next formed in the surrounding skin. Sometimes, when the patient is of a good habit, the causes of infection less active, and the constitution sufficiently strong, the disorder now stops. According to Boyer, it may not even extend to the whole surface of the ulcer. But most frequently its progress is extremely rapid, and occasionally quite terrifying. The edges of the wound, or ulcer, become hardened and everted; the granulations are large and tumid, being swelled up, as Boyer asserts, with a considerable quantity of gas. They are afterwards detached in the form of soft reddish sloughs, which very much resemble the substance of the fœtal brain in a putrid state. From day to day, until nature, either alone, or aided by art, puts limits to the disorder, it invades new parts, both in breadth and depth, so that its ravages extend to aponeuroses, muscles, blood-vessels, nerves, tendons, the periosteum, and even the bones themselves.

Amongst a number of severe cases which fell under the notice of Mr. Blackadder, "there was one in which the half of the cranium was denuded, the bones having become black as charcoal, and the integuments detached posteriorly to the second cervical vertebra, and anteriorly to the middle of the zygomatic process of the temporal bone; and this was originally a superficial wound of the scalp. In another case, the muscles, large arteries, and nerves of both thighs were exposed and dissected, the integuments and cellular substance being entirely removed, with the exception of only a narrow strip of the former, which remained on the outer side of the thighs. This was also originally a simple flesh wound. In other instances, the cavities of the knee, ankle, elbow, and wrist joints were laid extensively open, and, in one unfortunate case, the integuments and cellular substance, on the anterior parts of the neck, were destroyed, exhibiting a horrid spectacle, the trachea being also wounded." (*On Phagedæna Gangrænosa*, p. 3.)

He notices, that when the morbific matter is inserted in a puncture, or scratch, the first progress of the disease bears a resemblance to that of a part inoculated with vaccine matter. The primary inflammation in gangrenous phagedæna commences at the end of the second, or early on the third day.

When the disease attacks a recent gunshot-wound, the discharge, two or three days after infection, is found to be lessened, and to have become more of a sanious than purulent nature. The sore has a certain dry and rigid appearance; its edges are more defined, somewhat elevated, and sharpened; the patient is sensible of a change in the usual sensation in the sore, and complains of an occasional stinging sensation, resembling that produced by the sting of a gnat. At this period, but sometimes a day or two later, the integuments at the edge of the sore become inflamed, and the surface of the sore itself assumes a livid or purple colour, and appears as if covered with a fine pellicle, such as is formed on a coagulum of blood. (*On Phagedæna Gangrænosa*, p. 33.)

The surrounding integuments become indurated and inflamed, assuming, not unfrequently, an anserine appearance; and the patient complains of a constant burning, lancinating pain. In the vicinity of the sore, the integuments become more and more of a dark-red colour, in consequence of the violence of the inflammation, which is of an erysipelatous nature, and apt to terminate in sloughing, and carry off the patient. However, the inflammatory symptoms are sometimes mild, and, in other cases, exceedingly violent: a fact accounted for by differences of constitution. (*Blackadder*, p. 34.)

At Bilboa, the disease, in cases of wound, is said generally to have commenced with a sudden attack of severe pain in the head and eyes, tightness about the forehead, want of sleep, loss of appetite, a quick pulse, and other febrile symptoms; while the wound, which had been healthy and granulating, at once became tumid, dry, and painful, losing its florid colour, and assuming a dry and glossy coat. (*Hennen, On Military Surgery*, p. 214, ed. 2.)

In the hospitals at Bilboa, if the incipient stage was overlooked, the febrile symptoms very soon became aggravated; the skin around the sore assumed a highly florid colour, which shortly became darker, then bluish, and at last black, with a disposition to vesicate; while the rest of the limb betrayed a tendency to œdema. All these threatening appearances occurred within twenty-four hours, and, at this period, also, the wound, *whatever might have been its original shape, soon assumed the circular form.* The sore now acquired hard, prominent, ragged edges, giving it a cup-like appearance, with particular points of the lip of a dirty yellow hue, while the bottom of the cavity was lined with a flabby blackish slough. The gangrene still advancing, fresh sloughs were rapidly formed; the increasing cup-like cavity was filled up and overtopped by them, and the erysipelatous livor and vesication of the surrounding skin gained ground, while chains of inflamed lymphatics could be traced from the sores to the adjoining glands, there exciting inflammation and suppuration, which often furnished a new nidus for gangrene. The face of the sufferer assumed a ghastly, anxious appearance: his eyes became haggard, and deeply tinged with bile; his tongue covered with a brownish, or blackish fur; his appetite entirely failed; and his pulse was feeble and accelerated. In this stage, the weakness and irritability of the patient was such that the slightest change of posture put him to torture, increased by his inability to steady the limb, which, if lifted from the bed, was seized with tremors and spasmodic twitches. (*Hennen's Military Surgery*, p. 215, 216, ed. 2.) Authors vary considerably in their descriptions of the state of the tongue. Dr. Hennen found it brownish, or blackish; Delpech whitish, or yellowish. (*Précis Elémentaire* t i. p. 125); and Mr. Blackadder, covered with a white mucus. (p. 39).

[The exemption of some wounds is inexplicable, though not more so than the exemption of any individuals from the effects of any other morbid poison. A MS. note to the Thesis of M. Aubry declares, that of two fingers wounded at the same time, by the same instrument, and with the wounds in contact, the one was affected, the other not.]

It is explained by Mr. Blackadder, that when the disease attacks a large recent wound, the whole surface of the injury is sometimes affected from the first; while, in other instances, the disorder commences on or near the lips of the sore. When the patient is of an inflammatory diathesis, the sore is generally attacked with acute inflammation between the seventh and fourteenth days; and the slough is softer, and of a pulpy consistence; matter, of a strong and peculiar odour, and of a dirty brownish, grey colour, begins to ooze out at its edges, and becomes daily more copious. The inflammation gradually subsides; the slough becomes loosened, and finally detached, leaving the subjacent muscles, bones, fasciæ, or ligaments, completely exposed. When the constitution is not prone to acute inflammation, the slough remains long adherent; the discharge is very copious, and burrows under the skin, which then mortifies. Sometimes, after the detachment of a slough, florid granulations spring up, and, notwithstanding a slight recurrence of the phagedenic ulceration, the parts heal up by the almost unassisted operation of nature. However, most commonly, after the muscles are exposed, they continue to be gradually dissected; their connecting cellular membrane is completely destroyed, and they are left covered with an offensive, greasy-looking matter.

According to Mr. Blackadder, when a muscle has been wounded, it swells sometimes to a great size, and quickly assumes the appearance of a large coagulum, being altogether deprived of irritability. When it has not been wounded, but has become inflamed, it generally assumes a pale colour, with an appearance as if distended with a fluid, and occasionally, before losing its vitality, acquires a very surprising bulk; but when no inflammation has supervened, the muscles become of a pale brick colour, waste away daily, and the patient loses all power in them. As the disease advances, the integuments are undermined and slough, and hæmorrhage from small vessels is a common occurrence; but in a more advanced stage, some of the large vessels are apt to give way, and the bleeding from them frequently destroys the patient.

"When a stump is the site of the disease, and the patient is of a plethoric habit, or accustomed to live freely, the symptoms soon begin to indicate the existence of an intense inflammatory action through its whole substance, the tumefaction, pain, and heat increase rapidly, so that in a few days the stump shall have acquired more than twice its former size, being at the same time much indurated, and causing the most excruciating pain. In this state the patient has, in some instances, become delirious, and has been cut off by an effusion taking place into some of the larger cavities. It more commonly happens, however, that gangrene seizes upon the integuments and cellular substance; large sloughs are thrown off; and some of the large blood-vessels giving way, the patient sinks under the effects of repeated hæmorrhage. For it is commonly found that the usual modes of stopping hæmorrhage from a stump are, in such cases, either inadmissible, or totally inefficacious.

"Sometimes the progress of the disease in a stump is more gradual, but in the end nearly as fatal. The inflammation is much less acute; there is comparatively but little tumefaction, and the pain is much less severe; but the discharge is much more copious, and the cellular substance, connecting the integuments and muscles, is rapidly destroyed. Hæmorrhage generally comes on later than in the preceding instance, but it is the most common cause of death." (*Blackadder, On Phagedæna Gangrænosa*, p. 33—39.)

It is observed by another writer that artery seems to be the texture which resists most powerfully the destructive action of hospital gangrene (*Thomson's Lectures*, p. 460), a remark quite at variance with the statement of Delpech (*Précis Elém.* t. i. p. 129); but intended to refer, as I conceive, to cases in which the femoral, brachial, or some other large artery is seen for several days completely denuded, in the midst of the ravages of the distemper, yet not giving way. I have seen the same thing frequently exemplified in mercurial phagedæna, as well in the groin as in the arm. As for the smaller arteries, they are quickly destroyed, together with other parts.

"In some rare cases (says Dr. Hennen) I have seen the femoral and axillary arteries pulsating awfully, and apparently unaffected with disease; while all the surrounding parts were completely destroyed; but in a vast majority of cases, the blood-vessels partook of the general disease in which they were imbedded. They were not only completely separated from their natural connections, but their coats sloughed away at the immediate point of disease, while the disposition extended far beyond the apparently affected spot. Hence our ligatures but too often failed on the main branches, and any attempt on the smaller was invariably injurious. We were here naturally induced to tie the artery considerably above the seat of the disease; and this was done once on the femoral, and twice on the axillary artery below the clavicle. The former burst on the third, each of the latter on the second day afterwards." Dr. Hennen further remarks that, in general, the great vessels sloughed long after the acute symptoms of the disease had abated, and that, in severe cases, the eleventh day of the disease was always dreaded. (*On Military Surgery*, p. 221, ed. 2.) The indisposition of the large vessels to close, when taken up in the common way, appears referrible to three causes: viz. the tendency to rapid ulceration in the arteries in the situation of the ligatures; the formation of no effectual coagulum in the extremity of the vessel, like what happens in other cases of mortification; and the general incapacity of nature in examples of hospital gangrene to establish any process which can be accompanied with healthy adhesive inflammation.

In the last stage of the disease, as it occurred in the military hospitals at Bilboa, the surface of the sore was constantly covered with a bloody oozing, and, on lifting up the edge of the flabby slough, the probe was tinged with dark-coloured grumous blood, with which also its track became immediately filled. Repeated and copious venous bleedings now came on, which rapidly carried off the patient. The sloughs, whether they fell off spontaneously, or were detached by art, were quickly succeeded by others, and brought into view thickly-studded specks of arterial blood. At length, an artery gave way, which was generally torn through in the attempt to secure it with a ligature. The tourniquet, or other pressure, was now applied, but in vain; for while it checked the bleeding, it accelerated the death of the limb, which became frightfully swelled and horribly fœtid. Incessant retchings came on, and with coma, involuntary stools, and hiccough, closed the scene. Often, however, the patient survived this acute state of the disease, and sank under severe irritation, absorption of putrid matter, and extensive loss of substance, with common hectic symptoms. (See *Hennen's Mil. Surgery*, p. 217, ed. 2.) In the disease at Bilboa, the skin and cellular substance seemed to be the parts originally and principally affected. This, says Dr. Hennen, was obvious, even in the living body; but, on dissection, the disease of these parts was frequently observed to spread much further than external appearances indicated, as a diseased track was often found running up into the groin, or axilla, and completely dissecting the muscles and great vessels. (*On Military Surgery*, p. 219, ed. 2.) When the disease had occupied the outside of the chest, the same gentleman found the lungs in two cases, and the pericardium in a third, covered with gangrenous spots; and when the parietes of the abdomen had been attacked, he often observed the same appearances on the liver (p. 220).

The disease varies considerably in its severity in different cases, being sometimes of small extent, and even capable almost of a spontaneous cure. Patients have been known to continue afflicted more than a month; and when the duration of the disease was thus lengthened, the cases almost always had a fatal termination. In a few cases the wound puts on a favourable appearance again between the sixth and ninth days; and, in slight examples, the amendment is manifested between the third and fifth. Whatever may be the period of the complaint, its wished-for termination is always announced by a diminution of pain; the pus acquiring a white colour, and more consistence, and losing its fœtid nauseous smell. The edges of the ulcer subside, while its surface becomes less irregular, and puts on more of the vermilion colour. The red, purplish, œdematous circle, which surrounds the disease, assumes a true inflammatory nature; and the solution of continuity, restored to a simple state, heals up with tolerable quickness, even when the destruction of soft parts is somewhat considerable, unless any fresh untoward circumstances occur to interrupt cicatrisation. But sometimes, when the patient is on the point of being completely well again, his condition is suddenly altered for the worse; ulcerated spots make their appearance on the cicatrix, and these spreading in different directions occasion a relapse, which may happen several times.

According to Dr. Boggie, a relapse, and even repeated relapses, are very common, as his own experience fully convinced him; and he adverts to a case reported by Dr. Hennen, in which the patient survived twelve different attacks, and sunk under the thirteenth. (See *Edinb. Med. Chir. Trans.* vol. iii. p. 8.) So far as the observations of Dr. Boggie went, hospital gangrene was more frequent and severe in hot weather than cold. (See *Edinb. Med. Chir. Trans.* vol. iii. p. 13.)

From numerous cases of this disease, seen by Mr. Blackadder at Passages, in Spain, he drew the following conclusions:—

1. That the morbid action could almost always be detected in the wound, or sore, *previously to the occurrence of any constitutional affection.*

2. That in several instances the constitution did not become affected, until some considerable time after the disease had manifested itself in the sore.

3. That when the disease was situated on the inferior extremities, the lymphatic vessels, and glands in the groin, were observed to be in a state of irritation, giving pain on pressure, and were sometimes enlarged, before the constitution showed evident marks of derangement.

4. That the constitutional affection, though sometimes irregular, was in many cases contemporary with the second, or inflammatory stage.

5. That all parts of the body were equally liable to become affected with this disease.

6. That when a patient had more than one wound, or sore, it frequently happened that the disease was confined to one of the sores, while the other remained perfectly healthy, and this even when they were at no great distance from each other. (*On Phagedœna Gangrœnosa*, p. 19.)

Thus, Mr. Blackadder espouses the opinion that hospital gangrene is at first a *local* and not a *constitutional disease.*

In the hospital gangrene, observed by Dr. Rollo in the Artillery Hospital at Woolwich, "the action of the poison seemed to be limited and confined to specific effects. *The first were local, producing only a general affection by a more extensive operation on the sore.* Five or six days from the appearance of the small ulcer or ulceration, when it had extended over one third of the former sore, with pain and redness in the course of the lymphatics, and the glands, through which they led, with enlargement of them, general indisposition of the body became evident." Delpech, in his interesting memoir, particularly notices that the constitutional symptoms *always occurred the last in order of succession.*

Mr. Blackadder declares that the period at which the constitution begins to exhibit symptoms of irritation, is extremely irregular,— sometimes as early as the third or fourth day, and sometimes even as late as the twentieth. The countenance assumes an anxious, or feverish aspect; the appetite is impaired; the desire for liquids increases; and the tongue is covered with a white mucus. The bowels are generally rather constipated; and the pulse what may be termed rather irritated than accelerated. But the general symptoms may assume an inflammatory, or typhoid character, the pulse is frequent and sharp, and it is not uncommon for the patient to be seized with one or more shivering fits, succeeded by a great increase of heat, but seldom or never terminating in a profuse perspiration. The cold fit is sometimes followed by a bilious discharge from the intestines, and mitigation of the febrile disorder. If the local mischief be not arrested, the strength becomes daily more and more exhausted; the fever loses its inflammatory character; and, unless the patient be cut off by hæmorrhage, he falls a victim to extreme debility. When the disease has a typhoid character, the pulse is small and frequent; the appetite and strength gradually fail; and the patient at last sinks, retaining his mental faculties to the last. Not unfrequently diarrhœa hastens the event. (*Blackadder, On Phagedœna Gangrœnosa*, p. 39, 40.)

The sloughing phagedæna seen by Mr. R. Welbank, generally in the cleft of the nates, in the groin, or at the inner and upper part of the thigh, in the lowest class of prostitutes, and, according to his description, certainly resembling hospital gangrene, was attended, in its early stages, with little or no disturbance of the system; a circumstance which he also mentions as favourable to the doctrine that the disease is of a local nature. (See *Med. Chir. Trans.* vol. xi. p. 365.)

On the other hand, the generality of writers, nay, even some of those who represent the disease as always proceeding from a species of infection applied to the wound, take into the account the operation of constitutional causes, as predisposing to, and of course preceding, the local symptoms. Dr. J. Thomson believes that the constitutional symptoms mostly precede the local. (*On Inflammation*, p. 459.) The same sentiment is professed by Dr. Hennen.

Dr. Hennen mentions a remarkable instance, which also proves the possibility of a specific sore becoming affected, and fatal from this cause, in forty-eight hours after the patient had first been exposed to the infection. The patient "who had just landed from England, and was under the influence of mercury, employed for a venereal complaint, died within forty-eight hours after his admission, the gangrene having seized on an open bubo in his groin, eroding the great vessels in the neighbourhood, and absolutely destroying the abdominal parietes to a large extent." (*Principles of Military Surgery*, p. 218, ed. 2.)

The effects of hospital gangrene should be carefully discriminated from those of the scurvy. Ulcers attacked with hospital gangrene are not affected in any degree like scorbutic ulcers, by the use of vegetable diet and lemon-juice; and they occur among men who are fed upon fresh meat and vegetables, as readily as they do among those who have been fed altogether upon salt provisions. (*Thomson, Lectures on Inflammation*, p. 482.) In cases of hospital gangrene, the general symptoms of scurvy are also absent, such as soreness and bleeding of the gums, livid blotches and wheals on the fleshy part of the legs, œdematous ankles, &c.

Its occasional causes are: the situation of an hospital upon a low marshy ground; the vicinity of some source of infection; the uncleanliness of the individuals, or of the articles for their use; the crowded state of the wards, especially when they are small and badly ventilated; lastly, everything that tends to corrupt the air which the patients breathe. An infected atmosphere may produce in the most simple wounds unfavourable changes, partly, as Boyer conceives, by its immediate action on the surface of the wound, but no doubt, principally, by its hurtful influence upon the whole animal economy. The foregoing causes have also sometimes produced alarming and obstinate gangrenes of an epidemic kind, or, at least, a state of the constitution, under the influence of which all wounds and ulcers constantly took on a bad aspect, and were often complicated with the worst gangrenous mischief. Vigaroux saw such an epidemic disease prevail for twenty months in the two hospitals of Montpellier; and he states that the most powerful antiseptics were of little avail against the disorder, which often invaded the slightest scratches.

In general, this epidemic species of gangrene is not observed in new-built hospitals, nor in those which are erected out of the central parts of cities upon high ground. Hospital gangrene may occur in any season; but it is most common after the sultry heat of summer.

A bilious constitution, mental trouble, unwholesome or insufficient food, a scorbutic diathesis, great debility, and fevers of a dangerous type, are also reckoned by the French surgeons as so many predisposing causes of hospital gangrene.

The observations of Pouteau, and those of some other practitioners, convincingly prove that hospital gangrene may be communicated to the most simple wound or ulcer in a subject of the best constitution, and breathing the purest air, by merely putting into contact with such wound, or ulcer, sponges, lint, or charpie, impregnated with the infection of this peculiar disorder. But this inoculation is conceived to be the more alarming, and to take effect the more quickly, in proportion as patients have been more exposed to the influence of such causes as are themselves capable of producing the disease, and also in proportion as the kind of constitution predisposes to it.

Although the contagious nature of hospital gangrene has been generally admitted by all the best-informed writers on the subject, the doctrine was not considered by Dr. Trotter as having a good foundation. Modern authors, however, have not joined this latter gentleman, and Dr. J. Thomson, Dr. Hennen, Mr. Blackadder, and Mr. R. Welbank, all believe that the disorder is infectious. "The contagious nature of hospital gangrene (says Professor Thomson) appears to me to be sufficiently proved, 1st, By the fact that it may be communicated by sponges, charpie, bandages, and clothing, to persons at a distance from those infected with it. 2ndly, By its having been observed to attack the slight wounds of surgeons, or their mates, who were employed in dressing infected persons; and that even in circumstances where the medical men so employed did not live in the same apartment with the infected. 3rdly, By our being able often to trace its progress distinctly from a single individual through a succession of patients. 4thly, By its attacking recent wounds, as well as old sores, and that in a short time after they are brought near to a patient affected with the disease. 5thly, By our being able to prevent the progress of the disease in particular situations, by removing the infected person before the contagion, which his sores emit, has had time to operate. 6thly, By its continuing long in one particular ward of an hospital, or in one particular ship, without appearing in other wards, or ships, if pains be taken to prevent intercourse between the infected and uninfected." (*Lectures, On Inflammation*, p. 484.)

The air of a crowded hospital, as Mr. Blackadder observes, is a ready means of accounting for the origin of phagedæna gangrænosa; but he mentions a case in which the wound of a soldier was found affected with the disease, on his first arrival at an hospital, after having been accidentally detained with two other wounded comrades for five or six days, partly in an open building, and partly in a boat, quite exposed to stormy weather (p. 45); Dr. Hennen likewise gives an account of about thirty fresh-wounded men, in whom hospital gangrene first appeared in their journey from Vittoria to the hospital near Bilboa. (*Principles of Military Surgery*, p. 214, ed. 2.) And according to Mr. J. Bell, "there is no hospital, however small, airy, or well-regulated, where this *epidemic* ulcer is not to be found at times." (*Principles of Surgery*, vol. i. p. 112.)

[The venerable Guthrie observes, "How is this morbid poison generated? how does it originate? The answer I am about to give is a very dangerous one. It originates in consequence of, 1st, a failure in the discipline of the army; 2ndly, a failure in its medical organisation; and, 3rdly, from the absence of a sufficient number of good surgeons, regularly drilled to their respective duties. Hospital gangrene never appears wherever these three essential points are duly attended to; and, if it should occur, it does comparatively little mischief, and is always to be subdued." The venerable writer proceeds to say, that the first time the disease appeared during the Peninsular war, was when the wounded of Talavera were sent to Elvas in 1809 and 1810, and from this moment it was usually to be found in all *general* hospitals in Portugal and Spain. So soon as the wounded of the army in 1811 began to be amassed together in small houses, as at Celorico in Portugal, and in 1813 at Passages in Biscay, without the possibility of separating them, the disease appeared; or where they were brought together in large numbers in convents, as at Coimbra, without sufficient ventilation, and sufficient severity of discipline.

"Professor Brugmann," continues Mr. Guthrie, "says, that in 1797, in Holland, charpie, composed of linen threads, which it was found on inquiry had been already used in the great hospitals of France, and had been washed and bleached, caused every ulcer to which it was applied to be affected by hospital gangrene. He says, also, that the disease prevailed in one of the low wards at Leyden, in 1798, whilst the ward or garret above it was free. The surgeon made an opening in the ceiling between the two, in order to ventilate the lower or affected ward, and in thirty hours, three patients, who lay next the opening, were attacked by the disease, which soon spread through the whole ward. Our experience in Portugal and Spain," says Mr. Guthrie, "confirmed this fact, and left no doubt in the mind of any one who had frequent opportunities of seeing the disease, that one case of hospital gangrene was capable of infecting not only every ulcer in the ward, but in every ward near it, and ultimately throughout the hospital, however large. The disease, as long as it remains unaltered by destructive applications, may be considered infectious, as well as contagious."

Guthrie gives the sanction of his experience to the existence of two forms: one, the more concentrated and active; the whole surface becoming in 48 hours of a dark red colour and ragged appearance, with blood partly coagulated and half putrid appearing at every point; with burning pain and awful stench, and the extension of the disease in a circular form, so rapid as to be marked from hour to hour; "so that in another 24 or 48 hours, nearly the whole of the calf of a leg, or the muscle of a buttock, or even of the wall of the abdomen, may disappear, leaving a deep, great hollow, or hiatus." But the destroying process sometimes assumes more of a sloughing than of a gangrenous character, whence Delpech has named it *pulpeuse*. "It may attack," says Mr. Guthrie, "the whole surface of an ulcer at once, or in distinct points; all, however, rapidly extending towards each other, until they constitute one whole. The red of the granulations becomes of a more violet colour, and a layer of ash-coloured matter is soon seen covering them, which adheres so firmly as not to be easily removed, or if separated shows that it is a substance formed upon the surface, and constituting a part of the granulations themselves, which are ultimately confounded with it. About the end of the first week, and sometimes much later, this kind of ulcer becomes more painful; the edges, or the circumference of the wound, assume a browner hue, and the parts become somewhat pasty, the whitish colour of the part particularly affected being opaque grey and soft. It may be said that the false membrane having become very thick, has lost the little vitality it possessed and become putrid; the discharge which had been partly suppressed, now reappears, not as pus, but as a fœtid ulcer, exhaling the peculiarly offensive stench of the disease. This pulpy, yellowish putrid substance becomes thicker, and extends deeply; it invades the whole substance of a muscle."

"Whether," continues Guthrie, "the disease begin in the more concentrated form, or in the milder state of phagedænic ulceration, its tendency to assume the circular form, and its peculiar stench, always distinguish it."

With regard to the question of the relative precedence of local or constitutional symptoms, and the nature of the latter, and the effects of remedies, the following remarks by Dr. Tice, are quoted by Guthrie. (*Lancet,* 1848, vol. ii. p. 686.) He is disposed to believe that no amount of the disease can exist without some constitutional derangement, however small; he believes, also, in the acutely inflammatory nature of the complaint in some persons, and in the efficiency of antiphlogistic measures.

"That in many cases the general affection, or pyrexial invasion or attack, may be slight, and of so short duration as to elude the detection of the medical observer, there can be little doubt; but that some degree of constitutional variety takes place as early as the sore or ulcer loses its granulating and healthy action, subsequent remarks or inferences authorise our conclusion and decision.

"An important circumstance, which clearly shows how much the general constitution becomes affected on the first attack of hospital ulcer, which, in many instances, the fever will clearly and unequivocally precede, is that among the most certain methods of arresting its progress on the invasion, will be venesection and general depletion. It appears, therefore, a fair and rational inference, that when the disposition to hospital ulcer manifests itself, or becomes rife among men in hospital, the causes of the morbid innovation or action will be referred to those which influence generally or constitutionally, and not locally and individually.

"In many cases in which the morbid invasion has been very sudden, wherein the health of the individuals has been undisturbed, and especially where a robust habit, or what is commonly termed a healthy condition has appeared for some time to fortify the constitution against any virulent conversion in the progress of healthy ulcers or wounds, oftentimes the sudden accession will furnish a most ardent example of local and general inflammatory excitement, without any obvious prior admonition or apparent cause. In such attacks, I have observed delirium shortly to occur; the pulse becomes extremely quick, tongue dry and coated, eyes frequently are suffused, skin burning hot, and general evacuations are suppressed, or but sparingly obtained. These are preludes oftentimes to very extensive changes in the local deterioration of the ulcer or wound, and to very alarming advances on the animal functions.

So far Dr. Tice. Mr. Guthrie continues as follows:—"The fever is sometimes inflammatory, sometimes typhoid, and occasionally resembles the bilious remittent of the summer and autumn in hot climates, and ends in typhus. It is probable that a want of attention to these circumstances has decided the opinions entertained by different individuals as to the general character of the febrile symptoms, and of the treatment to be pursued for their removal. That this disease was generally considered a constitutional complaint, until nearly the end of 1813, must be admitted; and it was the very indifferent success which attended its treatment by constitutional means, and simple detergent applications everywhere, except during the last three months of 1813, at Bilboa, which caused the surgeons of the British army to view it more as a local disease, capable of giving rise to severe constitutional symptoms. This change of opinion was materially influenced by the knowledge that the French surgeons more generally considered, with Pouteau, that it was, in the first instance, local, and treated it by the actual cautery. In my hands, constitutional treatment, and every kind of simple mild detergent applications, always failed, unless accompanied by absolute separation, the utmost possible extent of ventilation, and the greatest possible attention to cleanliness; and not even then, without great loss of parts in many instances, which induced me, at Santander, in November and December, 1813, to try the mineral acids, not as then generally used as stimulants or detersives, but as caustics. This proceeding was always, however, accompanied by a constitutional treatment, regulated by the nature of the symptoms which at that station were never benefited by bleeding, although it had proved so effectual, without the local remedies, at the neighbouring seaport of Bilboa.

"Dr. Boggie, the great advocate for constitutional treatment, and to whom I particularly refer, says, that under him, at Bilboa, in 1813, where caustic applications were not used, or only as detersives, the disease was arrested by blood-letting to the amount of one or two pounds, and in some cases to the extent of three or four. He admits, however, that bleeding must be resorted to with the greatest caution in persons of less robust constitutions, who may have lingered long in hospital, or suffered much from ill health; and that in some cases it is altogether inadmissible—an acknowledgment which is decisive in my mind, that constitutional treatment is only auxiliary. He says he never saw the puncture made by the lancet affected by this disease; a convincing proof to me, who have seen it, that the virulence of the complaint, as an infectious disease, was subsiding at Bilboa, when the treatment he introduced proved so effectual."

The following case, reported to Mr. Guthrie by Mr. Boutflower, will show the kind of symptoms in which bleeding was supposed to be specific:—

"John Boyle, 71st Regiment, was wounded on the 18th of June 1815 by a piece of a shell which ran across the fore and upper part of the left thigh very superficially. While in hospital at Antwerp, the wound sloughed; it had nearly healed when he had embarked for England. On the passage it assumed an unhealthy appearance, and on his arrival here, on the 5th of November, was in a completely sloughing state. On the 6th, twenty ounces of blood were taken away. On the 8th, he was transferred to the sloughing ward, under my care: the wound was about twelve inches in circumference, the edges violently retorted, with excessive pain: he had a full and strong pulse, with general febrile symptoms. He was again bled to twenty ounces, his bowels freely evacuated, and the pure muriatic acid applied to the entire surface of the wound. It appears, by my notes, that after two applications of the acid, a great portion of the sore was quite clean, but that sloughing continued to go on at detached parts, principally at the lower edge, till the 27th. During this time the acid was applied to the sloughing portions, and lint, dipped in cold water, to the remaining surface. The inflammatory diathesis continued to prevail, and besides the forty ounces of blood abstracted on the 6th and 8th, the following bleedings were performed:—9th, sixteen ounces; 11th, sixteen ounces; 14th, twelve ounces; 17th, twelve ounces; 19th, twelve ounces; 21st, sixteen ounces; 26th, twelve ounces; making a total of 136 ounces. So strongly was I impressed with the necessity for continuing the blood-letting, that I bled the patient myself the two last bleedings, from the jugular, the state of the arms not admitting of further venesection. In addition to the bleedings, large quantities of calomel and extract of colocynth, and the neutral salts, were given, and injections frequently administered. To alleviate the excessive pain, large opiates were prescribed. During the whole time the morbid process was going on, he absolutely ate nothing; but diluents, particularly acid drinks, were liberally allowed. Notwithstanding these profuse evacuations he continued remarkably strong, and the blood was buffed with a large portion of coagulum to the last.

"The sore is now healing; at times pale and unhealthy granulations show themselves at different points, which are always corrected by the application of tincture of myrrh. His health is at present good, but it has suffered somewhat from a late severe attack of diarrhœa. It should have been observed that the extent of the sore on the 27th, by measurement, was twenty-two inches in circumference, the trochanter major forming the centre. This man ultimately recovered."

Our accounts of the disease have hitherto been drawn from European warfare; now let us take a view of it as it occurred in India, in the Sikh campaign. Mr. Taylor, Surgeon of the 29th Regiment, thus writes to Mr. Guthrie:—

"In the treatment of this disease I proceeded," says Mr. Taylor, "regularly on one plan, and found that so efficacious that I was not inclined to try any other. The plan adopted was the application of the strong nitric acid, so as completely to cut off the diseased from the sound part, or so far sound part as only to be affected with inflammation. The acid, however, required to be rubbed in with the blunt end of the probe, so that it not only destroyed the cuticle, but killed the cutis vera, and probably the cellular membrane underneath. The narrow yellow ring of dead skin thus formed, separated like a piece of leather, generally carrying with it the whole slough, and leaving a clean, healthy surface, as well as edges, to the wound. I never attempted to apply the acid to the surface underneath the slough, neither is such application necessary; the vital seat of the disease is on its circumference, however large its area. I must admit, that the disease sometimes crossed the acid boundary, and a second, and even a third application of the remedy was required, but this was rare. Neither was constitutional treatment neglected, but this varied according to the state of the patient; emetics, purgatives, saline medicines, and low diet being sometimes required; whilst in other instances, ether, ammonia, laudanum, and generous diet were administered.

"When speaking of the symptoms of this disease, I should have mentioned that a burning, gnawing sensation was sometimes loudly complained of. The application of the acid soon removed that pain, and the acid itself did not often seem to produce much suffering. In one instance, deemed a favourable one, I tried venesection, and I fear did mischief. Calomel and antimonials were useful. I did not try the arsenical solution. The change of air, which the march of the wounded on their return to Kussowlee occasioned, certainly had very beneficial effects on all the gangrenous and sloughing sores.

"At the same time that hospital gangrene was prevalent at Ferozepore, some wounds took on a malignant fungous affection, which spread over the healthy surface like the hospital gangrene. The dirty fibrous-looking fungous growth rose considerably above the edges of the wound, partially overlapping them; these edges were inflamed, but not livid and vesicated, as in the cases of gangrene; but here, also, the disease took the circular or oval form. The affection here noticed I observed only in wounds of the forearm and hand; Colonel Barr's wound, which was of the forearm near the wrist, took on this disease. The application of nitric acid in the same way as for hospital gangrene eventually checked its progress; one finger of a private thus affected I was obliged to remove. Colonel Barr's wound was a compound comminuted fracture of the radius from grape-shot, which penetrated but did not lodge. He was an exceedingly large, stout, fat man, and known to be of a bad habit of body; he had been twenty years in India. His death was occasioned by a sudden hæmorrhage from the radial artery, from the effects of which he never rallied.

"In no case that came under my observation did the gangrene directly prove fatal, though in many cases it contributed largely in bringing about an unfavourable termination."

CONCLUSIONS.

The following aphorisms are given by Mr Guthrie, as his "conclusions" on the whole subject.

"First.—Hospital gangrene never occurs in isolated cases of wounds.

"Second.—It originates only in badly-ventilated hospitals crowded with wounded men, among and around whom cleanliness has not been too well observed.

"Third.—It is a morbid poison, remarkably contagious, and is infectious through the medium of the atmosphere applied to the wound or ulcer.

"Fourth.—It is possibly infectious, acting constitutionally, and producing great derangement of the system at large, although it has not been satisfactorily proved that the constitutional affection is capable of giving rise to local disease, such as an ulcer; but if an ulcer should occur from accidental or constitutional causes, it is always influenced by it when in its concentrated form.

"Fifth.—The application of the contagious matter gives rise to a similar local disease, resembling and capable of propagating itself, and is generally *followed* by constitutional symptoms.

"Sixth.—In crowded hospitals the constitutional symptoms have been sometimes observed to precede, and frequently to accompany, the appearance of the local disease.

"Seventh.—The local disease attacks the cellular membrane principally, and is readily propagated along it, laying bare the muscular, arterial, nervous, and other structures, which soon yield to its destructive properties.

"Eighth.—The sloughing of the arteries is rarely attended by healthy inflammation, filling up their canals by fibrine, or by that gangrenous inflammation which attends on mortification from ordinary causes, and alike obliterates their cavities. The separation of the dead parts is therefore accompanied by hæmorrhage, which in large arteries is usually fatal.

"Ninth.—The operation of placing a ligature on the artery at a distance, or near the seat of mischief, does not succeed, from the incision being soon attacked with disease, unless it has been arrested in the individual part first affected, and the patient has been separated from all others affected by it.

"Tenth.—The local disease is to be arrested by the application of the actual or potential cautery. An iron heated red hot, or the mineral acids pure, or a solution of arsenic or of the chloride of zinc, or other caustic which shall penetrate the sloughing parts, and destroy a thin layer of the unaffected part beneath them.

"Eleventh.—After the diseased parts have been destroyed by the actual or potential cautery, they cease in a great manner to be contagious, and the disease incurs less chance of being propagated to persons having open wounds or ulcerated surfaces. A number of wounded thus treated are less likely to disseminate the disease than one person in whom constitutional treatment alone has been tried.

"Twelfth.—The pain and constitutional symptoms occasioned by the disease, and considered as distinct from these symptoms which may be dependent on disease endemic in the country, are all relieved, and sometimes entirely removed, by the destruction of the diseased surface, which must, however, be carefully and accurately followed to whatever distance, and into whatever parts it may extend, if the salutary effect of the remedies is to be obtained.

"Thirteenth.—On the separation of the sloughs, the ulcerated surfaces are to be treated according to the ordinary principles of surgery. They cease to eliminate the contagious principle, and do not require a specific treatment.

"Fourteenth.—The constitutional or febrile symptoms, whenever or at whatever time they occur, are to be treated according to the nature of the fever they are supposed to represent, and especially by emetics, purgatives, and the early abstraction of blood if purely inflammatory, and by less vigorous means if the fever prevailing in the country is of a different character.

"Fifteenth.—The essential preventive remedies are separation, cleanliness, and exposure to the open air—the first steps towards that cure which cauterisation will afterwards in general accomplish.

Dr. Macleod (*Notes on the Surgery of the Crimean War*, London, 1858) says "that hospital gangrene was not common in the East; during the first winter it prevailed a good deal in a mild form at Scutari, but it never became either general or severe. It did not appear to pass from bed to bed, but rose sporadically over the hospitals. It frequently attacked the openings both of entrance and exit, but occasionally seized on one only, showing, apparently, a predilection for the wound of exit. At times it showed itself only in part of a wound, and spread in one direction alone. It was never severe, and was invariably, as far as I saw, of the variety designated "ulcerous" by Delpech, and "phagedæna gangrænosa" by Boggie. In many cases, the best designation for it, as it appeared with us, would have been the old one, "putrid degeneration." The earliest symptoms were pain in the part, which sometimes preceded the ulcerative process by a couple of days. The edges of the wound did not swell up, but remained as they were, undermined. The pain generally continued during the process of destruction." "I never saw any marked gastric disturbance attend it. If it attacked the wounds of those already labouring under fever, it appeared to aggravate the fever."

"The abominable state of the barrack hospital at Scutari, even during its early occupation, may well have caused an outbreak of hospital gangrene among the broken down men who lay so thickly around the doors of the offensive latrines; but I cannot say that I noticed any greater tendency to its appearance at these places than in any other portion of the hospital."

"Nitric acid applied locally, and the exhibition of the tincture of the muriate of iron internally, in half-drachm doses, three times daily, proved to be the most efficacious means of stopping it as it appeared in our hospitals. The local nature of the complaint was universally recognised, and local measures relied on for its relief. The application of the escharotic, not only to the edges of the sore, but also to the healthy tissues at a little distance round the margin, seemed by far the best means of employing the remedy. A barrier of lymph appeared to be thus thrown up around, which prevented the spread of the peculiar inflammatory or destructive action in the skin and cellular tissue, to which it was always confined. The attendant fever was uncertain in its development; sometimes it preceded, sometimes it accompanied, sometimes it followed the local outbreak." "Often," continues Dr. Macleod, "there was little, if any. The most generous diet, stimulants, and fresh air, were of the greatest service. The disease often appeared to be a 'child of the typhus,' or of diarrhœa, or scurvy, and to depend more on lowered general health, than on specific causes. The introduction of disinfectants into military practice is said to have done much good."

"The French," says Dr. Macleod, "suffered from hospital gangrene in its worst form, both in the Crimea and in their hospitals on the Bosphorus. No fewer than sixty bodies were thrown overboard from the Euphrates transport, from this cause, during the thirty-eight hours' passage from the camp to Constantinople. The actual cautery was the chief remedy and was often used with success: the perchloride of iron, charcoal, tincture of iodine and lemon juice were adjuvants.

The author of the elaborate "*Medical and Surgical History of the British Army, which served in Turkey and the Crimea, during the War against Russia in the years* 1854, 1855, 1856, *presented to both Houses of Parliament, by Command of Her Majesty*, 1858," describes the phenomena as follows (p. 274): "In healthy suppurating sores, even in clean cut wounds made by the surgeon's knife, unhealthy action was sometimes set up, followed by sloughing, which, in a few instances, became extensive Many of the surgeons referred this to the presence of what they called a "sirocco," a remarkably dry wind from the southeast, which probably attains its peculiar dryness in a similar manner to the Sirocco of Malta, or the L'Este of Madeira, by passing over sand deserts. This occasionally prevailed, and during its continuance, some assert that a great tendency to this unhealthy action always existed. Others, again, having noticed that similar cases occurred when this wind was not blowing, refuse to receive its prevalence as an explanation of the phenomenon. The state of the sore here referred to, was usually either immediately preceded, or accompanied by slight febrile disturbance of the system, a slightly furred tongue, and a sense of malaise, with slight thirst, and some nervous irritability, and a disordered state of the bowels, generally costive, but sometimes diarrhœal. The granulating surface lost its florid, healthy look, and became pale; the pus secreted, was thin, and often had a slightly fœtid odour; the granulations became absorbed, and the wound then looked very considerably larger than before. In a wound thus affected, any ragged portion of tissue frequently died, and became converted into a slough, apparently without previous inflammation, and the wound slowly extended as if by ulcerative absorption. It very rarely led to a fatal termination, and rarely induced secondary hæmorrhage. The application of strong acids was very seldom required to check the progress of the disease. Washing the wound with a strong lotion of Burnett's liquid, or of the solution of chlorinated soda, and the application of charcoal poultices were the topical means usually resorted to, with the exhibition of a mild saline purgative, if constipation existed, or a dose or two of hydrargyrum c. creta, with some rhubarb or castor oil, and perhaps an opiate, if diarrhœa were present. The exhibition of chlorate of potash, in doses from five to ten grains, three times a day, was thought by some to have a beneficial influence, but this was considered doubtful by others. Those who attributed it to the wind already alluded to, thought the diseased action subsided shortly after its cause, but in most cases it disappeared in from seven to ten days under any mode of treatment, and indeed no mode appeared to have any special influence upon its continuance. In the healing of large shell lacerations (in which this affection usually appeared) a recurrence of it often took place two or three times during the cure. It appeared to be certainly neither contagious nor infectious, although, as a matter of precaution, wounds in this state were segregated; and although at first it was looked upon with some dread, it was soon found to be of little consequence in the generality of cases, and where ventilation and cleanliness were attended to, beyond retarding the cure. It thus appeared at the Castle hospital, and in most of the regimental hospitals; but a somewhat more intense form of this same disease appeared after the 8th September, in the general hospital in the camp, and in a few of the regimental hospitals; and a few cases occurred where, by this process, bones were bared to some extent, and became necrosed in consequence, and occasionally, but still more rarely, vessels of some magnitude gave way, causing secondary hæmorrhage.

Except this form of sloughing ulceration, nothing at all resembling hospital gangrene was at any time seen among the wounded in the Crimea. The nearest approach to it was in a case detailed among wounds of the scalp (*Hartwright*, p. 287); but even this was more probably of the nature above described. In the spring months of 1855, a bad form of phagedænic sloughing occurred in the 79th Regiment, which, at the same time, was suffering from typhus fever, maculated and contagious. Here the phagedæna also appeared to be contagious, and had many wounded existed at the time in the regiment they would have fared but badly. They were, however, few in number, and consequently in only one case of gunshot wound did the disease prove fatal. It attacked every variety of wound indiscriminately, from a cut finger to an open bubo, and several deaths were due to its agency. Strong nitric acid appeared to check the disease, but repeated applications were often required. The surgeon attributed both it and the fever in great measure to the locality in which the corps was encamped, which was a clay soil full of springs, and which did not admit of being thoroughly drained; but strategic reasons forbade the removal of the regiment."]

HOSPITAL GANGRENE IN CIVIL PRACTICE.

[The following account of hospital gangrene, as it appeared in University College Hospital, in the year 1841, is given by Mr. Liston, in a lecture. (*Lancet*, 1845, vol. i. p. 57.) The case he mentions followed the removal of some metacarpal bones and fingers. "All at once the stump, which had been healing kindly, assumed a carious appearance. It became enormously swollen within a few hours, and profuse hæmorrhage took place, which there was considerable difficulty in stopping. This might have been, and was sure enough by some who saw it, taken for malignant disease; but it was exactly like what I had seen before in unhealthy seasons, and in badly-regulated hospitals. The season was a very severe one; there had been a great snow-storm, with very cold weather of long duration. Not many days passed over before a number of wounds assumed the same appearance. The parts got puffy round about them, the discharge became slimy and tenacious, very putrid, and bloody fœtid gas filled the cellular tissue around them. They extended rapidly, presenting a circular form. Many patients lost a considerable quantity of blood; in fact, we were visited by a rather rare disease, hospital gangrene, one which I trust I may never see again. Luckily, out of a great many patients that were so attacked, and in all parts of the hospital almost simultaneously, not one perished. Many of the wounds and ulcers were frightfully extended, but they speedily got clean, and healed soon after very kindly. . . . After the separation of the sloughs, a circular, clean, granulating surface was left. We were at a loss to account for this invasion. There was nothing as regarded the hospital, its ventilation, or drainage, or management, the dressing of sores, &c. that could be blamed. The disease came upon us suddenly, and as suddenly disappeared; and I need not tell you that we have seen nothing of the kind since."

Mr. South, in his notes to his translation of *Chelius's System of Surgery*, says: "My friend Arnott informs me that in January, 1835, in one of the female wards of Middlesex Hospital, three cases occurred, which might be classed under the head of hospital gangrene, of which the following is a short account: —

"Case I. — The disease attacked a common ulcer of the leg. The surface became black and pulpy, with a broad, very red margin of integument, a raised edge, and great pain. From the size of half-a-crown, the disease extended, and occupied, ere it was stopped, a space of a large wash-hand saucer, exposing the muscles and bone. It was arrested by the application of pure nitric acid, and the removal of the patient into another ward.

"Case II.—The disease appeared on an ulcer by the side of the anus, presented the same character, but was arrested by balsam of Peru, locally, and a grain of opium every six hours internally. The disease recurred, and the patient was removed from the hospital.

"Case III.—A punctured wound of the chest did not heal, but that of the integument enlarged by the conversion of the tissue into a greyish pulpy substance (not black, and without the fiery margin and intense pain of the other cases), more like phagedæna. It was stopped by balsam of Peru. 'I have never seen,' he says, 'a similar case in the Middlesex Hospital before or since.'

"I have mentioned the above cases of hospital gangrene because they are, as far as I can ascertain, the only instances of the disease which have been seen in either of the London hospitals for many years. Cases occurred many years since in the old Westminster Hospital, and also in the York Hospital at Chelsea, which latter being a military establishment, the disease was believed to have been brought home by the sick and wounded soldiers from abroad. With these exceptions, I have the best grounds for stating that in no other hospital in London has it existed in the memory of either of the present surgeons; so that it is a disease entirely unknown to them, excepting to the few who have seen it elsewhere.

"The only cases that I have seen," continues Mr. South, "with the slightest resemblance to hospital gangrene, were the sloughy stumps now and then occurring, perhaps more frequently during those years, formerly, when our wards were much troubled with erysipelas. The operation would either seem to be going on favourably for two or three days, the patient comfortable, and adhesion in progress, when a sudden change would set in, the stump become painful, swollen, hard, and red, the ununited part become sloughy, and the united part falling asunder, and soon also becoming sloughy; or, the stump never making any attempt at union, but soon becoming painful, swollen, and sloughy. In either case, the patient himself hot, dry, flushed, with brown tongue, and foul alvine discharges, the pulse quick, irritable, delirium and death supervening. I said such cases occurred, perhaps, more frequently when erysipelas was rife; but they really do happen when no erysipelas is in the ward at the time, nor has been for some months, and they occur not unfrequently in primary amputations in stout persons who have been accustomed to large quantities of beer and spirits, or of both, and from which they are not unfrequently entirely at once (and, as I consider, improperly) debarred; and hence, with a greater call than usual upon the powers of the constitution, are left to meet it with diminished means. Such cases are to be considered merely as resulting from want of power; but they are never epidemic or contagious, and must not be confounded with hospital gangrene, which, however frequent it may be elsewhere, is, in London, at the present time, and has been for many years, unknown by personal experience to most hospital surgeons."]

TREATMENT.

With the view of preventing the disorder, the wards in which the wounded are placed should not be crowded; they ought to be freely ventilated, and, if possible, not communicate. The utmost attention to cleanliness should be paid, and all filth and stagnant water removed. It has been asserted, but with what accuracy I cannot determine, that the predisposition of the wounded to this species of gangrene may be lessened by a well-chosen diet, by drinks acidulated with vegetable acids, or with sulphuric acid, and by the moderate use of wine. The state of the stomach and bowels should be particularly attended to, and, if out of order, emetics and purgatives ought to be immediately employed, and repeated according to circumstances. The dressings should be applied with extreme attention to cleanliness, and too much care cannot be taken to prevent the infectious matter of one wound from coming into contact with another through the medium of sponges (see *Welbank* in *Med. Chir. Trans.* vol. xi. p. 365), instruments, &c. "Whatever may be the source of the disease (says a late writer), it is at least sufficiently ascertained, that when it occurs, its propagation is only to be prevented by the most rigid attention to cleanliness, and by insulating the person or persons affected, so as to prevent all direct intercourse between them and the other patients; for, so far as I have had an opportunity of observing, ninety-nine cases in the hundred were evidently produced by a direct application of the morbid matter to the wounds, dressings, &c.; while others, who were in every other respect equally exposed to its operation, never caught the disease. In attempting to prove this by experiment, I have placed three patients with clean wounds alternately between three other patients, severely affected with the disease. They lay in a part of a ward which was appropriated for patients who were labouring under the disease, and of whom there were at the time a considerable number. Their beds were on the floor, and not more than two feet distant from each other; but all direct intercourse was forbidden, and they were made fully aware of the consequences that would follow from inattention to their instructions. The result of this trial was, that not one of the clean wounds assumed the morbid action peculiar to the disease, nor was the curative process in any degree impeded." (*Blackadder, On Phagedæna Gangrænosa*, p. 46.)

As many experienced writers assert that the disease may also be communicated from one person to another through the medium of effluvia in the air, I am firmly persuaded that, in the present state of our knowledge of the subject, the cautions respecting ventilation and cleanliness (the chief practical deduction from the latter doctrine) are highly necessary and important. This sentiment may be adopted without implicit faith being placed in the opinion that the disorder can actually be transmitted from one person to another through contagion in the air, because, whether the last idea be true or not, attention to cleanliness and ventilation must be beneficial to the health, in this, as in every other species of gangrene; and, on this principle, it must be serviceable in diminishing the severity, if not the frequency and extent of the disease, as I am myself disposed to believe from the consideration of all the evidence adduced. These observations are strengthened by the fact, that it was chiefly in the foul wards of St. Bartholomew's Hospital that the disorder committed its ravages in that institution. (See *Med. Chir. Trans.* vol. xi. p. 365.) Where circumstances will permit, an entire removal of the patients from the place in which the disease has either had its first formation, or spread to any extent, appears likewise to be a most beneficial measure. But when this change of the wards or hospital is impracticable, the air which the patients breathe should be purified, by renewing it as much as possible, fixing ventilators, and especially by using the oxygenated muriatic acid fumigations, as recommended by Guyton-Morveau, or else those of the nitric acid.

The nitric acid chlorine fumigations are made by putting into a glass vessel, on the ground, half an ounce of concentrated sulphuric acid, to which an equal quantity of nitre is to be added *gradatim*. The mixture is to be stirred with a glass tube, when an abundance of white vapour will be produced.

The oxygenated muriatic acid (chlorine) fumigations are made by mixing three ounces two drachms of common salt with five drachms of the black oxide of manganese in powder. These two ingredients are to be triturated together; they are then to be put into a glass vessel; one ounce two drachms of water are to be added, and then, if the ward or chamber be uninhabited, one ounce seven drachms of sulphuric acid are to be poured upon the mixture all at once; or gradually if the patients are there. This quantity will be sufficient for a very large ward.

With regard to internal medicines, while irritation and febrile heat accompany hospital gangrene, diluent acid drinks are proper, such as nitrated whey sweetened with syrup of violets, lemonade, &c.

How different these sentiments are from those of Dr. Hennen who, in speaking of the effects of venesection, when the disorder was accompanied with an inflammatory diathesis, employs the following expressions: "The very patients themselves implored the use of the lancet." For several months "we used no other remedy, either as a cure or preventive."—"We never observed any of the lancet-wounds assume a gangrenous appearance, although previously, in almost every other instance, the slightest puncture festered." (*On Military Surgery*, p. 224, ed. 2.)

In the beginning of the constitutional attack, Pouteau and Dussassoy particularly recommended emetics; and Mr. Briggs, Dr. J. Thomson, and Dr. Hennen, are all advocates for this practice, though the latter gentleman makes his evidence rather ambiguous, by a subjoined note, in which he mentions that want of success, &c. led to the trial of venesection. (Op. cit. 222.) As for Mr. Blackadder, he deems the employment of emetics at the commencement of hospital gangrene useful only when the stomach is foul. (*On Phagedæna Gangrænosa*, p. 134.) Dr. Boggio found emetics generally very inferior to purgatives. (*Edinb. Med. Chir. Trans.* vol. iii. p. 37.) He chiefly approves of them when the stomach is loaded, and the fever of a bilious character. In the early stage of the case, writers seem all to agree about the utility of purgative and laxative medicines. When there is debility, good generous wine should be allowed, either by itself, or mixed with lemonade, according to circumstances. Bark is in general more hurtful than useful: Mr. Welbank objects to it generally on account of the common disposition to diarrhœa in the advanced stages of the disease (*Med. Chir. Trans.* vol. xi. p. 368); and Dr. Hennen assures us that he has seen great harm done by large and injudicious doses of this drug, before full evacuations had taken place, and the sloughs begun to separate. Boyer allows, however, that it may be beneficially given, when the feverish heat has abated, and the debility is very great.

In all stages of this disease, unattended with diarrhœa, acids are proper. The sulphuric acid is that which is given with most success; but the acidulous tartrate of potassa is also an excellent medicine. From two drachms to half an ounce may be given every day, and the best plan is to make an acid drink with it, which should be sweetened and strained.

In severe cases, attended with a quick and feeble pulse, depression, restlessness, and anxiety, an opiate becomes necessary. "So long as we wish to excite a degree of moisture on the skin (says Professor Thomson), Dover's powder, or laudanum with antimonial wine, form in general the best opiates." This gentleman, however, is not an advocate for the employment of opium, in the early stage of hospital gangrene, while the heat and other febrile symptoms are at their height. (See *Lectures on Inflammation*, p. 494, 495.) According to Mr. Welbank's experience, narcotics are beneficial, and he has seen a most irritable state of the stomach improve rapidly, and a foul furred tongue become clean, on the administration of large doses of opium at regular intervals. (See *Med. Chir. Trans.* vol. xi. p. 368.) Camphor, in large and frequent doses, was highly praised by Pouteau.

"I was told by several of the French surgeons (says a late visitor to Paris), that they did not rely at all on internal means for stopping the progress of hospital gangrene, and that their experience had proved them to be insufficient, if not wholly inefficacious. Dupuytren, in reply to the account I gave him of the practice and opinions of English surgeons on this subject, assured me that he had no confidence in any but local applications, and that internal remedies alone, as far as he had found, did almost nothing." The same remark has been made in a modern publication on hospital gangrene (*Delpech, Mém. sur la Complication des Plaies, &c.* 1815), "although it seems to be rather at variance with its being a constitutional and contagious disease, which the author has admitted." (See *Sketches of the Medical Schools of Paris, by J. G. Crosse*, p. 83.)

Perhaps every antiseptic application that can be mentioned, has been tried as a dressing for wounds or ulcers affected with hospital gangrene.

Dussassoy was convinced, by the observation of numerous cases, that the best application is powder of bark. He recommends the wound to be covered with several layers of this powder, which are then to be moistened with turpentine. When this composition dries, he asserts that it forms a fragile sort of coat, at the sides of which, and through which, the discharge escapes. After twenty-four hours the first coat is to be removed, and a fresh one applied. In general, according to this writer, four or five such dressings are sufficient in simple cases, where the disorder is confined to the skin and cellular substance. Healthy inflammation then occurs, the sloughs come away, and the wound puts on a healing appearance. In bad cases, Dussassoy sometimes added one-fifth of powdered muriate of ammonia to the bark. When this treatment failed, the actual cautery was used.

On the subject of bark as a local application to hospital gangrene, I need only remark, that it is now entirely relinquished, either as possessing no efficacy (*Delpech*), or even aggravating the symptoms (*Blackadder*).

The milder forms of the disease appear sometimes to have yielded to the application of the vegetable and diluted mineral acids; viz. lime-juice, lemon-juice, vinegar; and the diluted nitric and muriatic acids. And the same observation may be made with respect to solutions of the nitrates of silver and mercury. The two latter substances, and the oxygenated muriatic acid, and gas, were found by Dr. Rollo to be capable of effecting cures. Delpech, in particular, speaks of the benefit derived from the application of strong vinegar, after all the pulpy viscid matter has been carefully wiped away from the surface of the living flesh. The vinegar is then poured on the ulcer, which is to be covered with charpie wet with the same liquid. When the case is too far advanced for this treatment to answer, Delpech tries caustics, especially the nitrate of silver; and, if these fail, he has recourse to the actual cautery; and when the sloughs are very thick, so as to hinder the cautery from acting to a sufficient depth, he prefers thrusting into the sloughs, down to the living flesh, angular pieces of caustic potash at small distances from each other! (*Précis Elém. des Mal. Chir.* t. i. p. 151.) Surely this must be far more torturing, and less certain of success, than removing the sloughs, and applying the cautery.

Though the actual cautery is generally admitted to be one of the most powerful means of stopping the progress of hospital gangrene, the surgeons of this country entertain a strong aversion to the practice; and I confess that my own dislike to it is such as would always lead me to prefer any other treatment from which equal efficacy would result. At the same time it must be granted, that if the actual cautery will more certainly arrest some forms of hospital gangrene than any other known applications, the surgeon's duty is to put out of the question his own prejudices against it, and consider only his patient's welfare. I am far from thinking, however, that while there are such powerful caustics as the undiluted mineral acids, and a dressing so effectual as a solution of arsenic, it can often be absolutely necessary to employ red-hot irons.

The merit of having pointed out in modern times the great efficacy of Fowler's solution of arsenic, or liquor arsenicalis, as an application to phagedæna gangrænosa, belongs to Mr. Blackadder. In answer to the objection that the external use of arsenic is not unattended with danger, he assures us that he has heard but of one instance of hospital gangrene in which any deleterious effects were supposed to arise from the absorption of the arsenic; and the patient in question was very soon cured of his uneasy, and possibly merely nervous symptoms (p. 50).

"The first thing to be attended to in every case of disease (says Mr. Blackadder) is *cleanliness*, which, if always of great importance, is, in this instance, indispensable. The surface of the body ought to be made and kept perfectly clean by means of the tepid bath, or otherwise by a plentiful use of soap; and the linen and bed-clothes should be frequently changed, particularly when soiled with matter from the sore." In order to make the sore perfectly clean, and free it from the viscous discharge, without producing considerable bleeding and pain, Mr. Blackadder recommends two large tin hospital teapots to be filled with a weak solution of the subcarbonate of potass. One of these solutions is to be cold, the other tepid; because, sometimes one and sometimes the other is found most agreeable to the patient's feelings, though the warm is the most effectual in cleansing the sore. The liquid is to be poured over the sore, and received into a basin, which ought to be immediately emptied into another vessel placed at a distance from the patient. During this ablution, the glutinous matter which adheres to the sore may be gently detached, by means of small dossils of fine tow or lint; but these (says Mr. Blackadder) should never be used for two different patients, rigid economy, on occasions such as this, being a very mistaken principle. In these cases, the use of sponges (he justly observes) ought to be entirely laid aside, as they can seldom be used more than once with safety. When the sore has been thus cleaned, a piece of fine dry lint is to be spread over its surface, and gently pressed into all its depressions with the points of the fingers. When the lint is removed, a quantity of the discharge will be found adhering to it; and this operation must be repeated with fresh pieces of lint until the surface of the sore is made perfectly clean and dry.

According to Mr. Blackadder, the solution of arsenic will generally be found strong enough, when diluted with an equal part of water; but in slight cases it answered when weakened with twice its quantity of water; and, in a few examples, it was employed without being at all diluted. Several pieces of lint of the same shape as the sore, but a little larger, are to be prepared; one of these, soaked in the solution, is now to be applied to the cleaned surface of the sore, and renewed every fifteen or thirty minutes, according to the time in which it becomes dry. When the heat and inflammation are considerable, great relief will be derived from the frequent application of linen cloths, moistened with cold water, which must be kept from weakening the arsenical solution, by means of a small piece of oil-skin laid over the pieces of lint. When the disease extends into the track of a gunshot wound, Mr. Blackadder uses a syringe for cleaning the sore and introducing the solution. "A slip of fine lint, well soaked in the solution, may also be inserted by means of a probe, into the bottom of the wound; and when the openings are at no great distance (from each other), and not in the immediate vicinity of the large nerves and blood-vessels, the lint may be drawn through the wound in the form of a seton" (p. 53). When the pain caused by the application is very severe, and the constitution is irritable and debilitated, Mr. Blackadder prescribes an opiate, though he remarks that this practice will seldom be absolutely necessary. The morbid action in the sore is destroyed by the arsenical solution sooner or later, in different cases: *the best plan is to continue the application until an insensible, dark-coloured, dry slough occupies the whole surface of the sore, and until the patient is completely relieved from the burning and lancinating pain.*

After the slough is formed, Mr. Blackadder employs an ointment, composed of equal parts of the oil of turpentine and the yellow resinous ointment, or of two parts of venice turpentine to one of the resinous ointment. " These being melted and mixed together, are to be poured over the sore as hot as the patient can possibly bear." A pledget of dry lint, or tow, and a bandage are then applied; and this dressing may be renewed two or three times a day, the sore being each time carefully washed with the solution of potass. As soon as any part of the slough is loosened, Mr. Blackadder removes it with a pair of curved scissors. With the view of expediting the separation of the slough, he sometimes employed a linseed-meal poultice, which had the desired effect, but was found to be too relaxing. When it is used, therefore, Mr. Blackadder found it expedient, at each dressing, to touch the new granulations with the nitrate of silver.

After the detachment of the slough, Mr. Blackadder dresses the sore with the above-mentioned ointment cold, or with the addition of a small proportion of the subacetate of copper. The pledget of this ointment is covered with a piece of oil-skin, lightly rubbed over with soap, and a firm bandage is applied to the whole limb. (See *Obs. on Phagedæna Gangrænosa*, p. 49, &c. 8vo. Edinb. 1818.) The author declares that, after the introduction of the above treatment (with the exception of stumps attacked with hospital gangrene), he never saw an instance in which the remedy failed when applied in time and in a proper manner ; " that is, before the disease had made such progress as to preclude all rational hope of success from that, or any other mode of treatment " (p. 23).

In Dr. Rollo's *Treatise on Diabetes*, published in 1797, the opinion is plainly stated that the progress of hospital gangrene might be stopped by very active topical applications, and, in the same work, Mr. Cruikshank says that, " if an actual caustic were to be employed, we should have recourse to the strong nitrous acid." According to Mr. Blackadder, the oxygenated muriate of mercury and the nitrous acid were much recommended and employed by surgeons in the 16th and 17th centuries, as escharotics, in cases of gangrene and foul ulcers (p. 113). Several army-surgeons have informed me that the undiluted nitrous acid was successfully used as an application to hospital gangrene in the military hospitals at Antwerp, in the year 1815 ; but that other strong acids had an equally good effect. Dr. J. Thomson also notices that " the application of caustic substances, such as the strong mineral acids, the solutions of potass, corrosive sublimate and arsenic, seemed at Antwerp to arrest the progress of this sore, without exciting inflammation." (*Report of Obs. made in the Military Hospitals in Belgium.*)

In St. Bartholomew's Hospital the undiluted nitric acid has been used with great success as a local application to phagedænic gangrenous ulcers. " If the disease be not far advanced (says Mr. Welbank), I at once apply the undiluted acid, after cleansing the surface with tepid water, and absorbing the moisture with lint. Where, however, there is a thick and pulpy slough, it is better to remove as much of it as possible, with forceps and scissors, before the application is made. The surrounding parts being then protected by a thick coating of lard, or cerate, I proceed to press steadily, and for some minutes, a thick pledget of lint, previously immersed in the undiluted acid, on every point of the diseased surface, till it appears converted into a firm and dry mass. The parts may be then covered with simple dressings, and evaporation kept up by cooling lotions. As the application occasions more or less pain, from half an hour to one or two hours, I have generally given twenty or thirty drops of laudanum at the time of using it. It is always prudent, often necessary, to remove the eschar at the end of sixteen or twenty hours." When the patients have become perfectly free from pain, and the parts below the slough are found healthy and florid, Mr. Welbank treats the sore as a common wound or ulcer, though he has found stimulating dressings generally the best, as the ceratum lapidis calaminaris, or a solution of two or three grains of the nitrate of silver in an ounce of distilled water. But when there is a recurrence of pain at any point, or over the general surface of the sore, whether the affection be slight or severe, the slough superficial or deep, he recommends the employment of the undiluted acid again. (See *Med. Chir. Trans.* vol. xi. p. 369.)

[Welbank, however, used a remedy which Guthrie had used ten years earlier : on this point we have the evidence of Delpech, who was informed by some British surgeons belonging to the Anglo-Portuguese army, that the muriatic acid was in common use in the hospitals of that army as a local application for checking the ravages of hospital gangrene, being employed in a diluted state for slight cases, and in a concentrated caustic form for others.]

Pouteau, Dussassoy, Boyer, and Delpech, all bear testimony to the efficacy of the actual cautery, and they repeat the application of it, until the whole surface of the ulcer is converted into a firm hard eschar. Even the edges of the solution of continuity should not be spared — " *Ils doivent être torréfiés et rôtis pour ainsi dire.*" (*Boyer, Maladies Chir.* t. i. p. 332.) The latter surgeon then covers the eschar with a thick stratum of bark, moistened with turpentine. This application is to be removed in twenty-four, thirty-six, or forty-eight hours, and the surgeon is then to judge from the appearance of the flesh, and the quality of the discharge whether a further repetition of the cautery will be necessary.

About three years ago, I attended at Halliford a child that had been extensively burnt : and when the parts were nearly healed the sore was attacked with hospital gangrene, the ravages of which soon proved fatal. The cottage in which this case happened was noted for its crowded and uncleanly state. The chloride of soda was tried in vain.

[Velpeau, in his clinical lectures, *On the Wounded of the Revolution of* 1848 (*Lancet*, 1848, vol. ii. p. 172), speaks decidedly of the local and contagious nature of the disease; and recommends the vegetable acids as local applications: such as two and a half drachms of citric acid dissolved in an ounce of water, and applied by means of compresses.

M. Aubry recommends dressings with watery infusion of opium; washing the wound with vinegar, and forcibly detaching all filmy ash-coloured exudation; then covering it with powdered bark or charcoal containing powdered camphor, or powdered camphor only, or lotions of the oxygenated muriatic acid, with which the wound should not only be washed, but the pledgets be saturated.

He saw the disease at Prague, where he was prisoner of war in 1814, at Rome in 1812; and when in charge of sick, proceeding by sea from Spalatro to Zara in 1807, it affected ten wounded persons on board after fourteen days; all had embarked without a trace of it. In one case, in which a surgeon at Prague wounded himself with an infected bistoury, four days elapsed before the wound was infected.

The American surgeons in the Russian service, at the time of the siege of Sebastopol, found creosote to be a most useful application; as efficacious as nitric acid, and not so painful. (*American Journ. Med. Sc.* April, 1860, p. 570.)

In conclusion, the reader is referred to the article Erysipelas, which is a cognate disease, and the remarks on the origin, nature, prevention, and treatment of which, may be applied *mutatis mutandis*, to hospital gangrene. Here let us say, in three words, that the origin of the disease always points out defects in ventilation, cleanliness, and management, which must be removed at once; that the destruction and deodorisation of the diseased surface must be effected by one or more of the numerous list of chemical substances,—cautery, mineral acids, or creosote, besides the liquids of Condy and Burnett; and that bark and nitric acid, tincture of steel, wine, opium, and nourishment appear the best general remedies, with the addition of aperients, if symptoms require their use.]

R. Druitt.

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See also, the other works quoted in the course of this Article.

For the rest of the subject of gangrene, see Mortification.

[HYDATIDS.—True hydatids are animal parasites in the form of cysts, which may be developed in most of the tissues and organs of the body. They sometimes attain a large size and form cystic tumors, which may by their bulk be destructive to the organs or tissues in which they are lodged, and even to the life of the individual subject to them. The mode of origin of cystic parasites was long the subject of speculation, but the recent researches of Küchenmeister, Von Siebold, and others, have cleared up the mystery, and have demonstrated beyond all doubt, that they constitute stages in the development of tæniæ or tapeworms, which infest the intestinal canal of man and animals.

"The history of these entozoa," says Dr. Lankester, "involves some of the most interesting questions relative to the generation and reproduction of organic beings. Although it was easy to account for the presence of worms in the stomach and intestines by the ready explanation of the swallowing of the eggs, a difficulty always presented itself in the case of those creatures called hydatids, which evidently had an independent animal existence. They exhibited no sexes, they produced no eggs, and the readiest theory was that of spontaneous or equivocal generation. Even as this theory was successively driven from every other part of the animal and vegetable kingdom, it found a refuge amongst the strange and paradoxical creatures imbedded in the tissues of man and other animals, far removed from any external influences. The time has however at length arrived, when it can be demonstrated, that the cystic worm is the offspring of the tape-worm, undergoing one stage of its growth, through which it must pass before it can attain to the more dignified development of its parent. From this point of view we may compare the cystic worm to the caterpillar, or chrysalis, stage in the development of the insect. It differs, however, in this, that in many cases the cystic worm has the power of developing at this stage of its growth, a large number of creatures resembling itself, and these have each of them the power of developing themselves into tape-worms, as though the caterpillar had the power of producing in its interior any number of young caterpillars, each of which would grow into a perfect butterfly.

"Here the history of these entozoa becomes interesting from another point of view. They are illustrations of Steenstrup's theory of the 'Alternation of Generations.' The cystic worm,—let it be an echinococcus—has originated from the eggs of a tape-worm, the embryo of which has found its way from the stomach and intestines through their walls into the tissues of the body. This worm consists of a vesicle or bag, to which is attached a head, called the 'scolex.' In the cysticercus, the hydatid of the pig, there is but one scolex, but in the echinococcus there are many scolices. This scolex or scolex-head, as it is sometimes called, is the stock or germ,—the head—from which all the segments of a tape-worm proceed. The cyst of the echinococcus has the power of producing a large number of these heads, each of which may grow into a tape-worm. The cyst, the original cyst of the worm, is, in the language of Steenstrup, 'a nurse.' Küchenmeister and the Germans call it a mother cyst. But this cyst will not only produce scolex-heads, but other cysts like itself. These are 'daughter cysts,' and these secondary cysts will also produce scolex-heads. They are also 'nurses;' and in virtue of their existence the mother cyst becomes, in the language of Steenstrup, a 'parent nurse.' The second cyst may contain, as it frequently does in the *Echinococcus altricipariens* of Küchenmeister, a third cyst, a 'grand-daughter cyst,' which is also a nurse, and thus on. Another curious point about all these creatures is that they are sexless. Neither cyst nor scolex-head has any sex. Nor do they acquire sexuality as long as they remain in the flesh in the hydatid condition. It is to this condition of the worm that Professor Huxley proposes to apply the term 'Agamozooid.' The objection to this term is that it is equally applicable to all sexless forms of reproduction amongst animals as to those to which Steenstrup has applied the term 'nurses.'

"In order to acquire the conditions necessary to the development of sexual organs, the cystic or asexual form of the worm must be swallowed and *digested* by another animal. The scolex-head then becomes in its turn truly a 'nurse,' and this of a most prolific kind, for the cyst below being displaced, the numerous segments ('proglottides' as they have been called) begin to make their appearance. The conditions are now such that sexes appear; each segment is merely a capsule containing a male and female generative apparatus, and nothing else. Eggs, the result of the union of sperm cells and germ cells, are now produced in myriads. These pass into the external world, and being swallowed and digested, set free the embryos, which again become cystic worms as above described." (See *Dr. Lankester's Preface to his translation of Küchenmeister's Manual of the Animal and Vegetable Parasites of the human body.* Sydenham Society, 1857.)

We shall here subjoin a brief account of the most common varieties of the cystic worms which infest the human subject. They may be divided into two classes; the *cysticerci* and the *Echinococci*. The term *acephalocysts* has been applied to echinococcus cysts which remain barren and do not develop scolices, or worm-heads, in their interior.

CYSTICERCI.

1. *Cysticercus cellulosæ.*—The cysticercus cellulosæ is the cystic form of the tænia solium, or common tape-worm of the human subject. The pig is the animal in which this worm, in its cystic stage, is most frequently found, and its ordinary seat is in the cellular tissue and muscles, which it often infests in large numbers: pork so diseased is commonly known as "measly." It is not, however, exclusively in the pig that this cysticercus has its habitation; it is met with occasionally in other domestic animals, and the corresponding tissues in the human subject are also suited for its development, if the opportunity be afforded to it by the introduction of its ova into the stomach.

Under ordinary circumstances, it is by eating raw or partially dressed pork containing cysticerci that the tape-worm is introduced into the human intestines; and it is by swallowing the eggs of the tape-worm, or the segments containing eggs which have been passed with the fæces from the human intestine, that the cysticerci reach the tissues of the pig. Thus, by a repetition of this transference from the one to the other, the breed of these parasites is kept up. "The tænia solium," says Küchenmeister, "is very abundant wherever the breeding of pigs flourishes, as in Poland, Hungary, England, Pomerania, and Thuringia; and especially amongst those engaged in trades which bring them in contact with raw pork, and therefore with raw cysticerci, as butchers, cooks, eating-house keepers, &c. On the other hand, the tænia solium is almost entirely unknown where the use of this flesh is avoided, as among Jews or Mahomedans, or where these animals are almost entirely absent, as in Iceland."

A brief account of the mode in which this worm is developed will serve as a type for the whole class. When the ovum is received into the stomach of another animal, its envelope or shell is dissolved by the action of the gastric juice, and the embryo is set free. The embryo is provided with an apparatus consisting of six minute hooks or spines, adapted for boring through the tissues. By means of these it makes its way through the walls of the stomach, either into the peritoneal cavity, or into a blood-vessel; in the latter case, it may be carried passively with the current of the circulation to distant parts of the body. Then, becoming arrested in the finer ramifications of the blood-vessels, it may either burst through their walls, or may again actively penetrate the tissues, and if these are suitable for it, its growth and development will proceed. If, on the other hand, these embryos get into animals which are not suitable, or into such organs in an animal, otherwise suitable, as are not adapted for the particular species of worm, they are destroyed in a short time, usually in a very few days after their immigration. Under these circumstances, Küchenmeister thinks that a confusion of them with miliary tuberculose disease of the organ is not only possible, but may frequently have occurred. (Op. cit. p. 74.)

Having reached an appropriate destination, the worm, which at this stage consists of a minute vesicle, gradually increases in size, and becomes *strengthened* on its exterior by fibrinous deposition (*envelope cyst*), while in its interior the scolex is gradually formed. At one point in the vesicle, its innermost lining membrane is inflected towards its centre, and at the bottom of this tubular inflection are produced the four sucking discs and the double circlet of hooks which characterise the head of the mature tape-worm, with which the scolex is identical in every respect. A considerable period—some weeks—is required before this stage is reached, and when it is completed, the scolex remains in the same condition for an indeterminate period in the interior of the vesicle, and is nourished by the fluid which the vesicle secretes. Ultimately, however, it dies, and the cyst collapses; but the earthy materials entering into its composition usually remain permanently imbedded in the tissue. If the vesicle containing the mature scolex is swallowed by another animal, the vesicle is digested and dissolved, and the scolex (which appears in consequence of its vitality to have the power of resisting the solvent influence of the gastric secretion) becomes freed. It now protrudes its circlet of hooks, and by means of these and of its sucking discs, attaches itself firmly to some point of the intestinal walls. The generative segments of the mature tape-worm now begin to be formed from the opposite end of the scolex, and those which are first produced are gradually removed further and further from the head by the growth of new ones. When the segments have reached maturity, they are thrown off, either singly or in clusters, and make their escape, loaded with eggs, into the external world.

Generally speaking, the cystic worms occur in animals which serve as the prey of those which are capable of developing the cystic worm into a tape-worm in their intestines. Thus the cystic worm of the mouse (*cysticercus fasciolaris*) becomes the tape-worm (*tænia crassicollis*) of the cat; and many similar examples might be adduced. The same relation prevails between the hydatid (*cœnurus cerebralis*) which occurs in the brain of the sheep, and causes the disease known as the "staggers," and the tape-worm (*tænia cœnuri*) of the sheep-dog.

Sometimes, however, the *same* animal is capable of developing the worm in *both* its stages. This is the case in man with regard to the tænia solium and the cysticercus cellulosæ. In man, however, the cystic form of this worm is rare, and may be considered exceptional in its occurrence, while the mature tænia is sufficiently common. Individuals in whom cysticerci have been found, have not unfrequently been previously the subjects of tænia, from the eggs of which it is probable they may have infected themselves with cysticerci. "There are various ways," says Küchenmeister, "in which this may take place. The individual, when the mature segments (proglottides) have fallen into his clothes, may remove them with his fingers, and may thus contaminate the latter with eggs, after which, if he does not wash his hands perfectly clean, or neglects to wash them altogether, and then incautiously puts them to his mouth, his infection with the eggs, and consequently with cysticerci, is rendered possible. But a person infested with tænia may also infect himself with cysticerci without the previous escape of the proglottides from his intestine, if the proglottis, instead of passing downwards, proceeds upwards and reaches the stomach, or if it is carried there forcibly during vomiting." (Op. cit. vol. i. p. 44.) It appears essential, however, that the eggs should in some way reach the stomach, and be acted upon by the gastric juices, otherwise the egg-shells remain entire, and the embryos do not escape.

The cysticercus cellulosæ has been found in man in the cellular tissue, and in various muscles, especially in the muscular fibres of the heart, in the eye, and in the brain. It acquires various forms and sizes, according to the space afforded for its development, and the softness or yielding nature of the tissues in which it is placed. In the muscles its average size is about that of a pin's head; but in the ventricles of the brain, or in the eye, it may attain even the size of a walnut, and may assume the most various forms. The increase in size depends entirely upon the enlargement of the vesicle, and not of the scolex; and whatever the size of the vesicle, there is never in this variety of worm more than one scolex in its interior.

The symptoms produced by the cysticercus cellulosæ vary according to its seat; it is quite harmless in the subcutaneous cellular tissue; and in the muscles, with the exception of the muscular fibres of the heart, it causes little inconvenience or injury. When situated in the fibres of the heart, it may lead to their softening; and during the period of its retrogressive shrivelling or calcification, to abbreviation of the musculi papillares, to defects in the valves, and to the formation of diverticula and aneurisms. There are no means of discovering it when seated in the deeper muscles or in the heart. (Op. cit. p. 124.)

Cysticerci have been seen in the *anterior chamber of the eye* by several observers—Soemmering, Schott, Graefe, and others. The symptoms observed were; frequently recurring ophthalmia, sub-conjunctival injection, coating of the hinder wall of the cornea, as if with a fine exudative vapour, chronic and local iritis, and severe neuralgic pain. In the case recorded by Graefe, a round, milky, somewhat transparent vesicle, the size of a pea, made its appearance in the anterior chamber of the eye; on its lower part sat a perfectly opaque white knob, on which several lateral swellings (sucking discs) were detected, even with the naked eye, but better with a lens. Its movements were of a peculiar constrictive character, proceeding from the fundus of the vesicle, and diffusing themselves in an undulatory manner over the lateral portions. The same surgeon met with a case of cysticercus in the *posterior chamber*. This was so distinctly perceived by the patient himself that he was able to draw the shadow which the animal produced upon his retina. When situated in the aqueous humour, the vesicle may be removed by an incision through the cornea, or broken up with a needle; but the former process is preferable, as the chitinous structure of the vesicle does not disappear by absorption (p. 125).

In the vitreous humour.—Here, and in the other deeper tissues of the eye, the detection of a cysticercus has only been possible since the introduction of the ophthalmoscope. Two cases, observed by Graefe, are quoted by Küchenmeister. In the first, a membranous cylinder, of about one millim. with transparent membranous walls, was observed in the retina, near the optic nerve. It was directed forwards, so that it ran through the vitreous body nearly in the direction of the axis of vision. In this cylinder lay the cysticercus. The posterior end of the cylinder reached to the retina, but the fundus of the vesicle of the cysticercus separated distinctly a little before it. Anteriorly the longish vesicle diminished in calibre; the head was situated about in the centre of the eye, and appeared as a whitish swelling, the true relations of which were concealed by the enveloping cylinder, from which various streaky pseudo-membranous rays ran forwards and towards the lens. In front of the body just described, and on the hinder wall of the lens, lay a second body similar to a cysticercus, as to which Graefe was not perfectly clear at the time, but which might possibly have been a dead cysticercus. Graefe thought he recognised the undulatory movements of the worm, but they were not very distinctly perceived. The patient was afflicted with imperfect vision and strabismus. The other eye was sound. Tænia solium was present, but there were no cysticerci in other parts of the body. In the second case there was a movable cysticercus cellulosæ in the vitreous humour, which began to exhibit turbidity in consequence of the irritation to which the animal gave rise in it. Graefe established a coloboma in the sclerotic coat, and afterwards extracted the cysticercus with great difficulty by incision in the sclerotic. In this operation the vesicle was torn off, and the head and neck, which were seized by a serre-tête, could only be got out after several attempts. Only a portion of the cyst was removed. The suckers of the cysticercus continued to move for twenty minutes under the microscope. The visual power of the patient improved, he could read large print, &c.,

but at the time the report was made some fear of chronic choroiditis still remained.

Cysticerci in the Retina.—Four instances of this worm in the retina have been recorded by Graefe, and are quoted by Küchenmeister (loc. cit. vol. i. p. 129.) In one of these, which may serve as an example, the sensibility to light had gradually been completely extinguished in the affected eye. Examination with the ophthalmoscope showed that the lens and vitreous humour were clear, but in the middle of the retina a shining greenish body was seen, which was bordered by convex circular margins, and lay a little outwards from the centre of the retina, on the outside of the optic nerve. The rest of the retina was healthy. Examined in the reversed image, the body appeared as a perfect roundish greenish vesicle, four times larger in diameter than the entrance of the optic nerve. It was firmly attached to the retina, and projected with its anterior wall into the vitreous body, in which was perceived a white button-like projecting appendage, distinctly marked by its greater opacity and its colour, which shifted its place, although no separate parts could be perceived on the knob, and over which a pair of vessels ran forward. On this account Graefe supposed that the worm had a fine enveloping membrane. When the axis of vision was completely fixed, the walls of the vesicle exhibited flattenings or cup-like impressions in several places simultaneously, together with movements which diffused themselves in an undulating manner. In three weeks the vesicle increased about one-third in diameter and reached to the optic nerve. The head had passed from the centre to beneath the upper margin, and appeared to have grown like a small vesicle out of the previous one, that is to say, the *enveloping* cyst had probably burst, and a small vesicle protruded which sat upon the former. On the head distinct swellings, and a neck region, sometimes extended and sometimes retracted, were now seen. Ten weeks after the first observation the vesicle was not remarkably enlarged, but less greenish and more transparent. The above mentioned vessels appeared to be obliterated cords. The small appendage was nearly as large as the original vesicle, and covered the optic nerve entirely. The rest of the retina had lost its colour, and was covered with irregular blended pale spots. In five months the vesicle was completely collapsed, and instead of it a folded transparent membrane, without determinate outlines, was to be seen waving up and down, and the second vesicle also was less distinctly detected. The animal however was still alive, and its head lay towards the nose. In another similar case, Graefe thinks that the weakness of one arm, violent headaches, the glimmering, and subjective appearance of light in the other eye, might be referred to a simultaneous existence of cysticerci in the brain.

The removal of cysticerci from the retina has not, we believe, yet been attempted, but Graefe thinks, that when they are situated beneath the retina, as in one instance which came under his notice, their extraction with the aid of a speculum, might perhaps be undertaken. After a time the worm dies, fatty degeneration, calcification and shrivelling take place, and this may be accompanied by some alleviation of the symptoms; but how long a worm may live in an organism, without suffering injury, or being destroyed, are points unknown to us.

Cysticerci in the Brain.—The diagnosis of these parasites in the brain is generally impossible during life, and we can only assume their probable existence in those cases in which, simultaneously with cerebral symptoms, cysticerci occur in other and superficial parts of the body, and the presence of tænia solium, at the same time, or at an earlier period in the life of the patient, can be ascertained.

Cysticercus Tenuicollis—Cyst. visceralis.—This variety of cysticercus is derived from the tapeworm—*tænia marginata*—which inhabits the intestine of the dog and wolf. It is common in most of the domestic animals, its favourite habitations being the liver and mesentery; but it has occasionally, though very rarely, been met with in man in the same situations. It differs from the cysticercus cellulosæ in the large size of its vesicle, which may attain in animals the magnitude of a child's head, and is rendered remarkable by the concentric wrinkles or rings, visible externally, which pass round the worm, and which are crossed by very fine longitudinal striæ. For other specific distinctions in the hooks and other parts of the worm the reader is referred to Küchenmeister (vol. cit. p. 177). Küchenmeister thinks it probable that this worm may occur more frequently than has been supposed, and that some examples of it, in the liver or mesentery of man, may have been mistaken for echinococci, or acephalocysts. Sometimes he observes, when the enveloping cyst is unopened, "there is hardly any external difference to be found between echinococcus and cyst. tenuicollis, especially when the latter has its habitation in the liver." When the cyst is opened it is not so likely to be mistaken for a true echinococcus, from the number of scolices developed in the latter; but it might readily be supposed to be an acephalocyst or barren echinococcus, on account of the difficulty of discovering the single minute scolex on the walls of so large a cyst.

ECHINOCOCCI.

There are two varieties of this class of hydatids, they were usually distinguished by the names *Echin. veterinorum,* and *Echin. hominis.* These names, however, are not altogether appropriate, for it has been shown that the first mentioned variety is not exclusively confined to cattle, but may occur also in man; and in like manner that the second kind is not exclusively met with in man, but may occur also in cattle. Küchenmeister has therefore proposed to distinguish them from their mode of growth and development as Echin. Scolicipariens, and Echin. Altricipariens. The echinococci differ from the cysticerci, mainly in the fact that numerous scolices instead of a single one, and in Echin. Altricipariens, secondary cysts as well as scolices, are developed in their interior; also in the larger size which they attain, and the greater thickness of their walls, both as regards the worm cyst itself, and the fibrinous envelope which surrounds it. The structure of the true echinococcus vesicle is characterised by the following circumstances;—The walls are extraordinarily elastic, and tremble like jelly when touched, even after they are empty, which is not seen in the walls of a cysticercus. The walls never collapse entirely, as is the case with cysticerci, nor do they lie, like these after death, flat at the bottom of the envelope cyst, but even when dead, they adhere to particular spots in the envelope cyst, in which case an adhesion takes place between the latter and the worms as if by plastic exudation. The transverse section of the walls of an echinococcus distinctly shows a structure consisting of more or less numerous consecutive circular strata, varying according to age, which is merely found indicated in a very low degree in cyst. tenuicollis. (Op. cit. p. 196.)

The inner surface of the cyst, in the *Echin. scoliciparіens*, is beset with small elevations, some of which are the young scolices, in different stages of growth; while others may be the remains of the stalk or pedicle, by means of which other scolices, which have been thrown off, were formerly attached. These latter will be found in large numbers, swimming about free in the fluid of the cyst. Many of these are still furnished with the remains of the stalk by which they were attached. When examined by the microscope, they form, on the application of pressure, flattened circular discs; from the hinder third of this, towards the stalk, a circlet of hooks, arranged in a double series, shines through, and from its anterior extremity the four sucking discs appear in the same way (p. 197). This relative position of parts is caused by the retraction or inversion of the head into the neck or body of the worm. When the head is protruded, the circlet of hooks is situated anteriorly, or furthest from the stalk, and in front of the sucking discs.

In the *Echin. Altriciparіens*, scolices are formed from the inner wall of the original cyst after the mode just described, and, in addition, secondary or daughter-cysts are produced; and these secondary cysts, again, produce broods of scolices and tertiary or granddaughter-cysts, on the same plan. This process may be repeated any number of times. The daughter-cysts are at first, like the separate scolices, connected with the mother-cysts by a stalk, but they soon separate, and then float about free in the fluid of the mother-cyst. It has been observed, that when this echinococcus intrudes itself into the vacuities of tissues, or into the interior of blood-vessels or lymphatics, vesicular appendages, furnished with filiform peduncles, may be formed, which probably become separated by constriction, and form closed vesicles. These separate vesicles may proliferate again, or, what is probably more frequent, remain barren, and form acephalocysts. In this way numerous cysts in the same organ — the liver, for example — may be produced from a single embryo. The mode of generation and life here mentioned is interesting pathologically, as the appearance produced has been described by modern writers as a form of cancerous disease, under the name of alveolar colloid. Virchow thinks he has proved that the disease so called is nothing more than a number of emptied echinococcus vesicles. For a description of cases of this nature, described by Virchow, Zeller, and others, see Küchenmeister (op. cit. p. 211). The individual scolices in *Echin. Altric.* are more slender than in the other species; the head, with its double circlet of hooks, is more frequently protruded during life; the hooks are more numerous (from forty-six to fifty-four), and much more slender. The sucking discs are very distinctly marked The cysts in *Echin. Altric.* from their greater proliferant activity, attain a much greater size than those of *Echin. Scolic.* They sometimes form enormous tumors, whereas the *Echin. scolic.* seldom exceeds an orange in size. The *Echin. scolic.* or *veterinorum*, though very common in cattle, is rare in the human subject; but some few examples of it have been recorded. The solid abdominal viscera, such as the liver or spleen, are its most frequent seats; but one case has been recorded by Von Ammon in which it was found in the interior of the eye. (*Küchenmeister*, p. 198.)

The dwelling-place of the other species (*Echin. altric.*) is not so limited; indeed, there is scarcely a part of the body in which it may not be found; thus it occurs in the liver, the lungs, the kidneys, the sheath of the testicles, the spleen, the ovaries, the breasts, the throat, the sub-cutaneous cellular tissue, the bones, &c.

The hydatid disease is endemic in Iceland, and to so great an extent does it prevail there, that it has been estimated that one in seven of the whole population suffers from *Echinococci.*

The tænia belonging to the *Echin. altric.* has not yet been discovered. It probably resides in the human intestines, and also in the carnivorous domestic animals, such as the dog and cat.

The symptoms produced by this parasite depend upon the organ in which it is placed, the size which it attains, and the pressure which it exerts. The only *certain* evidence of its nature is the passage of the gelatinous vesicles from open cavities of the body after the bursting of a cyst, or a similar escape of them from the punctures or incisions made into the tumors. Thus they may escape from the lungs by coughing; from the liver or spleen they may burst into the intestines, and be discharged by the anus, or from the mouth by vomiting; from the kidney they may be evacuated with the urine. Cases of this latter kind are alluded to in Art. BLADDER, ante, p. 322. For a description of hydatids in bone see TUMORS OF BONE. When they are so situated as to admit of external examination, a peculiar jelly-like trembling when percussed has been said to distinguish hydatids from other cystic tumors.

The prognosis of the *Echinococci* varies according to the situation of the swelling, the accessibility of the organ attacked for operation, and according to the primary or secondary injury to important organs and the whole system; but the prognosis is more favourable than is generally supposed. The tumors, when they are accessible, are amongst the number of curable tumors; they may cure themselves by bursting; and when they are once got rid of, relapses in the same colony are rare and exceptional cases, and every new *Echinococcus* produced usually owes its existence to a new immigration of embryos. The natural cure by the bursting of a colony and the passage of daughter-vesicles, may be accompanied by symptoms dangerous to life; or if it take place in the direction of the larger bronchi, by difficulty of breathing, or may even lead to actual suffocation (p. 228). When accessible, they require to be treated surgically, by free incision, and by the evacuation of the whole of the contents of the cyst. Where a free incision is inadmissible, as much as possible of the contents of the cyst must be evacuated by puncture; and this must be repeated from time to time, if necessary.

Acephalocysts are similar in their origin, in their mode of growth, and in their external appearance, to the cysts of the echinococci; but they differ from them in the circumstance that, although their growth may proceed uninterruptedly, they never attain to the production of scolices in their interior. Acephalocysts, however, are not necessarily derived from the embryos of echinococci; barren cysts of cysticercus tenuicollis have also been observed, and it is probable that the same thing may occur with respect to the other varieties of cystic worms.

The acephalocysts which belong to the echinococcus species are of two kinds, corresponding to the two varieties which have been described. Those derived from *Tænia echin. scolic.* are simple cysts; but those from *Tænia echin. altric.* develope secondary and tertiary cysts in their interior, though neither these nor the mother-cysts are capable of producing scolices. The walls of these acephalocysts have the same laminated structure and exhibit the same gelatinous trembling as true echinococci, the only difference being that the enveloping cysts of acephalocysts, even when they are of small size, are thicker and more cartilaginous than those of the proliferant echinococci.

Acephalocysts inhabit the same situations, give rise to the same symptoms, and require the same treatment, as the more perfect echinococci.

For fuller information on the subject of the Cystic Entozoa, consult Küchenmeister, *Manual of the Animal and Vegetable Parasites of the Human Body*, translated for the Sydenham Society, *by Dr. Lankester*, 1857; *and Copland's Medical Dictionary*, art. Worms, vol. iii. pt. 2, p. 1375.]

James R. Lane.

[HYDRÆMIA (from ὕδωρ water, and αἷμα blood). Excess of water in the blood, the fibrin, albumen, and morphological elements being all diminished in quantity. The blood is thin or diluted, deficient in viscosity, and pale, in various degrees. "As an idiopathic disease this cannot be disputed, and it occurs frequently as a secondary condition." (*Rokitansky, Manual of Path. Anat.* vol. i. p. 403; *Wedl. Path. Histology.*)

We are called upon, at the present day, to examine closely the relations of water to the animal economy, owing to the reliance which is placed on the therapeutical powers of various processes which influence the quantity and proportions of this constituent, not only of the fluids, but of the most solid tissues of the organised fabrics. Its importance as a nutritive element may be inferred from the fact, that life can be prolonged for weeks if water be taken freely, but not many days without. Estimated as constituting from two-thirds to three-fourths of the weight of the body (*Chevreul; Burdach*), it exists therein in three states. 1; in a comparatively static condition; being a constituent of the most solid structures, as the bones, nails, and even the enamel of the teeth. 2; in a dynamic state; as a protoxide of hydrogen combined as an essential element with the other materials of the softer organic structures, as in muscles, nerves and membranes. 3; as a liquid holding various substances in solution, in the blood and other fluids. Both in the fluids and the semisolids the water holds definite salts in solution; and this saline fluid is again a solvent of albuminous, oleaginous and saponaceous principles. The solidification or fixation of a large quantity of this fluid by a small quantity of solid matter, without change of state, as in albumen, fibrine, and membrane, is a characteristic of organic substances. This saline liquor or solution, when structurally combined with other elements to form the tissues, is always so in constant quantities, and the properties of the different component parts of an animal body are modified by the nature of the saline and crystallisable materials contained in the water. Hence the mechanical properties, with their modifications, of different parts of the body; the liquidity and viscosity of the fluids, as the blood and lymph; the softness or consistency, the plasticity, elasticity, and extensibility of the semisolids, as muscular fibre and membrane; the flexibility and milk-white colour of cartilage, the transparency of the cornea, and the tenacity of bone. The following table exemplifies the great differences in the proportions of water in the fluids and solids of the human body:

	Water.	Fixed Principles.
Enamel	2	998
Epithelium . . .	37	963
Bones	130	870
Tendons . . .	500	500
Aorta	656	344
Muscles	725	275
Synovia	865	195
Urine	933	67
Lymph	960	40
Sweat	986	14
Pulmonary Vapour .	997	3

The blood, averaging 784 parts of water to 216 of soft solids; or, the liquor sanguinis, 902·9 of water to 97·1 of solids, is the central recipient of all the water of the economy. It supplies to the alimentary canal, through the glands and mucous membranes, say twenty to thirty pounds or more of water daily, holding digestive principles in solution, and converting all the materials for nutrition into a very dilute fluid. Those who may not have considered this point will be a little startled at the estimated amount; but add the saliva, the gastric and other intestinal juices, and the bile together, and it will not, if the more recent physiological researches are to be credited, be found too high. The blood receives back daily an equivalent quantity of water; all the products of primary and secondary digestion, the pabulum for the nutrition of the organic tissues, and the effete materials of the tissues being reconverted by the agency of water, into thin liquids, and conveyed through lymphatics and veins, as also by the lacteals, to the blood. Hence there is not only a circulation of blood, in the economy, but a continuous, aqueous circulation — an outer circulation of fluids, and an inner circulation of blood — a greater circulation, which reaches beyond the blood, and at the same time includes the blood.

During this circulation of the fluids, water is lost to the economy, a portion being evacuated with effete matters, as in urine, perspiration and fæces; and a portion conveyed away in regulating animal temperature, by cutaneous and pulmonary transpiration. The water thus expended, under ordinary circumstances, is comparatively small. Its quantity differs very materially, according to age, temperament, climate, season, habits of life, and state of health. In order to have a wide margin, we may say from three to seven pounds are expended daily (*Sanctorius, Keil*). This loss, from a body containing 120 or 130 pounds, or more, is but a small percentage. The water is replaced, mainly ready formed, as an essential part of the ingesta, and through the alimentary canal; absorption by the skin being only an exceptional occurrence. If there be a small excess of loss over the water of the ingesta, it is most probably compensated in the laboratory of life by the direct union of hydrogen and oxygen. Thus, virtually, a constant and necessary correlation exists between the water received into the system and the water evacuated.

The water employed in the economy is an approximate measure of the activity of the vital processes. The most healthy members of the community will be found in classes of men who, from laborious exertion, perspire freely and drink freely; their assimilation of solid food being in direct relation to the disintegration of tissue; both being measured, approximatively, by what may be termed the water of compensation. Of course this relation is disturbed when stimulating drinks are taken in excess, or the blood contains any other acrimony. But it is well illustrated, although the cases are not quite parallel, in the vegetable kingdom. Take two plants of the *Cobœa scandens;* place them as nearly as possible under similar circumstances; water one freely, and you may make it grow at the rate of four or five inches daily; water the other scantily, and it will not grow above an inch daily; the assimilation of solid matter and the growth of the plant are just in proportion to the water employed. Bearing this in view, there are classes of society who never undergo laborious exertion; and numerous individuals are to be found who rarely, if ever, freely perspire. Owing to the cold and humid climate, and their sedentary habits, the water discharged and renewed, in such subjects, is reduced to a minimum, and is inadequate to sustain the healthful vigour of the vital processes. But for the action of the kidneys, the consequence of this state of things would be more immediately serious than it is; yet the kidneys cannot continuously perform their own functions and supply the defects of the function of the skin, nor do they ever thoroughly compensate for the loss of freedom in the action of the latter organ.

The blood is the central reservoir of the water of the economy. By way of illustration, taking the estimate to be correct of the quantity of fluid required for the solution of the digestive principles, the blood ought to part with the whole of its water of solution, and have the whole of it renewed in much less than twenty-four hours, for the purposes of primary digestion alone. The proportion of water habitually contained in the blood forms a part of the physical constitution. The tissues, as we have seen, contain fixed quantities essential to their integrity; but they also always imbibe water as a liquid, holding saline and organic substances in solution. As there is a correlation between the water eliminated from and received into the blood, so there is a constant and necessary correlation between the proportion of water in the blood and the tributary fluids, including the fluid in the interstices of the tissues; and the water in the blood and that habitually pervading the solids and fluids of the economy varies, within limits, without detriment to nutrition or healthy function.

Water, then, constituting the largest, and one of the most essential of the constituents of the animal economy, and of its various structures, a large and definite amount of it being necessary to digestion, to the circulation of the blood, lymph and chyle, to the double processes of assimilation and disintegration, constituting nutrition and secretion, to cell growth, and to the play of the vital affinities and nervous powers,—being the only solvent for the conversion of all the materials of nutrition into a liquid before they can be assimilated, and the reconversion of all the effete materials of the organic structures again into a liquid, before they can be eliminated, the body being subject to a daily and hourly loss of water, and the continuance of life absolutely demanding that such loss should be repaired, and the blood being the central reservoir, there can be no surprise that the condition of the blood, as respects the proportion of its aqueous constituent, and the quantity of water habitually passing through it, should exert a very powerful influence over all the organic functions.

The quantity of water in the blood corresponds with the quantity habitually forming a part of the physical constitution, and varies greatly in different individuals, according to age, sex, and temperament; there being a larger proportion in females than in males, in early than in adult life, and in the leucophlegmatic than in the sanguine temperament. Every individual has a physiological standard, for the blood and tissues generally, variable, without detriment to health, within confined limits. From water in excess, the body becomes disturbed, and, if diminished below the physiological standard, it collapses. A fixed amount is essential to each structure, but the proportion in all the solids and fluids may oscillate, within certain limits, without detriment to nutrition or healthy function.

The system, in a state of health, is very sensitive of any considerable change in the proportion of water in the blood; taken into the stomach, it is rapidly absorbed, and, if not required for assimilation by the tissues or the blood, it is equally rapidly eliminated. At moderate or low temperatures of the surrounding medium, and when the body is at rest, the kidneys are the chief regulators of the fluidity of the blood. The blood being overcharged with water, as when drink is taken, not being required, the excess, if absorbed, is suddenly expelled as urine, and the water separated at a rate precisely conformable to the concentration of the blood, the kidneys requiring and receiving but very little aid in this function by the lungs and skin. (*Roberts; Observations on some of the daily Changes of the Urine; Edinburgh Monthly Journal*, March and April, 1860.)

Enormous quantities are taken by some individuals, in hydropathic establishments, and a corresponding increase of urine takes place. Dr. Thudichum states that "a student drank fifteen half litres of weak beer within the hours from eight till eleven at night. A patient at one of the German Spas used to take sixteen half-pint glasses of weak saline water, between the hours of six and eight in the morning. In both cases, the quantity of urine discharged within the next hour amounted to about one-half of the quantity of fluid consumed during that hour, and in all cases, the excess of fluid seemed to be discharged within two hours and a half after the last ingestion. (*Pathology of the Urine*, 1858, p. 26.)

The balance between the fluid ingesta and egesta is maintained, however, at a high temperature, by the skin, with very little assistance from the kidneys. Large quantities of water may be taken in hot weather, with the secretion of only a small quantity of high-coloured urine, and the same thing occurs under violent exercise, and in the hot-air bath. Under these various circumstances, the healthy action of the kidneys and skin in general, so effectually restores the balance in the economy, that no injurious results accrue from the temporary hydræmia produced.

The animal economy is protected from the consequences of excessive concentration, or of excessive dilution of the blood, in health, by the rapidity of absorption, and the corresponding rapidity of exhalation. Under some pathological conditions, also, an additional protection results from indigestion of the liquids received into the stomach, and diminished absorption. Nevertheless the blood may become morbidly concentrated or diluted. When suddenly, and to a great extent deprived of its water, by diuresis, diaphoresis, or alvine discharges, it has a tendency to become denser, darker coloured, and more rapidly coagulable; to prevent which, thirst, more or less intense, sets in, with very rapid absorption from the alimentary canal, and from the tissues and serous cavities. This is exemplified in diabetes and cholera, and also in the Roman or hot-air bath. If the deficiency be maintained for any length of time, a disturbance takes place in the chemico-vital molecular actions of the fluids in the tissues, and also in the more stationary particles, which are then liable to assume a degree of fixity, entailing an arrest of the processes of assimilation and disintegration. This promotes encrustation, and ultimately perfect stagnation and death.

Hydræmia, or dilution of the blood, is an opposite condition. This state is never produced permanently by an excess of the fluid ingesta alone. Drinking watery fluids in excess, the action of the excreting organs being perfect, occasions no inconvenience; it does not disturb the water of the economy in its static or its dynamic conditions. Drinking water in excess also, the action of the excreting organs being temporarily interrupted, may produce temporary inconveniences, without being regarded as a disease. Hydræmia and its consequences are the results of the operation of more continuous and often combined influences, of which a low temperature, with great humidity of the atmosphere, excessive ingesta of diluting fluids, defective nutrition, and deficiency of active exercise, acting coetaneously, and in various degrees, are the most direct.

A state of hydræmia is easily produced by habitual deficiency of nutriment, and occurs, in a more or less marked form, in all diseases attended with loss of appetite, and especially in exhausting diseases, from the combined influence of excessive waste and diminished supply. Keeping patients too long on a low diet has the same tendency. Loss of blood produces the same effect, being rapidly followed by the absorption of fluids of less density than the liquor sanguinis. Hence, a scantiness of solid constituents in the blood from these causes is not, as a general rule, associated with a diminution of the volume of blood circulating in the vessels, or true anæmia, there being a constant tendency in the blood to retain its volume; but anæmia cannot occur, to any extent, without being quickly followed by hydræmia. Most of the symptoms of slow or chronic anæmia are the results, not simply of a diminished quantity of blood in the vessels, but of this condition, in a greater or slighter degree, combined with an impoverishment of the qualities of the blood. (*Lehmann*, *Path. Chemistry*, p. 241.) Whenever the watery discharge from the kidneys is diminished, failing an adequate compensating action of the cutaneous or mucous surfaces, as often happens in fevers, and acute and chronic inflammations, and in diseases of the heart and liver, a temporary or permanent state of hydræmia may be produced, and in many of these diseases the blood, at first hyperinotic, ultimately becomes strictly hydræmic. Every circumstance which tends to impede the action of the skin, the lungs, or the kidneys, and to intercept the necessary expenditure and renewal, and the perfect circulation of the aqueous fluids of the economy, conduces to the effect.

Hydræmia, as a primary morbid state, must not be confounded with the condition of the blood in which a relative excess of water occurs, owing to a loss of red corpuscles, the liquor sanguinis retaining the same, or a larger proportion of solid constituents than usual, as in chlorosis. On the primary invasion of many diseases, the red corpuscles are either destroyed more rapidly, or not renewed as quickly as usual, or both circumstances take place; hence the blood, as a whole, is more watery, but the serum retains its density; and, notwithstanding the absorption of water to supply the place of corpuscles and replenish the vascular system, it may be even richer than usual in solid constituents. This has been observed in erysipelas, acute inflammations, articular rheumatism, puerperal peritonitis, and other diseases, in many of which the liquor sanguinis contains an excess of fibrine. (See HYPERINOSIS.) The products of the destructive metamorphoses of the corpuscles appear in these cases to be retained in the liquor sanguinis for a time; but as such diseases progress, from the diminution of the secretions, and from the solid matters supplied by the corpuscles becoming gradually exhausted, the solid constituents of the liquor sanguinis also diminish, and a perfect state of hydræmia may be produced. Hence hydræmia is the result of blood-consuming diseases, as typhoid and malignant fevers, and a consequence of the action of substances which destroy its crasis, as many metallic poisons; but in most of these diseases an excess of water is only one element in the morbid condition, and constitutes a part only of the blood disorganisation. (See SPANÆMIA; TOXHÆMIA.) A relative excess of water is also produced by diseases probably seated in organs deeply concerned in the blood-making processes. (See LEUCOCYTHÆMIA; MELANÆMIA; HÆMORRHAGIC DIATHESIS.) In all these cases it is a secondary element of the morbid state of the blood, being associated with a disturbance of the healthy proportions of the fibrine, of the red or white corpuscles, or with poisons or acrimonies, and other derangements of the constituent principles. (See HETEROCHYMEUSIS.) So, also, it occurs as a secondary condition, or forms a part of other complex blood derangements in scorbutus, purpura, tuberculosis, cancer, and albuminuria. (*Rokitansky*, lib. cit.)

But "hydræmia as an idiopathic affection cannot be disputed." When the blood is watery, or essentially *poor*, it is thin and deficient in viscosity; and the fluids of the economy generally are too liquid. This condition cannot be maintained permanently without a correspondence taking place between the diminished density of their contents and the density and porosity of the parietes of the vessels, rendering them more distensible, and more prone to hyperæmia or congestion, and being favourable to the transmission of free liquids, whether it be by endosmose, pressure, or any other process. Thus the tissues acquire the power of fixing more water than they ought to contain. The organic cells become distended by imbibition, rupture readily ensues, and the diluted contents escape, leading to dropsical or aqueous effusions; the young and thin-walled cells being more easily ruptured than those with older and thicker membranes, which are capable of bearing greater distension. The constituent particles of the fibrils and the interstices become surrounded with aqueous fluid, leading to pallor, relaxation of the contractile fibre, diminished elasticity and plasticity, increase of bulk, diminished nutritive power, and diminished power of sustaining animal heat, in variable degrees in different structures. A stasis of aqueous fluid in the tissues, even to the constituent cells and connective tissue, must be the result. We see the effects of hydræmia very remarkably exhibited in the mucous membranes, in their flabbiness and pallor; in relaxation of the uvula, trachea, larynx, and bronchial tubes; in fungoid-like tonsils; and in a tendency to profluvia in both sexes. It is exhibited in the flabbiness of the muscles, and in incapacity for continued active exertion. We see it also in the dyspepsia and hypochondriacism of vast numbers of people. The relaxation and debility of the intestinal tunics, and the extreme dilution of the digestive principles, account for this latter effect.

A permanent state of hydræmia is attended with feeble action of the heart and general debility. The urine may be normal in quantity, but it is of low specific gravity, often about 1010, pale, containing but a small quantity of urea, uric acid, and fixed salts, and depositing no sediment. It sometimes contains albumen, probably owing to stasis in the kidneys, and when the action of these organs is diminished, and the urine becomes concentrated, the amount of solid constituents is relatively but not absolutely increased. There is a correspondence between the diminished density of the blood and the porosity of the vessels, these being easily distended. If the mean proportion of water in the blood be taken at 780 in 1000, and that of the aorta, for instance, at 656, an habitual large increase of water in the blood must increase the watery element of the artery, and thereby directly weaken its structure, and diminish its elasticity; and the same with the capillary vessels. The low specific gravity of the blood is favourable to exosmosis, and accumulation of fluid is easily produced in the areolar tissue, and in the serous cavities. Water, also, readily transudes through the parietes of the vessels in dependent parts, and especially in tissues affected with hyperæmia, producing œdema. The transudation may be either water pure, or with variable quantities of albumen, salts, or even fibrine. Even the more solid structures, as the membranes, the muscles, the nervous masses, and the medullary substance of the bones are liable to become infiltrated. Inflammatory products are characterised by their poverty in plastic materials, and by their serous character, and a common form of softening of the tissues is promoted by this pathological condition.

The effect of hydræmia, in an extreme degree, may be interpreted by the following circumstances. When a large quantity of water is injected into the vessels of an animal, so as to dilute the blood suddenly to a considerable degree, biliary pigment first appears in the urine, and afterwards, albumen and hæmatin are discharged simultaneously. These substances are derived from the red corpuscles, and, about twelve hours after the experiment, the urine resumes its normal colour. (*Herrman, On the Influence of Dilution of the Blood on the Secretion of Urine, Virchow's Archiv*, vol. xvii.) In oxen, after large draughts of water, the blood sometimes becomes so dilute that the corpuscles burst, and their coloured contents have been discharged from the body. An extremely watery condition of the blood may also produce, in the same way, petechiæ, deposits of pigment, ecchymoses, and bloody secretions and excretions. It has been suggested that sudden death, after copious draughts of cold water, in a state of fatigue and exhaustion, may have resulted from sudden distension and rupture of the red corpuscles of the blood by the aqueous fluid. A true hydræmic plethora is a frequent cause of sudden attacks of hæmoptysis, hæmorrhoids, and other hæmorrhages, or sudden effusions producing apoplexy, paralysis, coma, or convulsions. It may become mortal, by its general effects, from deficient nutritive matter in the blood, or by œdema of the glottis or lungs, or any of the local diseases already referred to.

Treatment.—The treatment of hydræmia merges in a large proportion of cases, into that of the various diseases of which it is a secondary complication. (See ANÆMIA; HÆMORRHAGIC DIATHESIS; LEUCOCYTHÆMIA; SPANÆMIA; TOXHÆMIA, &c.) Nevertheless, the appropriate remedies for this morbid state of the blood, regarded especially as a proclivity to, or actual element of diseases which occur in surgical practice, and often complicate injuries and operations, require to be stated. The subject involves also, at least one or two considerations of very great practical importance. The general treatment of hydræmia, regarded as a predisposition to disease, or in its slighter forms, is in some respects analogous to that of anæmia, but in others it differs very widely. A nutritive diet, laborious exercise, so as to excite perspiration, or some substitute for it when that cannot be taken, a warm, dry atmosphere, and friction or shampooing, are among the chief remedies. The indication is to excite a more perfect aqueous circulation throughout the tissues of the economy, by increasing the action of the heart and blood-vessels, promoting the action of the skin, increasing the expenditure of water by the blood, and thereby augmenting assimilation and depuration, both in the blood and in the tissues. Bleeding is not to be proscribed absolutely as in anæmia. Where hydræmia depends on visceral diseases, starving the blood of its morphological elements, or destroying them, or upon any of the causes of direct debility, bleeding is not to be thought of; but in many cases of hydræmic plethora this measure, simultaneously with generous diet, has the best effect. A great increase of water in the urine is sometimes found as a sign of improvement in a diluted state of the blood; and many salts, which act as diuretics, not only relieve the hydræmia, but promote the absorption of dropsical fluids, and relieve œdema in the solids, more or less dependent on the morbid state of the blood. Such remedies often increase the vital changes in all the solid tissues; thus, chloride of sodium in a large proportion of water, is absorbed rapidly, and again secreted rapidly by the kidneys with diuresis, the urine, not only containing a large amount of the chlorides, but also of other constituents, indicating an increased metamorphosis of tissue. (*Bischoff.*) Where a portion only of the salt passes off by the kidneys, other secretions are increased, and probably the cutaneous exhalation; and where œdema, or effusion, has taken place, and the hydræmia has been thus relieved by diuresis, the blood, becoming more concentrated, these morbid states are relieved by endosmosis. But the kidneys often fail to produce this effect from the agency of dilution, if free or unassimilated soluble substances, which these organs are capable of separating, be not also contained in the blood.

Hence the skin, the obstructed function of which is most frequently concerned in the production of a permanent state of hydræmia, is the organ by which this morbid condition may be most easily remedied, and, indeed, unless the skin be restored to a perfect physiological state, all other measures will certainly fail. Where the health is not too much deteriorated, active exercise, as in hunting, quick walking, athletic games, or manual labour in a high temperature, daily, so as to excite free perspiration, with a generous diet will suffice; but where this cannot be resorted to, sudorifics are indicated. Of these the warm and the vapour bath have hitherto been regarded as the most efficacious, but of late the hot-air bath, introduced into this country by the Romans, and employed in the East since their period, has been revived under the designation of the Turkish bath. The patient, divested of all clothing except a cummerbund (loin-cloth), is introduced into the *tepidarium*, which is a room heated, say from 110° to 115° Fah. After becoming thoroughly warm, with his skin slightly perspiring, he passes into the *sudatorium*, in which the temperature varies from 135° to 160°; here a profuse perspiration breaks out; he is then subjected to the process of shampooing, and ultimately to showers of hot and cold water alternately, in the *lavatorium*; returns for a short time to the hot-air chamber, and then passes to the *frigidarium*, or cooling chamber. This is the most powerful sudorific process known. It is well calculated to restore the deteriorated function of the skin, and the aqueous circulation of the economy, and when resorted to twice or thrice a week, it bids fair to prove one of the best remedies for the hydræmic condition incidental to this variable and damp climate.

The consequences of too dilute a condition of the blood, and of hydræmic plethora, point to the necessity of watching the hygrometric condition of the atmosphere of the sick room; and to the use of the wet and dry bulb thermometer, particularly in the wards of hospitals. A sick room has often been surcharged with moisture by merely washing the floor, and the result has been temporary hydræmic plethora, and attacks of hyperæmia with coryza, bronchitis, nephritis, and other inflammatory affections, or hæmorrhoids, and even apoplexy and other hæmorrhages, from a sudden arrest of the cutaneous evaporation without an adequate compensating action of vicarious organs; and the true cause has not been suspected. Atmospheric changes in our variable climate frequently lead to similar results. Individuals in health or disease, taking habitually large quantities of fluid ingesta, the blood being already too fluid, are dependent for their safety upon the action of the secreting organs; and if cutaneous transudation and vaporisation be suddenly arrested, or habitually interfered with, too great a stress is made on the organs, often resulting in a derangement of their functions, and in disease. The hygrometric condition, as well as the temperature of the atmosphere of the sick chamber, should be sedulously watched, and the fluid ingesta allowed to patients judiciously regulated. In the atmosphere of a room the proportion of vapour conducive to health and to recovery from disease depends on its temperature. It may be taken at three grains per cubic foot at 50°, four grains at 60°, and five grains at 70°; and these proportions exist when the wet bulb of the thermometer reads respectively 45°, 54°, and 63°. When the atmospheric air is very dry, or when the external air, being at a very low temperature, and consequently containing a low proportion of moisture, the air of a room is raised to a very high temperature, rendering it extremely dry, rapid evaporation takes place from the skin and lungs, owing to the caloric of the surface of the body becoming latent, and depression of temperature occurs with contraction of the superficial blood-vessels, chilliness, and often internal hyperæmias. This extreme dryness has accordingly to be provided against in surgical practice. When the air is extremely humid, as measured by a high dew-point, evaporation from the surface is greatly diminished, or may be completely arrested. In this case the blood must become rapidly hydrated, unless the deficiency of evaporation be compensated for by the action of the kidneys or bowels, or the supply of fluid ingesta be reduced. If a number of persons be crowded in an unventilated apartment, one of the effects is to saturate the air with moisture, and produce a temporary hydræmia. It may be estimated that each individual supplies the air with twelve grains of vapour per minute; sufficient to *saturate* nine cubic feet of air of the ordinary healthy hygrometric standard, at 50°, six feet at 60°, and four and a half feet at 70°. In a hospital ward containing twenty patients, 180 cubic feet of air, supplied from without at 30°, will be saturated with moisture per minute. The importance of this consideration to scrofulous patients, and others whose blood is already poor, confined in the surgical wards of a hospital for weeks or months for the treatment of local disease, has been too much overlooked. (See *Report of the Committee appointed to inquire into the best Mode of warming and ventilating Dwellings. Printed by Order,* 1857.)] *Henry Ancell.*

[HYDRÆMIA LYMPHATICA. This has been described as a peculiar form of anæmia. The blood is extremely watery, and deficient in red corpuscles and coagulum. It resembles a pink-coloured water, and is often not like blood at all. The symptoms are a perfectly white or blanched state of the whole body, enlargement of the lymphatic glands, serous exudation into all the tissues, extreme debility, breathlessness, and utter prostration. The urine is not albuminous, there is no excess of white corpuscles in the blood, and there is no tubercle. There are not the symptoms of deficiency of blood in the vessels, or true anæmia. It is slow death by loss of the vital constituents of the blood and dropsy. On post-mortem examination, the lymphatic glands are often found greatly enlarged throughout the body from adventitious deposit, all trace of glandular structure being replaced by nucleated fibre; there is enlargement of the spleen from a similar deposit, and sometimes, also, deposit in the liver and kidneys, also effusion into all the serous cavities, and often œdema of the lungs. (*Wilks; Guy's Hospital Reports*, vol. v. 1859, p. 89.)]

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HYDRARTHROSIS. *Hydrops articuli.* A collection of fluid in the synovial cavity of a joint; usually the result of chronic synovitis. (See Joints, Diseases of.)

HYDRARGYRIA. A peculiar eruption, *eczema mercuriale*, occasioned by the use of mercury. (See Mercury.)

HYDRIODATE OF POTASH. (See Iodide of Potassium.)

HYDROCELE. (From ὕδωρ, water, and χήλη, a tumor). The term, *hydrocele*, if used in a literal sense, means any tumor containing water; and occasionally we hear of hydroceles of the neck, cysts formed in that region, which contain a serous fluid, and sometimes attain considerable magnitude. We hear now and then of hydroceles in women, which are collections of a similar fluid in the canal of *Nuck.* (*Regnoli*, see *Revue Méd.* Oct. 1834). [Ascites is occasionally called hydrocele of the peritoneum, and spina bifida, hydrocele of the spine.] We much more frequently meet with collections of fluid in a hernial sac, constituting another kind of hydrocele. But, in ordinary surgical language, hydrocele signifies a collection of fluid in the tunica vaginalis of the testicle, or in a cyst formed in the spermatic cord. The *hydrocele* by infiltration of French writers, is only an œdematous or anasarcous swelling of the scrotum.

Anasarcous Tumor of the Scrotum.

[This condition, known also as dropsy of the scrotum or *Œdema Scroti*, frequently accompanies ascites, and is often met with, occurring generally as a symptom of organic disease, in conjunction with serous infiltration of the extremities or body at large. It is frequently seen in persons suffering from Bright's disease of the kidneys.] According to Dupuytren, *idiopathic* hydrocele by infiltration rarely occurs but in new-born infants and in men of advanced age. (*Clin. Chir.* t. iv. p. 436.)

[It is observed occasionally as a local affection in old men, and in persons debilitated by disease, especially where the scrotum is particularly pendant. Disease of the inguinal glands, and obstruction of the circulation in the veins and lymphatics, have been known to produce it. The rupture of a hydrocele, or puncture of a hydrocele, may also give rise to it. The characters of the affection are as follow: — "The œdema commences at the most depending part of the scrotum, to which it is confined when the infiltration is slight. When the whole scrotum is involved, the part presents an uniform indistinctly-defined tumor, with a soft and doughy feel, and pits on pressure; but, owing to the large size of the spaces, the fluid traverses the connective tissue so freely that the parts retain the impression of the finger for but a few moments. As the tumefaction increases the tegumental rugæ are obliterated, and the surface of the skin becomes smooth and somewhat tense, and has a pale, glistening, semi-transparent appearance. The testicles are so surrounded with the infiltrated serum that they cannot be distinguished. When the œdema is considerable, the integuments of the penis generally participate in the distension; the prepuce becomes twisted and distorted, and so enlarged as to conceal the glans penis. The tumefaction often extends also to the groins and lower part of the abdomen." (*Curling, On Diseases of the Testis*, p. 467.)]

As the cellular tissue on one side of the scrotum is a continuation of that on the other, and both freely communicate, the accounts delivered by certain authors, Pott amongst others, of the possibility of this species of hydrocele being confined to one side of the scrotum, are not credited by Boyer. [Although the connective tissue is usually somewhat condensed in the course of the septum, there is always a ready and free communication between the two sides. In Pott's case, Curling believes that the septum must have been particularly close and dense, to permit of the cause of the dropsical effusion to operate only on one side.] At all events, such a case is extremely rare, and, when it happens, is probably induced by the irritation of the urine in infants, or of the friction of the clothes in old persons, only acting upon a part of the scrotum. [In tapping a hydrocele, the partial escape of the fluid into the connective tissue and infiltration around the sac of the affected side would induce the same thing.] (See *Dict. des Sciences Méd.* t. xxii. p. 193.) If the cellular tissue under any of the investments of the spermatic cord, or tunica vaginalis, was anasarcous, then, indeed, as M. Velpeau observes, the swelling might be confined to one cord, or one side of the scrotum. (See *Nouv. Elém. de Méd. Opér.* t. iii. p. 507; also *Dupuytren, Clin. Chir.* t. iv. p. 436.) Such a case, as Dupuytren observes, would require more or less free incision, instead of a small puncture.

[This local œdema, in rare instances, might be mistaken for a hydrocele, or there might be a combination of œdema and hydrocele together, and much tact would then be necessary to discriminate between the two.

When the disease depends upon some one of the constitutional causes of dropsy the treatment more properly comes within the province of the physician, and internal remedies are required; but the distension is sometimes so great as to threaten mortification or bursting of the scrotum, and a reduction of its bulk becomes absolutely necessary. Two plans have been recommended to effect this object, namely puncture and incision. Pott effected the first of these with the point of a lancet, but it is now usual to employ a darning or cataract needle to make one or two punctures, and as the spaces so freely communicate with each other, they are found sufficient to relieve the most bulky swellings. (*Curling*, op. cit.) The multiplication of punctures is an unnecessary proceeding, and they should not be made too close to one another.]

Boyer had a case, in which the making of very slight punctures in an anasarcous scrotum was followed by the total destruction of this part, denudation of the testis and cord, and the patient's death, attended with dreadful suffering. (See *Dict. des Sciences Méd.* t. xxii. p.195, 196.)

[The danger of incisions, which were formerly much practised, is that they are very likely to be followed by diffuse inflammation, which may end in mortification. The scrotum must be properly suspended in general anasarca, or such a position adopted as may cause the scrotum to be elevated, and the tendency to its tumefaction to be lessened.

The scrotum is liable to become suddenly distended by the effusion of serous fluid, which Mr. Liston has called *inflammatory œdema*, resembling in many of its characters infiltration of urine, but requiring in some respects a different treatment. The serum is often of a putrescent and acrid character. This affection supervenes upon ulcers or sinuses in the groin, perinæum, or neighbourhood of the anus in patients out of health. It occurs also occasionally as a consequence of injury of the genital organs, or is associated with bad strictures, without any disease of these parts, and without the least cause for the suspicion of urine having escaped in the cellular tissue. Suddenly the scrotum begins to swell, and sometimes in less than twelve hours it will be found immensely distended; and this arises generally from the infiltration apparently of a very acrid and fœtid sanies. If this be allowed to distend the scrotum without being arrested, it will have the same bad effects as the effusion of urine. The cellular tissue, together with the skin, is destroyed, and the testicles exposed. The only chance of saving the tissues consists in early and free incision of the most dependent part of the swelling, generally the inferior and posterior, in the mesial line, if the disease be seen early, or on each side of the raphé. A poultice may then be applied, and the scrotum well elevated and supported on a small pillow. When the sloughs come away, should sloughing supervene, the granulating surface is to be treated in the ordinary way, with water dressing or zinc lotion. Attention should be paid to the general health. (See *Liston*, *Med. Chir. Trans.* vol. xxii. p. 288, and *Elements of Surgery*, p. 449.)

In elderly persons predisposed to this complaint, the wearing of a bag truss is recommended for its prevention.]

Hydrocele of the Spermatic Cord.

The spermatic cord is affected with two species of hydrocele: the first is an œdematous affection, extending to more or less of the areolar tissue around the spermatic vessels, and called *diffused hydrocele of the spermatic cord;* the second is a collection of fluid in a particular cavity, or cyst, which has no communication with the cavities of the common areolar tissue of the cord. This form is denominated, accordingly, *encysted hydrocele of the cord.*

[*Diffused Hydrocele of the Spermatic Cord.*— This condition has been well described by Pott, under the name of *hydrocele of the cells of the tunica communis.* The disease is of the nature of simple œdema, a watery fluid being diffused throughout the loose tissue connecting the vessels of the spermatic cord, and enclosed in a sheath of condensed tissue, which is invested by the musculo-aponeurotic structure of the cremaster muscle. On dissection the sheath is found distended, and when the complaint has lasted for some time, more or less thickened. The areolar tissue beneath is infiltrated with a limpid albuminous serum of a white or yellowish colour, which flows out in the course of the dissection. It is owing to the confinement of the fluid by the investing sheath that the swelling assumes an uniform surface, and definite shape. The cells infiltrated with serum are converted into large vesicles, some of which are big enough to admit the end of the finger. These cells are larger and more delicate towards the base of the swelling, where they sometimes disappear altogether; so that there is only one considerable cavity, the fluid having a tendency to collect towards the lowest and most depending part, and to form a fluctuating tumor. The base of the swelling corresponds to the point at which the spermatic vessels join the testicle, and at this part a dense septum cuts off all communication with the tunica vaginalis. (See *Curling*, *On Diseases of the Testis*, p. 149, and *Scarpa*, *Memoria sull' Idrocele del cordone Spermatica*, 4to. Pavia, 1823.]

That the cellular tissue of the cord as well as of the scrotum is often distended with serum, is very commonly witnessed in persons affected with general anasarca; and hence the distension is a frequent concomitant of the anasarcous condition of the scrotum, which has been already described. But, as I have never seen an instance in which such disease was restricted to the cellular texture of the cord, I am led to suppose that it is a very uncommon case. [Mr. Curling mentions that œdema of the cord alone is a very rare affection. Sir Astley Cooper does not allude to it, and Mr. Pott to whom we are indebted for the best description of it, probably met with a greater number of cases than have occurred in the practice of any surgeon since his day. "Causes obstructing the return of blood from the testicle, as induration and enlargement of the glands in the course of the cord, would conduce to its production. I have observed a slight œdema of the cord in two or three instances after acute orchitis, but it always disappeared as the inflammation subsided." (*Curling*, op. cit.) The pressure of a truss worn for inguinal hernia has also produced it.] The following is said by Mr. Pott to be the state of the disease while of moderate size. The scrotal bag is free from all appearance of disease; except that when the skin is not corrugated, it seems rather fuller, and hangs rather lower on that side than on the other, and if suspended lightly on the palm of the hand, feels heavier: the testicle, with its epididymis, is to be felt perfectly distinct below this fulness, neither enlarged nor in any manner altered from its natural state: the spermatic process is considerably larger than it ought to be, and feels like a varix, or like an omental hernia, according to the different size of the tumor; it has a pyramidal kind of form, broader at the bottom than at the top: by gentle and continued pressure it seems gradually to recede or go up, but drops down again immediately upon removing the pressure, and that as freely in a supine as in an erect posture: it is attended with a very small degree of pain or uneasiness; which uneasiness is not felt in the scrotum, where the tumefaction is, but in the loins.

[At the commencement of the disease the tumor assumes a cylindrical form, but afterwards, as it increases in size, it becomes pyramidal, especially in the erect posture. The form of the tumor again is slightly changed, if the position is changed to the recumbent: it then becomes more oblong, and nearly of equal dimensions from the ring to the testicle. In some instances the effusion extends along the cord into the abdomen, as in a remarkable case related by Pott. However much the swelling may increase, it has been observed that the penis never appears so much retracted as in simple hydrocele of equal size.

An omental hernia, or an encysted hydrocele of the cord, might be mistaken for a diffused hydrocele of the spermatic cord. In regard to the former, Scarpa observes, that "the diffused hydrocele of the cord, when it enters into the ring, resembles an omental hernia so closely that it is very difficult to distinguish the two complaints. Both have a cylindical form, and extend into the ring. They are similar in consistence and degree of sensibility, as well as in the difficulty experienced in returning them. Pott represents that the omentum, when returned, remains in the abdomen until the patient assumes the erect position, or makes some effort; while the swelling in diffused hydrocele comes back immediately. I have found, however, that the omentum comes down quickly in some omental herniæ, and that the swelling, when pushed up, does not reappear immediately in some cases of diffused hydrocele. I have observed that the swelling is firmer and more irregular on the surface in the epiplocele than in the watery effusion; and that the latter is larger below than above, while these proportions are reversed in the rupture." (*Sull' Ernie*, *Mem.* 1, xxxii. quoted from *Lawrence*, *On Hernia*, 5th edit. p. 251.) Mr. Lawrence remarks, that "the distinction of the two cases must rest on the following points:—the impulse on coughing in the rupture; the complete removal of the swelling, and the sense of the omentum passing up into the abdomen; its visible and tangible escape from the cavity when the rupture is brought down again by coughing, and the free natural condition of the cord and ring when the swelling has been replaced. The fluctuation of the watery tumor at its lower part; the absence of impulse in coughing; its imperfect removal under pressure, so that the cord can never be felt in a natural state; and sometimes a visible enlargement of the inguinal canal and its neighbourhood when the fluid is pressed upwards."

Mr. Curling thinks that an irreducible epiplocele would be even more liable to be mistaken for a diffused hydrocele. In cases of much difficulty and doubt, an opinion should not only be guarded, but any operation must be performed with caution. Scarpa, indeed, frankly confesses the imperfection of our art with respect to the diagnosis in these cases. Diffused hydrocele is distinguished from encysted hydrocele of the cord by the pyramidal and somewhat diffused form of the swelling, which extends to the ring; by the alteration in shape producible by pressure; and by the absence of fluctuation in its upper part. In diffused hydrocele the testicle is clearly perceptible, and the case cannot well be mistaken for simple hydrocele; nor again can it be confounded with varicocele.]

In the treatment of this affection it is recommended to leave it alone when very small, and a suspensory bandage to be worn; but when it is large, and inconvenient both from its size and weight, according to Pott the only method of cure which it admits of is that of making a free incision into the swelling. But this is by no means void of hazard, and has led to fatal consequences, as mentioned by Pott. [It admits, however, of temporary if not permanent relief, with less risk than he supposed. For as the cells communicate freely, it is not necessary to make a large incision for the removal of the fluid, one or two acupunctures in the depending part of the tumor being sufficient to enable the fluid to escape into the areolar tissue of the scrotum, from which it will be removed by absorption. The cyst then becomes consolidated. Before adopting acupuncture, blisters, counter-irritant plasters, friction with camphorated mercurial or iodine liniments, and a suspensory bandage should be tried; and they will occasionally prove successful.]

Encysted Hydrocele of the Spermatic Cord.—This condition occurs more frequently in children and young persons than in adults. The same kind of disease also, sometimes, is met with in the round ligament of the uterus, and accompanies it through the abdominal ring. Hydrocele of the cord was known to the ancients, and has been accurately described by Albucasis, Celsus, Paulus Ægineta, and others.

It is much more frequent than diffused hydrocele of the cord, but not at all equal in frequency to that of hydrocele of the tunica vaginalis. Richerand has calculated that the average proportion of encysted hydroceles of the cord to those of the latter description is not more than as one to two hundred. (*Nosogr. Chir.* t. iv. p. 262, ed. 4.)

[The cyst is formed of a thin transparent membrane, possessing the ordinary characters of a serous membrane, and contains, generally, a limpid aqueous fluid, with little or no albumen, but sometimes a straw-coloured serum, similar to the fluid of simple hydrocele. In form it is oval, and varies in size, but seldom exceeds that of a hen's egg, and is usually smaller. It is loosely attached to the vessels of the cord, which are situated at its back part, but become separated and displaced by it. The investments of the cyst are the integuments, superficial fascia, external spermatic or intercolumnar fascia, musculo-aponeurotic sheath of the cremaster muscle, and fascia transversalis. Its situation varies along the course of the cord, being either immediately above the testicle, in the middle of the cord, or just below the abdominal ring, and even within the inguinal canal. Mr. Curling states that, usually, there is a single cyst, but occasionally several are developed, and a chain of them has been formed along the cord.

The origin of encysted hydrocele of the cord is attributed to a partial or imperfect obliteration of the prolongation of peritoneum, formed at the period of the descent of the testicle, and in consequence of this serous membrane remaining unclosed at one or more spots, an isolated sac or sacs are left in the course of the spermatic cord. A cyst of this kind, when distended with serum, constitutes an encysted hydrocele. "Such is obviously the mode of origin of this affection when occurring in infants, and no doubt in adults it generally originates in the same way. Jules Cloquet has remarked that the remains of the peritoneal process accompanying the testicles in their descent were met with in male subjects of all ages, and he mentions, as a singular circumstance, that they were nearly as frequently found in the old as in the young subjects." (*Curling*, op. cit. p. 156, ed. 2.)

The swelling is not painful, and is seldom discovered until it has attained to a considerable size. The swelling is oval and well defined, and perfectly distinct from the testicle and epididymis, which are to be felt below it. Mr. Curling mentions that the vessels forming the cord can generally be traced to the posterior part of the cyst. It undergoes no alteration from change of posture, is not affected by coughing or sneezing, and occurs very soon after birth, but is observed at all periods of life.]

Scarpa observes that the diagnosis is more difficult when the encysted hydrocele is of considerable bulk, because the testis is buried, as it were, in the tumor.

[It is liable to be mistaken for an inguinal hernia. The size and shape of the tumor, and absence of the signs of hernia, will readily distinguish between the two, besides that it does not extend up to the ring. If the tumor is small, and near the abdominal ring, it may admit of being pushed upwards into the inguinal canal, a circumstance which renders the diagnosis rather difficult. On this point Mr. Curling remarks: "The facility, however, with which the vessels of the cord can generally be felt when the tumor has descended again, and the parts between the swelling and the ring are grasped between the finger and thumb, will enable the surgeon to ascertain the nature of the case. But if, as sometimes happens, the cyst be situated within the inguinal canal, or at the opening of the external ring, it is extremely difficult to distinguish the swelling from a hernia, for it disappears under pressure, is very apparent when the patient is in the erect position, and is removed, or is less manifest, when he is in the recumbent posture. The diagnosis will be facilitated by observing that although the tumor cannot be made to descend below the external ring, neither can it be thrust completely into the abdomen like a portion of intestine." (*Diseases of the Testis*, p. 160.) A case of this kind is related by the last-named writer, in which difficulty was experienced in the diagnosis, for above the swelling there was a slight hernial descent.

Besides hernia, this affection might be mistaken for a hydrocele of the tunica vaginalis, and sometimes it cannot be distinguished without difficulty from an encysted hydrocele of the testicle. Indeed, as has been observed by Mr. Curling and others, cases have been described as hydroceles of the cord, with fluid containing spermatozoa, which have been, in reality, encysted hydroceles springing from the epididymis. "When the cyst in the cord is situated high up, the distinction is clear; but when it is close to the gland, and of large size, so that the testicle is more or less embedded in the tumor, this form of hydrocele is very readily mistaken for an encysted hydrocele of the testicle; nor is the diagnosis always possible. The chief distinctive mark is the circumstance that, notwithstanding its apparent close connection with the gland, the cyst may be detached by manipulation, and proved to be formed above, and distinct from, the testicle or epididymis; whereas, when an encysted hydrocele of the epididymis is pushed towards the ring, the testicle closely follows or moves with it." (*Curling,* op. cit. p. 159.)]

If the fluid was not absorbed, Pott recommended the cyst to be punctured in young children, and divided through its whole length in adults. Sir J. Earle proposed treating this case in the same way as the hydrocele of the tunica vaginalis, viz. by an injection of red wine and water. (*On Hydrocele,* p. 154, edit. 2.) However, an injection frequently fails, and is less certain to answer than the excision of a part of the cyst, or even a simple incision into it, the interior of the cyst being properly dressed afterwards. Dupuytren cites an instance in which fatal peritonitis ensued from injection, as there was a communication with the cavity of the abdomen. A cautious incision into the cyst, in an obscure case, is the safest plan; it clears away all doubt. (See *Dupuytren, Clin. Chir.* t. iv. p. 443.) I have practised with success, in three or four examples, the operation of cutting down to the cyst, and removing the forepart of it, as described by Bertrandt, Hey, Richerand, and others. The cavity is then to have a little soft lint put into it. In this way the wound is to be dressed, till granulations have filled up the cavity. In removing a piece of the cyst, care must be taken not to injure the spermatic vessels. (*Dupuytren,* op. cit. p. 443.) Some surgeons merely cut into the swelling, and then introduce the lint. Sir Astley Cooper cures the hydrocele by passing a small seton, of three or four threads, through it, which is a mild and certain method. (See *Sir A. Cooper, On the Structure, &c., of the Testis.*) Sir B. Brodie takes out the seton in about a week.

[In children, the hydrocele often disappears spontaneously, and Mr. Curling thinks it better not to interfere with it in them or adults, so long as it is small and not painful. The compound tincture of iodine may be painted over the swelling every second or third day; and if it be a source of annoyance from its bulk, acupuncture may be performed. "The injection of the tincture of iodine is quite applicable to this form of hydrocele, and is the treatment which I recommend as both safe and effectual." (See *Curling, On Diseases of the Testis,* edit. 2, p. 162.) Mr. Hey considers the simplest and often the most efficient agent to be local depletion, and he has cured many by the application of two or three leeches. Should injection of iodine fail after puncture, the sac may be laid open and filled with lint, cotton wool, or charpie. To open the sac by elaborate dissection, with a view to its removal, he states is not justifiable. (See *Hey's Operative Surgery,* edit. 2, p. 608.) MM. Malgaigne and Ricord simply puncture the cyst, and then keep its walls in apposition by means of one or two pins. (See *Jamain, Path. et Clin. Chir.* t. ii. p. 539.)]

[ENCYSTED HYDROCELE OF THE TESTICLE AND EPIDIDYMIS.]

[Besides the foregoing varieties of hydrocele, there are others, which are also termed encysted. The effused fluid occupies one or more cysts distinct from the sac of the tunica vaginalis. "They may be developed in three situations: 1. Beneath the visceral portion of the tunica vaginalis investing the epididymis; 2. Between the testicular portion of the tunica vaginalis and the tunica albuginea, which are thus separated from each other. 3. In connection with the loose or reflected portion of the tunica vaginalis. The first is by far the most common situation, the two latter are very rare. These cysts are composed of a thin delicate membrane, and the fluid contained in them differs from that of simple hydrocele in being perfectly limpid and colourless, and nearly free from albumen. The fluid contains molecular granules in great abundance. In the larger cysts, formed on the epididymis, the fluid, instead of being limpid, often presents an opaline opacity, arising from the presence of spermatozoa." (See *Curling,* op. cit. p. 131.) When the cysts developed in the upper part of the epididymis assumed a pedunculated form, they were erroneously supposed by Morgagni, Dupuytren, and others, to be hydatids. Mr. Curling and M. Gosselin, who have observed these cysts in the different stages of their production, have shown that they are not hydatids. These pedunculated cysts never acquire a large size, and seldom exceed that of a currant. M. Gosselin states that similar cysts are sometimes developed in the little appendage to the tunica vaginalis, so often found connected with the upper part of the testicle. According to the same observer, these cysts are liable to be developed from the period of puberty to the age of thirty or thirty-five, but are rare at this period. After the age of forty, they are very common, having been met with by him in at least two-thirds of the testicles examined. (See *Gosselin*, *Archives Générales de Médecine*, 4e série, t. xvi. p. 27, and his *Translation with Notes* of *Curling's Work*, p. 190.)

The researches of Müller and Kobelt have shown satisfactorily that the small cysts, called hydatids by Morgagni, which are so often seen upon the upper end of the epididymis, and which often become pedunculated, are not really new formations, but are the remains of some of the tubes which composed the Woolfian bodies of the fœtus. The Woolfian bodies consist of a series of parallel tubes, blind at one end, but opening by their other end into an excretory duct. In the male subject, as development proceeds, this excretory duct of the Woolfian body becomes converted into the canal of the epididymis and vas deferens; while about eighteen or twenty of the tubes become connected by their free or blind extremities with the generative gland (testis) to constitute the coni vasculosi and vasa efferentia. A few of the uppermost of the cæcal tubes do not join the testis, but remain in relation with the upper end of the epididymis, where, by their subsequent enlargement, they may constitute the cysts formerly described as hydatids. These cysts seldom or never acquire any size, and it is probable that they are not usually concerned in the formation of the ordinary encysted hydrocele, but that the latter is an independent cyst, developed in the areolar tissue connecting the tubes of the epididymis. This view is borne out by the statement made by M. Gosselin, that the small cysts are habitually found on the postero-superior aspect of the epididymis, while the larger ones take their origin from the antero-inferior surface, beneath the head or globus major, in a situation where the small cysts are rare. Some of the lower cæcal tubes of the Woolfian bodies, like the upper ones, do not join the testis; these either disappear, or remain and become elongated and tortuous, and constitute the vasa aberrantia of Haller. For an interesting account of the structure of the Woolfian bodies, and the changes which they undergo in the process of development in the two sexes, see *Cyclop. of Anat. and Physiol*, vol. v. p. 593, art. *Uterus and its Appendages, by Arthur Farre, M.D.*

Mr. Curling has observed the encysted hydrocele of the epididymis in all its various modifications, from the enlargement simply of a single cyst, to the complication occasioned by the varied development of several. As a cyst enlarges, the epididymis becomes flattened, and displaced to one side, whilst the testicle is found either in front or at the bottom. It is sometimes at the side, but rarely at the posterior part of the swelling. The tumor is in general of smaller size than a simple hydrocele, the fluid commonly not exceeding three or four ounces in quantity. Mr. Curling has, however, removed as much as thirty-two ounces from a single cyst. When the hydrocele is composed of several cysts, they are seldom of large size, but form a more or less complicated and irregular cluster. The cysts are liable to become filled with blood, constituting a variety of hæmatocele.

When an encysted hydrocele forms in the second situation, namely, between the tunica albuginea and the inner layer of the tunica vaginalis, the cyst is generally single and of small size. As it grows, it separates the two membranes, naturally closely adherent to each other. According to Mr. Curling, this is a very rare form of hydrocele, but some specimens of it are preserved in our London Museums.

With respect to the third variety, also extremely rare, Mr. Curling remarks: "In examining a healthy testicle I once found six or seven small cysts about the size of currants, studding the surface of the loose portion of the tunica vaginalis. Two of them were situated in a part of the membrane extending up the cord. They projected internally, and contained a limpid fluid. I have twice since seen a similar kind of cyst in the same portion of the tunica vaginalis. Similar adventitious cysts have also been found on the internal surface of the sac of a simple hydrocele, and a preparation of the kind is contained in the Hunterian Museum. If a cyst developed in this membrane were to increase to any size, it would constitute a swelling which might appropriately be termed *an encysted hydrocele of the tunica vaginalis.*"

Mr. Curling has made many examinations of the cysts in encysted hydrocele in order to make out how they are formed, and he is satisfied that they are independent formations, being simply serous cysts developed in the areolar tissue between the collected tubes and their investing serous tunic.

An interesting circumstance in connection with this form of hydrocele is the occurrence of spermatozoa in the fluid contents of the cyst, a discovery made by Mr. Liston in 1843, and one which appears to have been made independently by Mr. Lloyd, about the same time. (See *Med. Chir. Trans.* vol. xxvi. p. 216, 368.) Since that period they have been met with in a large number of instances, in persons of various ages, and in cysts of all sizes, from that of a filbert to the largest which the hydrocele attains. When very numerous they give to the fluid an opaline appearance resembling cocoa-nut milk; indeed this appearance is pronounced to be characteristic of their presence.

They are often as lively as in fresh semen, and sometimes are very few. Mr. Curling has found them more frequently in the larger cysts, and has detected them in cysts tapped for the first time, and also in small cysts connected with the testicles removed after death.

Their presence has been accounted for in various ways. Mr. Liston suspected that the cyst was formed by the dilatation of a seminiferous tube. This view is opposed by Mr. Curling, who says that the cyst is quite distinct and completely separated from the ducts, though close to them. Their presence has been attributed to a wound of an adjoining duct in the operation of tapping; this is negatived by finding them in cysts tapped for the first time, and in others never before opened until after death. Mr. Paget considered the more probable explanation of these cases to be "that certain cysts seated near the organ which naturally secretes the material for semen may possess a power of secreting a similar fluid." (See *Surgical Pathol.* vol. ii. p. 53.)

His theory was combated by Dr. Macdonnell, who supposed that in the first instance "the disease is merely a simple dilatation of one of the ducts, the result of contraction or obliteration of its canal from local inflammation, caused by some injury to the part; that, after some time, this dilatation gives way and pours its contents into the cavity of the tunica vaginalis, in which they accumulate, in some instances without interfering with the functions of the membrane, but in other instances the serous membrane takes on diseased action, and its secretion becomes mixed with that originally poured out from, and still secreted by, the ruptured cyst." See *British American Journal of Medicine*, March 1849, and *Ranking's Abstract*, vol. x. p. 98.) In this way, he observes, we can understand how the fluid may, in one case, present a limpid appearance, devoid of albumen, and in the other exhibit a copious admixture of albumen and a variety of colours; and in both we may find many or few spermatozoa, in some cases alive, in others dead and partially disorganised. The practical deduction drawn from this is, that their presence should not deter an attempt at radical cure, which, if not accomplished by one method, may be effected by another.

The explanation given by Mr. Curling is very similar to Dr. Macdonnell's; it is as follows:— "The explanation which I offered shortly after the discovery of spermatozoa in these cysts was, that their presence was probably owing to the rupture of one of the tubes of the epididymis, and the escape of semen into the sac of the hydrocele, The close proximity of the efferent tubes to the cyst, the slight texture of the ducts, the thin and delicate walls of the sac, and the liability of the part to contusion and injury when a swelling even of moderate size exists, seemed to favour this view." (Op. cit. p. 138.) In investigating the history of these cases, Mr. Curling found in a majority that a swelling had formed after an injury to the testicle, so that it was most probable that a duct had been ruptured by the contusion. With the assistance of Mr. John Quekett he succeeded in detecting a communication between the tubes and sac in two instances, a true solution of the presence of spermatozoa in encysted hydroceles. Luschka states that the cavity in many instances communicates so openly with the seminiferous canal that the hydatid may be taken to represent a vesicular dilatation of the extremity of the latter, projecting beneath the epididymis. The communication with the seminal tube, when narrower can, however, always be demonstrated by the introduction of a bristle, or by mercurial injection. (See *Virchow's Archiv f. Path. Anat. u. Physiol.* vol. vi. p. 310, and *Curling's Work*, p. 142.) In those cases of hydrocele of the tunica vaginalis which have been said to contain spermatozoa, it is believed that they may have been in reality encysted hydroceles; or examples of a combination of the two conditions, in which the encysted hydrocele had burst, and its contents had escaped into the cavity of a hydrocele of the tunica vaginalis. The diagnosis between the two conditions is acknowledged to be very difficult, but the observations of several accurate investigators rather confirm the presence of spermatozoa in some instances of vaginal hydrocele, although their occurrence is admitted to be extremely rare. Mr. Lloyd believes that in some cases he obtained them from hydroceles of the tunica vaginalis, and his belief was confirmed by the examination of a case after death, as stated by Mr. Paget. (See *Surgical Path.* vol. ii. p. 55.)

Mr. Miller thinks "it is still matter of dispute whether these had escaped from an accidental wound or giving way of the tubular structure, either of the testicle or of the epididymis; or whether the cyst from which they were derived had been formed by dilatation of the tubular structure — as takes place in lacteal tumors of the breast, and in ranula. If the latter opinion prove true, as is inclined to by Mr. Liston, little benefit need be expected to result from injection in such cases." (See *Practice of Surgery.*)

An encysted hydrocele of the testicle, or epididymis, commences imperceptibly, increases gradually, and produces no pain. When as large as a grape or walnut it may remain stationary for many years. It can be felt through the scrotum, with the testicle of an irregular form. It sometimes continues to grow until it forms a tense elastic swelling, twice, thrice, or even four times the size of the testicle, but which seldom becomes so large as a simple hydrocele. In large tumors the situation of the testicle may be ascertained, as in simple hydrocele, by transmitted light, by the solid feel at one part, and the pain there on pressure. If two or more cysts are present, the tumor in the scrotum is lobular, but the elastic fluctuating cysts can generally be distinguished from the solid gland. In some cases more pain is felt than in other forms of hydrocele, the uneasiness extending up to the loins. The pain is generally relieved by puncturing the cysts.

In endeavouring to form a correct diagnosis the following facts must be remembered: the gland is differently placed to what it is in ordinary hydrocele, being generally in front or at the bottom of the tumor; the smaller size of the swelling, and the limpid and colourless character of the fluid evacuated. As the position of the testicle is liable to variation in ordinary hydrocele, the nature of the case cannot always be determined with accuracy until the cyst has been punctured and the nature of the fluid ascertained. By this means Mr. Curling made out a small encysted hydrocele combined with a large varicocele; the diagnosis was, however, difficult, as the dilated veins concealed the cyst, and rendered fluctuation indistinct. A few drops of milky fluid containing spermatozoa, which were obtained by puncture with a needle, rendered the nature of the case sufficiently clear. If the hydrocele is multilocular, fluctuation and transparency are usually indistinct. M. Sedillot thinks that the term *spermatic hydrocele* is the best suited for this form of hydrocele, in consequence of its nature and the impossibility usually of distinguishing it from ordinary hydrocele. (See *Union Médicale*, 1857).

The treatment is almost solely confined to iodine injections, as practised by Curling, Macdonnell, and many others, with results on the whole of a most satisfactory nature. Mr. Curling advises noninterference if the tumor is small and painless.

If troublesome from its size, acupuncture or the trocar may be applied either at the back or the side of the hydrocele, in order to avoid wounding the testicle, the exact situation of which should first be ascertained. The relief sometimes proves permanent, as in a case related by Curling (p. 141), but more generally the fluid collects, and it becomes necessary to employ other means of effecting a radical cure, and iodine does this. The seton in the hands of many surgeons has not answered, and is now abandoned. When there are small cysts, one only at a time should be operated upon, and the result watched before meddling with the others. A curious case of the kind is recorded in the work of the last named author.]

HYDROCELE OF THE TUNICA VAGINALIS, or common hydrocele, is an accumulation of fluid in the cavity of this membrane, without any open communication existing between such cavity and that of the peritoneum. If this communication prevailed, the disease would be termed *congenital hydrocele*, which is less frequently noticed.

[Common hydrocele, or dropsy of the tunica vaginalis, is a purely local affection, resulting from a disturbance of the nicely-adjusted balance between the functions of secretion and absorption. The same general causes which give rise to effusion in other serous membranes no doubt operate occasionally in hydrocele; but besides these, the exposed and depending situation of the testicle, the liability of its vessels to obstruction, and the irregular exercise of its functions, will account for the frequency of this affection. Sir Astley Cooper looked upon common hydrocele as the result of relaxation in the arteries and veins, rather than the effect of inflammation. (*Sir A. Cooper, On the Structure, &c. of the Testis*, p. 176.) A varicose state of the spermatic veins is believed by Ruysch and Rokitansky to be a cause of hydrocele, but although these veins are sometimes varicose in patients afflicted with hydrocele, the latter affection more frequently exists without the condition of the veins specified; so that it cannot be regarded as a cause of the effusion of fluid in the tunica vaginalis. Violent strains or great fatigue, or a slight blow on the gland occasionally give rise to hydrocele. In many such cases the effusion is attributed to a low degree of inflammation of the tunica vaginalis. Mr. Curling has observed marks of previous inflammation in the sacs of hydroceles. In some few instances this surgeon has met with hydrocele under circumstances which lead him to suspect that the disease was connected with, or sympathetic of, a chronic affection of the urethra, as stricture and morbid irritation in the canal. Loose, accidental bodies in the tunica vaginalis give rise to hydrocele, from the irritation they produce. Although disturbed states of the circulation, from disease of the heart, commonly give rise to effusion in other serous cavities, it is but seldom that hydrocele is produced by it. In cases of general anasarca, however, slight effusion has been met with by Mr. Curling and other writers.]

In most instances a hydrocele takes place without any evident cause, though, in a few cases, it has appeared to be the effect of a contusion, or of rough long-continued friction of the scrotum. The disease is observed to affect persons of the best health, and most robust constitution, as well as others; and its existence seems quite unconnected with dropsy or debility. In short, it may be regarded as a disease entirely of a local nature. Its production is so slow and gradual, and at the same time so void of pain, that the patient seldom attends to it until it is of some size. Sometimes, however, it is produced very suddenly, and soon attains considerable magnitude.

[Hydrocele is a disease which occurs in persons of all ages, and in all ranks in life, and in most climates, but is especially frequent in warm countries. It is observed in newly-born children (*Pott, and others*) and young infants, and is then usually of the congenital form; but is perhaps more common at the middle period of life. Velpeau found twenty-seven persons, out of sixty cases of hydrocele, affected between the ages of thirty and fifty. (*La Presse Médicale*, Mai 1837.) In 1000 cases of hydrocele, treated by iodine injection, at the native hospital of Calcutta, none of the patients were less than eighteen years of age; 214 were from eighteen to twenty-five years; 473 were from twenty-six to thirty-five; 257 from thirty-six to forty-five; and 56 from forty-six to seventy. (*Gazette Médicale de Paris*, tom. xvi. 1838, p. 561.)]

The fluid of hydrocele is usually transparent, and of an amber, pale yellow, citron, or straw colour, and resembles the serum of the blood; but sometimes it is thick and dark coloured from the admixture of blood. Its specific gravity is usually about 1024, and it contains albumen and salts in varying proportions. Occasionally a quantity of flabby matter, or flocculent albumen, is found floating on the fluid; and in old people it frequently contains an abundance of cholesterine, in the form of a multitude of minute shining particles.

[The quantity of serum present is usually eight or ten ounces, but it varies considerably. Mr. Curling says in this country it seldom exceeds twenty ounces, though it has been known to amount to several pints (he has met with forty-eight ounces in one case). Mr. Cline removed from Gibbon, the historian, as much as six quarts. (*Sir A. Cooper's Lectures, by Tyrrel*, vol. ii. p. 92.) This was the largest Sir Astley Cooper had heard of. A hydrocele has been seen of such a magnitude that it hung down to the knees. (*Sir B. Brodie, in Lond. Med. Gaz.* vol. xiii. p. 89.) Dr. J. G. Davey met with a case in Ceylon, in which the hydrocele was hardly smaller than the body of a robust child. It reached far below the knees, its diameter being so great as to interfere very materially with progression. It was only partially evacuated on the first tapping, and about a gallon of fluid was withdrawn. (*Brit. Med. Jour.* 1857, p. 593.) Of 1000 cases of hydrocele which occurred at the native hospital of Calcutta, in a table constructed by Dr. Dujat, the quantity of serum evacuated varied from less than ten to upwards of one hundred ounces. Of 370 cases of double hydrocele, the fluid was more abundant on the right side in 109, and on the left side in 128. Of the 630 cases of single hydrocele, in rather more than a third of the number the quantity of fluid was under ten ounces; in two-sevenths it was from ten to nineteen ounces; in nearly a third, from twenty to forty-nine; and in eighteen cases the quantity of serum was from fifty to a hundred and twenty ounces. Dr. Jones records an instance of hydrocele in his work on Surgery, which contained two gallons of fluid. (See *System of Surgery, by Samuel D. Gross, M.D.* vol. ii. 1859, p. 944.)

Velpeau, Gerdy, and Dujat found the hydrocele to be more frequent on the left than on the right side, whilst Mr. Curling's experience showed it to be more common on the right. The last surgeon met with six double hydroceles in 115 cases. There can be no doubt that the double form is more common in hot climates, for M. Dujat tabulated 370 out of 1000 cases in the native hospital of Calcutta. In young infants it is usually single, but is sometimes met with double.]

The usual situation of the testicle in simple hydrocele is two-thirds of the way down the tumor, at its posterior part, [or rather below the centre of the sac.] But as Sir Astley Cooper has correctly explained, a great deal of irregularity is met with in this respect, the testis being sometimes in front of the hydrocele, a circumstance arising from the existence of adhesions between the inner and outer layer of the serous membrane at its fore part, previously to the formation of the hydrocele. The testis is sometimes found at the bottom of the swelling, as is exemplified in a preparation shown by the same gentleman, where the fluid had been prevented from descending below and in front of the testis by the inner and outer coats of that organ being so connected together by the adhesive inflammation. He has one specimen in which the fluid was situated only at the sides of the testis, adhesions having prevented its accumulation at other points; and another, in which the hydrocele seems as if it had arisen from the tunica vaginalis, in the same manner as an aneurismal sac is occasionally formed from the coats of an artery. (*Sir. A. Cooper*, *On the Testis*, *&c.*)

[The position of the testicle in front, according to Mr. Curling, may also be owing to an original inversion of the organ, in which the free surface presenting backwards, the fluid collects in that direction, and presses the testicle to the front of the sac. Adhesions sometimes occur, producing a sacculated arrangement, and form what is termed a *multilocular hydrocele;* and it is stated that occasionally the cysts thus formed have no communication with each other. In two instances Mr. Curling has seen a membranous partition in the sac of a hydrocele, separating it into two distinct cavities, formed by a layer of false membrane; but such a separation is extremely rare, and he believes that what is called the multilocular hydrocele is, in general, either a form of the encysted, or a complication of the vaginal and encysted.

The same surgeon speaks of a kind of sac or pouch, often met with in hydroceles, which is not commonly described. It is situated on the inner side of the testicle, but the opening into it is always found on the outer side, between the body of the gland, and the middle of the epididymis. This sac, which varies much in size, is formed by the distension of the cul de sac, which he has described as existing naturally at this part. Two examples of this kind of pouch are contained in the Hunterian Museum, one of which is figured in his work. (*Curling*, op. cit. p. 79.) In large hydroceles the epididymis is usually flattened, elongated, and displaced; and instead of a pouch being formed, the central part of the epididymis is drawn to some distance from the body of the testicle. In the hydroceles of children, the testis occupies a lower situation than the same organ in the hydroceles of adult persons, and the swelling passes further up towards the abdominal ring. The hydrocele, in fact, is in them situated rather in front of the cord, than of the testis, which is always at the lower and back part of the swelling.]

Dupuytren and Sir Astley Cooper relate cases in which the trocar had been passed into the testicle, which was adherent in front, and such facts prove the necessity of always endeavouring to learn the precise situation of the gland by manual examination, before an operation is attempted. When the surgeon presses rather strongly on that organ, he will feel the part much firmer than the rest of the tumor, and the patient will complain of a severe and peculiar pain.

[The following are the symptoms and general characters of simple hydrocele:—an oval or pyriform elastic swelling, with sensible fluctuation, and smooth and even surface, commencing in the scrotum, and extending upwards. At its back part there is a firmer and more solid feel from the position of the testicle, which can then be compressed, and if the hydrocele be not too large, the spermatic cord can be felt above it. The larger the hydrocele, the more tense it becomes, and the cutaneous veins are prominent; sometimes it is so soft and lax that both the testicle and the fluid surrounding it are easily discoverable. The penis is partly or wholly buried in the swelling, and the surrounding skin is drawn forwards into the scrotum, giving to the orifice of the prepuce a form resembling the umbilicus. The tumor is perfectly indolent, in itself is painless, but according to its dimensions, if unsupported, causes a degree of uneasiness in the loins. If examined by transmitted light, it is found to be transparent throughout, except at the position of the testicle, where it is opaque. Its progress is slow, and after attaining to a certain size it remains stationary; but occasionally it continues to enlarge without cessation.]

The *transparency* of the tumor, according to Pott, is the most fallible and uncertain sign belonging to it; it is a circumstance, says he, which does not depend upon the quantity, colour, or consistence of the fluid constituting the disease, so much as on the uncertain thickness or thinness of the containing bag, and of the coverings of the tunica vaginalis. If they are thin, the fluid limpid, and the accumulation made so quick as not to give the tunica vaginalis time to thicken much, *the rays of light may sometimes be seen to pass through the tumor.*

With respect to Pott's remarks on the transparency of the swelling, as a symptom of hydrocele, they are correct in the main, inasmuch as the absence of this sign is no proof that the disease is not of this nature. But on the other hand, it should have been explained that, *when the transparency is present, it is one of the surest marks of this species of hydrocele.*

[Mr. Curling properly observes that the value of transparency, as a sign of hydrocele, is underrated in these remarks. In ordinary cases the surgeon should certainly be able to detect the disease *without* its assistance; and this is the more necessary, as its absence is no proof that the tumor is not a hydrocele. But it would be absurd, he adds, to reject the aid of a symptom which, when present, constitutes one of the most certain signs of the disease, because of its inconstancy; and, in the present day, there are few surgeons, even of experience, who do not avail themselves, in cases of doubt, of this ready and simple mode of examination. (Op. cit. p. 87.)

Independently of the diagnosis, there are other advantages in it, for the exact position of the testicle can always be ascertained; and this is of the more importance in the encysted form of hydrocele, or where there is inversion of the testicle, so that the risk of injury may be avoided. It is usual to examine a hydrocele in a dark room, with a lighted candle, the tumor being thrust forward by the hand grasping it from behind, whilst the edge of the other hand is applied to the front of the tumor in order to intercept the light from the candle. A common stethoscope is often employed to detect the position of the testicle. Segalas recommended the use of a tube in doubtful cases.

In old hydroceles the sac is often very much thickened, together with the surrounding tissues. It is occasionally indurated, and in the lapse of years becomes apparently ossified. These alterations have been attributed to the effusion of fibrin on the parietal portion of the tunica vaginalis. Cartilaginous and calcareous concretions are sometimes found in the fluid in long existing examples of the disease. They have been observed by Sir A. Cooper, Curling, Laennec, Gosselin, and many others. The glandular structure of the testicle is usually sound, although it may have become flattened by the compressed fluid.]

Occasionally the tumor is constricted in its middle, so as to present the hour-glass shape. This is the *hydrocele en bissac* of French pathologists. The two portions for a certain time communicate, but at length, the opening between them may become obliterated. [This peculiarity is observable in children after birth, from the tunica vaginalis being unobliterated for some distance along the cord. The contraction is found just above the testicle, corresponding to the point where the obliteration of peritoneum usually takes place.] A gentleman applied to Sir B. Brodie with an hour-glass hydrocele. The water was drawn off from the lower part, and in doing that, it emptied also the upper. A year later the operation was repeated, but now the tumor formed two distinct compartments, the constriction having completely obliterated the communication. Another puncture was therefore requisite. (*Sir B. Brodie, Lond. Med. Gaz.* for 1833-34, p. 91.) [A somewhat similar contraction is sometimes produced by bands of adhesions between the surfaces of the tunica vaginalis. In consequence of the sac and its investing tissues yielding unequally to the pressure of the fluid, the surface of the tumor, instead of being smooth and even, may be more or less irregular and unequal.

The fluctuation will be found to vary according to the quantity of fluid, and the thickness or thinness of the vaginal coat. The size of the hydrocele has been noticed to vary, being larger and more tense in the after part of the day than in the morning, and this has depended upon some slight absorption during the night, when the parts have lain at rest.] From the prominence of the tumor it is very liable to be ruptured by an accidental blow, and if a blood-vessel is burst, the hydrocele is converted into a hæmatocele. (See HÆMATOCELE). In other instances, the fluid simply escapes into the areolar tissue, and the swelling subsides. Sir B. Brodie relates a case in which these circumstances happened, but the disease returned, and was afterwards cured in the usual way. Bertrandi and Sabatier have known a cure follow violent efforts in coughing, or expelling the urine. Loder records a cure which arose from the tunica vaginalis being burst by the kick of a horse. Similar facts are cited by MM. Boyer, Serre, and Bertrandi. In a case under M. Roux, on the day fixed for tapping the hydrocele, the fluid had all disappeared. (See *Alf. Velpeau, Nouv. Élém. de Méd. Opér.* t. iii. p. 511.)

[Although the diagnosis of a hydrocele may generally be made out with facility, it is nevertheless liable to be confounded with various tumors of the testicle, of which medullary cancer is one of the more important, and also with inguinal hernia, and hæmatocele. In malignant disease of the testicle "the progress of the malady, the absence of pain, the regularity in the form and extent of the swelling, and the appearances of fluctuation in the degenerated gland, might sometimes give rise to error. The following signs, however, will help us to recognise the true nature of the disease: — in cancer, besides softened spots, we find others harder again, which do not occupy the position of the testicle, and throughout which pressure does not produce that active pain which ensues when the testicle is compressed ; a hydrocele is transparent, whereas a cancerous tumor is opaque." (See *Nélaton, Path. Chir.* t. v. p. 611.) Sometimes it is almost impossible to distinguish between the two, notwithstanding these precautions; such cases have occurred to Dupuytren, Curling, and others. In obscure cases it is recommended to introduce a grooved needle or fine trocar into the swelling, when, if the case be hydrocele, the escape of fluid would at once manifest the nature of the disease. The case of Mr. Curling was an indolent tumor of small size in the scrotum of an old man ; it was irregular and uneven, felt solid, and weighed heavy, and it was uncertain whether it was morbid enlargement of the gland, a hæmatocele, or a hydrocele with the sac unusually thickened and indurated. He died of disease of the chest, and the tumor was found to be a hydrocele, the sac of which was lined with a thick and very dense false membrane, and contained a soft oleaginous substance, consisting chiefly of cholesterine. The difficulty of diagnosis, in cases of cartilaginous thickening of the tunica vaginalis, has been well attested by Dupuytren.

In inguinal hernia the tumor is developed at the ring, and gradually descends, whereas in hydrocele the swelling commences at the lower part of the scrotum. The spermatic cord is felt above the tumor, but in hernia it is either traced along the back of the swelling, or not at all observed. The testicle cannot be felt distinctly in hydrocele, but in hernia the gland can be readily perceived at the bottom of the swelling; and, lastly, in hydrocele there is no impulse on coughing, and the tumor mostly remains of one size. (See HERNIA.) The diagnosis between hydrocele and hæmatocele is oftentimes extremely difficult, but transparency does not exist in the latter, and the surgeon will be guided in some measure by the patient's previous history. (See HÆMATOCELE.)]

Independently of the diagnosis between a hydrocele and the affections already named, it must be remembered that it may be complicated with disease of the testis, hernia, cirsocele, hydrocele of a hernial sac, or encysted hydrocele of the cord.

A collection of fluid in the tunica vaginalis, complicated with chronic induration and enlargement of the testicle, is well known under the name of *hydro-sarcocele.*

" Here (as Sir Benjamin Brodie has remarked), there is local cause of irritation. The tumor of the testicle keeps up an increased secretion of fluid from the inner surface of the tunica vaginalis, just in the same manner as a solid tumor of any kind, projecting into the cavity of the abdomen, may lay the foundation of one kind of ascites, or as a medullary tumor of the lung, projecting into the cavity of the chest, may produce hydrothorax." (*Lond. Med. Gaz.* vol. xiii. p. 89.) In some instances of this disease its nature sometimes remains questionable, until the evacuation of the fluid gives the surgeon a fair opportunity of ascertaining the diseased state of the testicle.

A hydrocele of the tunica vaginalis is sometimes divided into several distinct cells, or cavities, each of which requires to be opened to discharge its contents. The complication of a hydrocele of the tunica vaginalis with an encysted one of the cord, may generally be known by the swellings having begun at two different points, and by a kind of constriction between them. The latter symptom is, however, not infallible, because the tunica vaginalis of a common hydrocele is sometimes more or less constricted at the middle of the tumor, which is thus made to appear as if it consisted of two distinct pouches. While the two kinds of hydrocele have an interspace between them, they may readily be distinguished.

Hydrocele, complicated with hernia, is chiefly seen in old subjects. The hydrocele is commonly situated in front of the hernia (see *Sir A. Cooper, On the Testis*, p. 175); but now and then, though very rarely, it glides behind it. (See *Dupuytren, Clin. Chir.* t. iv. p. 450.) When the hernia lies in front of the hydrocele a portion of intestine, or omentum, sometimes passes through rents in the tissues covering the tunica vaginalis, and projects into the midst of the fluid of the hydrocele. These secondary tumors are covered by the hernial sac, and by the serous coat of the testicle.

The combination of hydrocele with hernia should always be remembered in operations for this last disease in a state of strangulation, and also in tapping a hydrocele, especially as their relative situation to one another is subject to variety. The surgeon must avoid plunging a trocar into a hernial sac ; cutting the coverings of a hydrocele instead of those of a hernia ; and dividing the ring when the bowel is strangulated in a laceration of the tunica vaginalis of a hydrocele. (See *Dupuytren*, op. cit. p. 452.)

[As hydrocele is commonly met with, it is essentially chronic; but when the symptoms have commenced with inflammation it constitutes *acute hydrocele.* The same changes then take place as in other serous membranes, namely exudation of lymph and serum, and the former may present a honeycomb appearance, as is noticed sometimes in the pericardium. Such cases have been described by Sir Benjamin Brodie, Curling, and others. In the museum of the London College of Surgeons is a preparation showing the effects of inflammation after the application of lunar caustic; it is figured in Mr. Curling's work on the Testis, p. 74. Another preparation of the same kind is preserved in the museum of the Dublin College of Surgeons, in which the inflammation arose from the passage of an instrument in a case of enlarged prostate. Mr. Curling mentions that " inflammation of the tunica vaginalis is not only the most frequent disease of the testicle, but it is also one of the most common affections to which the body is liable. In some of the disorders of the gland, especially orchitis, this membrane usually becomes inflamed, and adhesions between its opposed surfaces are scarcely less common than those of the pleura." (*Curling*, op. cit. p. 76.)]

TREATMENT OF HYDROCELE OF THE TUNICA VAGINALIS.

A hydrocele is by no means a dangerous complaint, though from its weight and size it is a disagreeable incumbrance, and the patient is always obliged to wear a bag truss or suspensory bandage, in order to prevent a painful extension of the spermatic cord. Troublesome excoriations are also frequently caused by the friction of the tumor against the inside of the thigh; and when the swelling is very large, it draws over itself the integuments of the penis, which appears buried in the tumor, and the genital functions are seriously interrupted. Hence the greater number of patients are very anxious for relief.

[It does not often happen that a hydrocele undergoes a spontaneous cure in adults, although this is a constant occurrence in infants. Mr. Pott has recorded two instances in the adult of confirmed hydrocele, which subsided without treatment. One was a gentleman, aged forty-five years, in whom the dropsical collection dispersed during six weeks' confinement for a severe fit of gout. The other, a middle-aged man, who fell, whilst intoxicated, and struck his scrotum against a piece of scaffolding, which caused considerable ecchymosis. In a fortnight this had disappeared, and the hydrocele was found to be smaller. In three weeks the whole of it had subsided, and it did not afterwards return. (See *Pott's Chir. Works.*) It is most probable that the sac was ruptured, and the cure effected by inflammation of the membrane, the result of the injury. The accidental rupture of a hydrocele by violence, however, does not always lead to a radical cure: one instance of this has been already cited of Sir B. Brodie; another is mentioned by Sir Astley Cooper, in which the fluid collected again; and another is quoted by him, in which the blow changed the hydrocele into a hæmatocele. (*On the Testis*, op. cit. p. 177.)

Sir B. Brodie also mentions that he has met with two examples of the spontaneous cure of hydrocele. In one of them the removal of the disease appeared to have resulted from inflammation set up in the sac. (See *Lond. Med. Gaz.* vol. xiii. p. 90.) A hydrocele has even been known to disappear permanently after an attack of orchitis, consequent upon the extension of inflammation from the urethra. But these cases are, as Mr. Curling remarks, exceptions to the general rule, and are not to be taken into account in determining upon the treatment to be adopted.]

The surgical methods of cure, though various, are all reducible to two, viz. the *palliative* and the *radical.* One merely gives temporary relief by discharging the fluid, which commonly soon accumulates again. The other aims at bringing about a complete and permanent cure.

[*The palliative treatment* consists of an extremely simple operation, and one of easy performance, and with ordinary precaution is free from danger. It consists in puncturing the tumor so as to allow of the escape of the fluid in the sac of the tunica vaginalis. The operation may be performed with a lancet or a trocar, but most usually the latter is employed. Formerly, the lancet was much used in doing this operation, but it is not now much employed; for, as Mr. Curling remarks, "the whole of the fluid cannot well be evacuated through the opening thus made, without much squeezing and handling of the parts; and there is also the risk of division of some small vessel which, by pouring blood into the tunica vaginalis, may produce a hæmatocele." (Op. cit. p. 96.) The same surgeon lays down some good rules in the selection of a proper trocar, the canula of which is about two inches long, and a line in diameter. In selecting an instrument the surgeon should see that the canula fits properly, and that its shoulder does not project too much; cr else, after the point of the trocar has penetrated the cyst, the canula may hitch outside it, and instead of entering the cavity, push the tunica vaginalis before it. In such a case, if the accident be not perceived in time, the testicle, or the back part of the cyst, is very liable to be wounded. The trocar, before being used, should be thrust through a piece of washleather held tense, and unless it penetrates readily, the instrument is unfit for use. This advice, Mr. Curling observes, may seem unimportant, but it should be recollected that, in addition to converting the case into a hæmatocele, any bungling in an operation, of so simple a nature as the tapping of a hydrocele, may induce the patient to suspect a general want of skill.

As usually performed, the operation is done with the patient in a standing position; but it is recommended that, if he be timid, or liable to faint, or that the tumor is very bulky and inconvenient by its weight, he may be seated in a chair, or placed in a recumbent position. The following are Mr. Fergusson's directions for tapping a hydrocele:— "The scrotum should be seized in the left hand, gently raised, and squeezed so as to render the skin tense in front; then the point of the trocar, held in the right hand, with the apex of the forefinger almost close upon it, should be thrust into the front of the swelling, about midway between its upper and lower end, at any interval between the vessels of the scrotum. As soon as the instrument has entered, which will be readily known by the cessation of resistance, the finger must be raised, and, as the trocar is withdrawn, the canula should be thrust somewhat deeper, where it must be allowed to remain until the fluid has run off." (See *Fergusson's Pract. Surgery*, 4th ed. p. 738.) When the operation is over, and all the fluid is drawn off, the canula is to be withdrawn, and the edges of the wound slightly squeezed together, and a small piece of adhesive plaster applied to the wound.

The value of the trocar and canula over the lancet is thus seen in the complete evacuation of the fluid. Although it is recommended to make the puncture a little below the centre of the anterior part of the tumor, as the most convenient on account of the position of the testicle at the upper and back part of the hydrocele, yet the situation of the testicle should be first ascertained, as its position may have become altered by adhesions or other causes, in which event it may be necessary to puncture at the side, or even behind. It is recommended as better, however, to avoid the posterior part if possible, as in this situation there is some risk of wounding the spermatic artery. On no account should the surgeon neglect any of the customary precautions, for it has been most truly remarked, that simple as the case may appear, more mishaps have occurred in the puncture of hydroceles than in any other operation in surgery.

Free from danger as the operation of tapping a hydrocele ordinarily is, it is important that the patient, after the parts have been properly suspended, remain quiet for the next twenty-four hours; he should be directed to walk as little as possible during that period, and to abstain from all active exercise for a day or two; this is the more necessary in individuals of an irritable or unhealthy constitution, or in advanced life. If this advice is neglected, *acute* inflammation of the tunica vaginalis is liable to succeed the operation, with, perhaps, sloughing of the scrotum, or other bad consequence. Mr. Curling tapped the hydrocele of a healthy man, who, notwithstanding this precaution given him, walked several miles the same afternoon; severe inflammation of the sac followed, with sloughing of the scrotum, and after much suffering, he recovered in eight weeks, with the disease cured. A healthy man had his hydrocele tapped by Mr. Lawrence, and went to work immediately after the operation, his occupation requiring him to run up and down stairs; the consequence was, an enormous hæmatocele, but from which he recovered. (The *Lancet*, vol. i. for 1860, p. 394.) Another instance, of a similar kind, occurred to Mr. Wakley junr. in a bookbinder, aged 15, who went about his avocations immediately after the operation, which was followed by a hæmatocele larger than the original tumor; from which, however, he recovered. (*Idem.* vol. i. for 1849, p. 313.) A person, whose hydrocele had been tapped in the morning, travelled at night by the coach to Manchester, and had sufficient inflammation brought on to produce a cure. (See *Sir A. Cooper*, *On the Testis*, p. 181.) At a later period of life, if proper precautions be not taken, the palliative operation can scarcely be viewed as free from danger. Sir Astley Cooper mentions two instances of persons in advanced age, who walked out the day after the operation; this was followed by inflammation and sloughing, which ended fatally. Mr. Hamilton, of Dublin, related to Mr. Curling a case of gangrene of the scrotum ending fatally, which occurred in a person of unhealthy constitution, from simple tapping. The necessity for rest and quietude after the operation, especially in aged persons, will be apparent from what has been just related.

The small wound made by the puncture usually heals by the first intention, sometimes it festers, and there may be some surrounding subcutaneous œdema. The operation should be repeated as soon as the tumor has become sufficiently large to require it, from its inconvenient size and weight. The period of time before it will be again required varies much in different individuals; in some it may be a year, in others as much as three or four; while its repetition may be necessary in some cases every four or six months, if the fluid collects rapidly. A small quantity of fluid gives rise to much uneasiness in some persons, whilst others, again, experience but little inconvenience until the hydrocele has attained a large size. The patient's feelings will, in the majority of cases, be the best guide for a repetition of the operation. It seems to be admitted, on all hands, that the palliative cure is the most suitable for very old persons.]

Various Plans for the Radical Cure.

External Applications.—[These are found to be successful in very young children, and succeed in nine cases out of ten, according to Sir B. Brodie; but in adults they mostly fail. Mr. Keate recommended, in 1788, a lotion of an ounce of hydrochlorate of ammonia, four ounces of distilled vinegar, and six ounces of water. This, or painting the scrotum with tincture of iodine, will generally cause the absorption of the fluid; but it should be conjoined with support to the scrotum, by means of a bandage. If this is not successful in children, it is recommended to puncture the sac with a cataract needle in two or three places, and allow the fluid to run into the areolar tissue of the scrotum.

In adults, the cure of hydrocele has been attempted by highly stimulating lotions and liniments, frictions with iodine, tartar emetic, and mercurial ointments, and the repeated application of blisters to the scrotum. Dupuytren once succeeded in curing a hydrocele by blisters; Sir Astley Cooper tried blistering repeatedly, without a cure; and Mr. Curling has applied blisters and the mercurial liniment in many cases, but without success.] Velpeau saw two hydroceles cured by the muriate of ammonia lotion and frictions with mercurial liniment. I believe with him, that in general such treatment will succeed when the hydrocele is recent, and has arisen from an external injury, or in children; or when hydrocele is the result of inflammation of the testis the plan will answer (*Sir A. Cooper*). [Dr. Hudson cured a hydrocele after puncture and other means had failed, by the use of tartar emetic ointment for two weeks; the inflammation produced effected a cure. (*Amer. Journ. Med. Sciences*, 1855.) Dr. Lorenzo Rossi, of Venice, has cured hydrocele by compressing the layers of the tunica vaginalis, by means of plates of lead, leaving the testicle and cord quite free. Punctures had failed before compression was resorted to. (See *Lancet*, vol. i. for 1848, p. 314.) M. Pétrequin, of Lyons, has cured hydrocele by electricity. (See *Gaz. Méd.* Jan. 1859.) The want of success which attends external applications, unless in certain solitary instances, is a serious objection to their employment, besides the loss of time which this mode of treatment occasions. In young children, however, it commonly cures.]

Of other methods which have been resorted to for the permanent cure, besides external applications, may be mentioned acupuncture, incision, excision, the application of caustics, the introduction of a tent, the use of a seton, and the injection of various stimulating fluids into the tunica vaginalis. Some of these are now exploded; some are practised by a few with success, but with much suffering; some are uncertain; while others are recommended both by their mildness and general success.

Acupuncture.—[This plan was first suggested by Mr. Cumin, of Glasgow, who recommended it to be done by means of a cataract needle, introduced between the cavity of the tunica vaginalis and the areolar tissue of the scrotum. He did not, however, actually treat a single case.] Mr. Lewis was the first surgeon who recommended it on the ground of its practical utility in effecting a radical cure. He punctured the hydrocele with a fine needle, until a drop of fluid oozed out on withdrawing it, and in three days (says he) the hydrocele will completely disappear. In fifty cases there was not a single failure. (See *Lancet*, vol. i. 1836—37, p. 559.) [The absence of danger, the slow re-accumulation of fluid, and the simplicity of the operation, are the advantages which he considers to be obtained by this mode over the operation of removing the fluid at once. Dr. Lanyon has treated a number of cases by Lewis's plan with a radical cure. (See *Lancet*, vol. i. 1847, p. 199.) Mr. Curling employs a common cataract needle, introduced in two or three places, rotating the instrument between the finger and thumb, to render the openings in the sac sufficiently patent. "In the course of a few hours the scrotal swelling becomes a good deal changed, and instead of a tense, smooth, and defined tumor, presents an œdematous tumefaction, with a soft, doughy, and inelastic feel. In large hydroceles the œdema extends to the integuments of the penis." (Op. cit.) The effused serum gradually disappears, in from three days to a week.] I tried the plan of Mr. Lewis once in University College Hospital, but it required to be repeated several times, and the tumor was a long time in disappearing. I attended a clergyman who had a hydrocele, and, in attempting to introduce the trocar and canula into the tunica vaginalis, the canula was stopped by its edge being too thick; and, on withdrawing the instrument, the serous fluid passed into the cellular tissue. The fluid was absorbed, and did not collect again. In Germany, as I am informed, acupuncture for the radical cure of hydrocele is followed up by the plan of making considerable but equable pressure on the scrotum, with compresses and a bandage, whereby the fluid is made to escape more certainly into the cellular tissue. [Dr. Linhart adopts subcutaneous incision in children, and allows the fluid to become effused into the scrotum. "A fold of the scrotum should be raised, and a concave tenotomy knife passed in front, between the scrotal skin and the serous sac, so as to make an incision of from one to one and a half inches in length, in the processus vaginalis. (See *Froriep's, Notizen*, 1856, vol. ii. No. 4.)] The attempt to cure hydrocele by acupuncture is not new; my friend, Mr. Robert Keate, having found in the Medical Gazette for Feb. 1837, p. 789, that it was tried twenty years ago by a physician on himself, and with a perfectly successful result. [It has been tried by Mr. Keate, Mr. Travers, Mr. Curling, Mr. Stanley, and many other surgeons both in hospital and private practice, with a varying amount of success; and although it is perhaps the mildest plan of all, it is uncertain in its results. It is a useful addition to our other remedial means, but cannot supersede the trocar. Yet it is likely to be generally useful in children. Mr. Curling refers to a patient under Mr. Luke, who was about to proceed to a place in South America, where there was no surgeon nearer than 400 or 500 miles, who was instructed to perform this simple and harmless operation on himself.]

Incision.—Making an incision so as to lay open the cavity containing the fluid, is the most ancient method, being described by Celsus. Paulus

Ægineta says, the incision is to commence at the middle of the tumor, and be carried to the upper part of it, in a line parallel to the raphe. This incision is only to go through the integuments; the bag which contains the water is then to be opened, and part of the sides of the sac taken away. A director is next to be introduced, and a division of the tunica vaginalis made to the bottom of the swelling. The cavity is afterwards to be dressed with lint, and healed by granulations. Hildanus, Dodonæus, Wiseman, Cheselden, Heister, and Sharp, all coincide in stating the dangerous and even fatal consequences sometimes following this mode. Pott also severely condemned this operation, while B. Bell preferred it to every other. [M. Jobert, of Paris, has cured several cases by this method, but the treatment proved very severe, and confined the patients to bed for a long time. Mr. Curling has seen three cases of hydrocele, attended with considerable thickening of the sac, successfully treated by incision, after injections had failed; the consequences were less severe than the representations of Pott and Sharp would lead us to expect: but in these cases the tunica vaginalis was evidently less disposed to inflammation than usual. (See *Curling's Work*, already quoted, p. 104.) At the present day this plan of treating hydrocele seems all but abandoned, but under certain conditions, in which great thickening of the sac, or loose cartilages are present, an incision may be made with advantage.]

Excision.—Albucasis gave the first clear account of this operation, though Celsus has certainly mentioned removing some of the sac. White and Douglas used to adopt this method. The latter advised making two incisions, so as to form an oval, from the upper to the lower part of the tumor; dissecting off the oval piece of the scrotum, and then making an opening into the sac, and enlarging it with scissors. The tunica vaginalis was next to be entirely cut away, close to where it was connected with the spermatic vessels. The cavity was afterwards filled with lint. [It was in 1755 that Douglas revived excision in England, and about the same period Bertrandi, and several surgeons of eminence in France adopted the operation; but it soon fell into disuse, and is now nearly exploded.] In later years it has been modified by Mr. Kinder Wood, but his plan differs entirely from the ancient method, and is one of the mildest modes of excision yet suggested for the radical cure. It consists simply in puncturing the hydrocele with an abscess lancet, and drawing out a little bit of the sac with a tenaculum, and cutting it off. (See *Med.-Chir. Trans.* vol. ix. p. 33.) [Sir James Earle, Sir Astley Cooper, and Mr. Curling condemn the operation; the last-named surgeon remarks that "Mr. Wood's report, although his experience at the time it was published was very limited, is upon the whole favourable; but the advantages which he claims for this mode are not such as appear to me to entitle it to any preference over injection." (Op. cit.) Mr. Curling has seen it practised but once, on a young man in whom the sac was thickened, and after injection had failed. In modern days, excision is only sanctioned when the tunica vaginalis is in a more or less ossified state; for a mere thickening of it does not prevent the success of milder plans of treatment. In a case of hydrocele in which the walls of the sac were so thick that they did not collapse after tapping, Mr. Hutchinson dissected away the front wall, and dressed the opening with charpie. Suppuration followed, and the patient was cured. (See *Med. Times*, vol. xiv. 1857.) Walsch has practised a more simple proceeding than any of the preceding; it consists of dividing the tissues to the extent of a few lines, down to the vaginal sac, dissecting and excising a little flap of the serous membrane, evacuating the fluid, and reuniting, by means of sutures, the borders of the wound made in the membrane. (See *Nélaton Chir. Path.* t. v. p. 612.)]

Caustic.—Paulus Ægineta advised destroying the skin with a cautery of a particular form, dissecting off the eschar, and then cauterising the exposed membrane. It has been practised and described by many others, and recommended by Mr. Else and Mr. Cline. The former advised the laying "a small caustic upon the anterior and inferior part of the scrotum, which it is intended to affect, and, if possible, penetrate through the tunica vaginalis." The intermediate parts have also been destroyed by the actual cautery.

The objections to caustic are the needless destruction of parts, and the formation of an unhealthy sore; besides which its action cannot always be regulated, its operation is slow, and the consequences sometimes unnecessarily severe and painful; and death has been known to ensue from its application. Its use, therefore, has long been superseded by safer and milder measures.

Tent.—This was first mentioned by Franco. The operation consists in making an opening into the tunica vaginalis, and keeping the wound open with a tent of lint, linen, or sponge, so as to make the cavity suppurate in which the water was contained. [Sometimes the tents were smeared with irritating substances, and occasionally a more solid substance, such as a canula, or piece of elastic gum catheter, were introduced in place of the lint, so as to induce inflammation. When the tent was not of an irritating nature, and was soon removed, the inflammation excited terminated in the effusion of lymph, and the adhesion of the sides of the membrane. When suppuration followed in less favourable instances, the cyst was obliterated by granulation.]

The distinguished French surgeon, Baron Larrey, recommended, after drawing off the fluid by means of a trocar, the passage of a short piece of elastic gum catheter through the canula into the interior of the tunica vaginalis, and to leave it there until a sufficient amount of inflammation was excited to procure adhesion of its surfaces. (*Mém. de Chir. Militaire,* t. iii. p. 409, &c.) [Although he has spoken of it so favourably, it does not seem to have answered in the hands of others; and this, as well as other forms of the tent, are rarely resorted to at the present day for the cure of hydrocele. Recently, however, Dr. Solis cured a double hydrocele in forty-three days by the introduction of lint into the vaginal sac. This plan is called the treatment of Dr. Argumosa, and is frequently practised at Madrid. (*La Union*, *Anales de Cirugia*, 1851.)]

The Seton was first mentioned by Guido di Cauliaco in 1498, as a means of curing hydrocele. In modern times, Pott preferred it to every other method, if we except injection, of which, according to Sir J. Earle, he expressed his approbation before his decease. When stimulating lotions fail, Sir A. Cooper retained a preference to the seton for children, on account of its more easy application in them than injection. (*On the Testis*, p. 194.) Pott's plan consisted in passing a seton of coarse sewing silk, by means of an eye-probe, carried through the canula of the trocar along the whole length of the sac. [Within twenty-four hours after this has been done the parts begin to inflame, and resemble a hernia humoralis, and require to be treated in the same manner as in that complaint. When the parts have resumed their natural state, which is in about ten or twelve days, the seton is gradually removed, a few of the threads only being withdrawn at a time. Mr. Green has advocated this plan, and his operation is nearly the same as Pott's, but that the seton is retained upon an average about twenty-four hours, at which time inflammation has set in. (See *St. Thomas's Hospital Reports*, No. 1, p. 59.) Dr. James Deane, of Greenfield, Mass., has employed a seton of many distinct threads for many years in hydrocele, and in a considerable number of cases he had but one failure, and but one case of suppuration. The time of its retention has varied from one hour to two weeks. He does not withdraw it until after the inflammation has subsided, as was practised by Pott. (See *Boston Med. and Surg. Jour.* vol. xxxiii. 1845.) Mr. Skey has treated several hydroceles, which had resisted other treatment, by means of a thread passed through the sac; he recommends withdrawal if much irritation follows. (See *Oper. Surgery*, ed. 2, p. 606.) Mr. Curling has resorted to a seton of two or four threads in many cases of encysted hydrocele of the cord or testicle; and, as the tumor in these cases is usually small in size, the seton proves the best means of cure. In cases of simple hydrocele, after the failure of injections by others, he has also used the seton with success; and he has tried it, too, in cases where no other treatment has been adopted. The great objection to its use in simple hydrocele he considers to be the uncertainty of its operation.

Of later years metallic setons have been given a sort of preference over the thread and silk, but up to the present time the results have been by no means comparable to those following the use of injections; the number of cases, too, have been comparatively small in which they have been tried. M. Duperry, in operating for hydrocele, passes the trocar through the scrotum, like a seton needle. In 200 cases, 89 were cured by the admission of the air, or air and water: in 114, liquid excitants were required to produce the necessary inflammation. The point of the trocar is removable. (*Gazette des Hôpitaux*, 1851.) M. Carron du Villiards, of the Antilles, in consequence of the bad effects which result from injection in that part of the world, has devised a modification of Larrey's operation, and has performed it fifty times with forty-eight cures; and M. Camilleri and others 187 times, with but seven relapses. It is attended with no accident and no pain; is adapted for all complications of hydrocele, is of easy execution, and requires but little confinement or after-treatment. He punctures the most dependent part of the scrotum with a strong and narrow lancet, which he passes slowly in. As soon as fluid escapes, he slides a long narrow trocar along the blade of the lancet, keeping the point of the instrument within the canula, until the upper boundary of the tumor is reached. Here the canula is projected externally, and it is replaced by a grooved silver wire, which traverses the two apertures, and is left *in situ*, on removal of the canula. Spirit lotions are used, and after twenty-four hours, inflammation is set up. On the twelfth day (the patient being usually able to get up on the third) the wire is removed, and a suspensory bandage worn for twenty-five or thirty days, when the patient is cured. (See *Mon. des Hôpitaux*, 1857, No. 128.) A single silver wire, applied in the same manner as threads, has been tried lately by many surgeons with variable success. In the hands of Mr. Pollock and some others, they have proved effectual in perfecting a radical cure. (See *Lancet*, vol. i. for 1859, p. 266, and vol. i. for 1860, p. 36.) On the other hand, they have not only failed, but cases are related in which the life of the patient was endangered by the extreme severity of the constitutional symptoms, and suppuration of the sac has ensued in several instances. Mr. Pollock considers the advantage of using the wire seton to be, that the patient suffers much less pain than when the sac is injected with iodine. The general test of united experience, however, goes to prove that this method of treatment does not fulfil the expectations of those surgeons who have been led to try it, and it has already been nearly abandoned.]

Injection.—[The treatment of hydrocele by this method, was first proposed by Celsus, who advised the use of a solution of nitre. Lembert, in his *Œuvres Chirurgicales* (1667), recommended the injection of sublimate dissolved in lime water. Mr. G. Monroe, a Scotch surgeon, revived this practice about the middle of the last century, and at first employed spirits of wine, but subsequently, in consequence of the pain which it excited, substituted wine. (See *Monroe on the Dropsy*, ed. 3, p. 322.) Mr. S. Sharp, of London, also made trial of spirits of wine. Douglas, Le Dran, and Pott, all disapprove of injections in their works. To Sir James Earle is due the credit of introducing injections into general practice, by showing the advantages of a milder mode of proceeding. He used port wine mixed with an equal quantity of water, or in the proportion of two thirds to one third of water; and this is still used by many surgeons in this country. Mr. Liston, from the commencement of his practice, was in the habit of using port wine without water, and rarely failed in effecting a cure. The strongest bodied and harshest port wine will, he observes, in some cases produce not the least heat or uneasiness in the part, however long retained. There will follow no excited reaction, and consequently no cure. Three or four ounces of port wine are injected, and allowed to remain for a few minutes, and then it is permitted to escape, when a fresh quantity is injected. After a little while the cavity is emptied thoroughly, and the surfaces are rubbed slightly on each other. (See *Practical Surgery*, p. 462.) Chelius recommends one part of red wine diluted with two of water, injected moderately warm, till the sac is almost distended to its previous size. (See *System of Surgery, translated by South*, vol. ii. p. 503.) As the strength and other qualities of port wine vary considerably, Sir Astley Cooper preferred a solution of the sulphate of zinc, ʒj. to a pint of water. This is still much used, and, with the wine, is preferred even to the iodine, presently to be described. Mr. Wordsworth has frequently radically cured hydrocele amongst the negroes of the West Indies by injecting a solution of the sulphate of zinc. (See the *Lancet*, vol i. 1857, p. 164.) Other kinds of stimulating fluids have been employed; for instance, solution of alum, nitrate of silver, lime water, cold and warm water, dilute spirits of wine, brandy and water, &c.

The tincture of iodine, originally introduced by Sir Ranald Martin whilst practising at Calcutta, is now commonly preferred as a more certain and a safer mode of treatment than any other, and is fast superseding all other substances hitherto employed for effecting a radical cure. In a report of cases thus treated at the native hospital of Calcutta, it is stated that thirty-two cases were injected in the first year, 1832; and 660 in the eighth year, 1839, showing the growing confidence of the natives of the value of this new treatment. During the eight years, 2393 cases were injected, and the failures were rather under one per cent., a result that must indeed be regarded as remarkably successful. (See *Lancet*, April 30, 1842.) The peculiar value of the iodine process is authenticated by Dr. Goodeve, another Indian practitioner, who employed retained injections in 272 cases with but two failures, or much less than one per cent. M. Velpeau employed the remedy in many hundreds of cases without accident, and he at one time had the credit of introducing iodine into practice for hydrocele; but it was long employed in India before he used it. The success of iodine injections has been confirmed by writers all over the globe. In 1148 cases thus treated only three failed; in ten, injections with port wine had failed; and in nine, port wine and sulphate of zinc had failed. (See *Frorieps*, *N. Notizen*, 1836, and *Oppenheim* in *Hamburg. Zeitschr.* 1828.) Mr. Liston abandoned the port wine for the iodine in the latter years of his life; and there are now very few hospital surgeons of eminence who do not employ it, for it must be regarded as a remedy of specific virtue in the radical treatment of hydrocele.

Sir Ranald Martin uses the simple tincture in the proportion of ʒij. to ℥j. of water, injecting only a small quantity, which is allowed to remain in the sac to be removed by absorption. It is the simple tincture which is also used by Velpeau and many others; and Mr. Fergusson thinks its effects more certain than the compound tincture. (See *Practical Surgery*, ed. 4, p. 742.) On the other hand, Mr. Curling has found this too weak, and has latterly used a compound tincture of the following strength, undiluted:—Iodine ℈ij., iodide of potassium ʒjs., spirits of wine ℥i., injecting from two to three drachms, and allowing this to remain in the sac for five minutes. The greater part of the fluid is then withdrawn, about half a drachm only being left behind in the sac. He has not found the tincture employed in this way in adults at all too stimulating. In operating, however, on persons under puberty, he dilutes it one half. (See *Diseases of the Testis*, p. 115, ed. 2.) The apparatus required for injecting a hydrocele is a medium-sized trocar, and a half-ounce glass syringe, with a metallic nozzle, which fits into a small stopcock adapted to the canula. The metallic parts are recommended to be made of palladium, which is not acted on by iodine, and is therefore preferable to silver.

A good deal of pain sometimes follows the operation, but the amount of inflammation excited by it cannot be estimated by the degree of pain suffered at the time. If the inflammation is likely to be too active, it must be moderated by suitable treatment; but if no pain or other symptoms arise, the surgeon must endeavour to excite it. Thus, in eight or twelve hours the patient must move about, and the testicle may be handled so as to occasion slight friction between the surfaces of the tunica vaginalis. If the swelling should become considerable, and the inflammation so great as to produce pain and constitutional disturbance, the treatment of acute orchitis must at once be adopted. Fortunately this is but seldom required, yet an isolated example may sometimes occur. In employing iodine it must be remembered that it is not necessary to excite a sharp attack of inflammation, for it is surprising, as has been remarked, how slight a disturbance will sometimes be sufficient for the cure, so that the surgeon is rarely disappointed in the result of the operation. A writer, who has been already quoted, observes that iodine injection so seldom fails that it is better generally to wait the result of the operation, even when the effects are mild, rather than resort to a measure which is not free from the risk of producing suppuration, namely the seton, which can be passed at a later period if the injection prove a failure.

There is a caution which it is necessary to offer before taking leave of the subject. It is, not to persist in the use of injection should the canula slip out of the tunica vaginalis and become situated in the areolar structures of the scrotum; for this is very liable to be followed by inflammation, abscesses, and sloughing. When such an accident has happened, punctures should be made in the scrotum to let out the stimulating fluid, and then fomentations should be applied and aperient medicines given. The sac of the tunica vaginalis should never be distended by the injection, as Sir Astley Cooper has shown that the cremaster muscle contracts and forces a part of it out in the areolar tissues of the scrotum.

Air and chlorine gas have been introduced into the tunica vaginalis with the effect of producing a radical cure in some instances. Mr. Lloyd, of Bartholomew's Hospital, has for years relied upon the introduction of a grain of red precipitate of mercury, which he conveys into the sac by means of a greased probe, passed through the canula after tapping has been performed; the salt is allowed to remain. The sides of the sac are then gently rubbed together, to cause the powder to be spread over the surface. (See *Lancet*, vol. i 1850, p. 28, and vol. i. 1857, p. 164, &c.) Afte practising this plan for upwards of twenty-four years, he has never failed in a single case; no unpleasant consequences have ensued, nor has the disease returned. M. Defer, of Metz, has treated a number of cases of hydrocele successfully with the solid nitrate of silver, introduced into the tunica vaginalis by means of a stilet carried through the canula, subsequent to tapping. The caustic is rubbed over the walls of the sac.]

A case is mentioned by Sir A. Cooper in which milk was injected, on the supposition of its being a mild, unirritating fluid; however, severe inflammation followed, and an abscess in the tunica vaginalis. When an opening was made, the milk came out in curds.

CONGENITAL HYDROCELE.

This term is applied to a collection of fluid in the tunica vaginalis, with a communication between the cavity of this membrane and that of the peritoneum, which was not closed at birth. When the patient is laid upon his back, the fluid returns into the belly, but descends again when the body is erect. Pressure will also cause the contents of the tumor to recede; but this happens very gradually, and less quickly than the return of a hernia. The opening of communication between the two cavities is generally small, but varies from the size of a probe to that of a goose-quill. (*Sir B. Brodie*, *Med. Gaz.* vol. xiii. p. 89.)

[In these cases it is difficult to determine whether the fluid is secreted in the abdomen or in the tunica vaginalis; since, if poured out by the peritoneum, it must naturally tend to accumulate in the more depending cavity. But as the fluid usually becomes absorbed after the communication between the abdomen and tunica vaginalis has been obliterated by pressure, it seems probable that the fluid is originally formed in the abdomen. (*Curling*, *On the Testis.*)

In the treatment of this form of hydrocele the main object is to obtain the obliteration of the neck of the sac, so as to cut off the communication with the abdomen. This is accomplished by constantly wearing a truss, so made as to press firmly on the inguinal canal; and after adhesion has taken place the fluid usually disappears: its removal may be encouraged by the application of a stimulating lotion, or may be effected by acupuncture. In early life this plan of treatment is generally successful; but should it fail after many months' trial the truss should still be worn, not only to prevent the passage of fluid from the abdomen into the sac, but also to impede the descent of a hernia, and to afford a further chance of obtaining obliteration of the opening. This form of hydrocele very rarely requires injection for its cure, and the operation, or even that of simple puncture, should never be performed unless the surgeon is fully satisfied that a communication no longer exists between the sac and abdomen. If the sac be injected before closure of its neck, peritonitis is very liable to ensue, and to endanger the life of the patient. (*Curling*, op. cit.)]

HYDROCELE IN WOMEN.

[Closely resembling hydrocele of the tunica vaginalis in man is the congenital hydrocele of women, in which, by the collection of water in the peritoneal sheath of the round ligament, a swelling is formed, which passes through the inguinal canal into the lower part of the labium pudendi, and is at first returnable, but afterwards not so.] It is an exceedingly rare disease. The researches of Sacchi, Palletta, Scarpa, Monteggia, and Regnoli, prove that it is generally situated in the canal of Nuck, and may communicate with the abdomen, or not. In one example of the kind, a cure was effected by Regnoli by incision. (See *Revue Méd.* Oct. 1834.)

Thomas Wakley, Junr.

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HYDROPHOBIA (from ὕδωρ, water, and φόβος, fear. A dread of water). This being for the most part a striking symptom of the fatal indisposition which results from the bite of a mad dog, and some other animals affected in the same way, the disease itself has been named hydrophobia: some have used the more general term hygrophobia, from ὑγρὸν liquid. But strong objection has been made to both these terms, because derived from a symptom which does not exclusively belong to the disease, nor constantly exist in it.

The old writers, as we learn from Cœlius Aurelianus, used the terms aërophobia, or a dread of air, and pantehobia, or a fear of all things, since the impression of cold air sometimes excites terror, and the disorder is marked by a singular degree of general timidity and distrust. Others called it phobodipson (δίψος signifying thirst), because the patient is thirsty, yet fears to drink. Several modern authors, however, objecting to any appellation expressive only of one symptom, denominate the disease rabies, and rabies canina, canine madness.

and λύσσα, lyssa, fury. [The French call it *la rage*. The Germans call the disease in the dog *Hundswuth* or *Tollmuth*, and in man, *Wasserscheu*. The Italians name it *rabia*.

The first mention of rabies is made by Aristotle (*Hist. Animal.* lib. vii. cap. 22), who held, however, the erroneous opinion that man is incapable of being infected by the bite of a mad dog. Xenophon seemed to share the same opinion. (*Anabasis*, v. 7, 26.) Asclepiades first taught that man can suffer from the bite of a rabid dog, and pointed out the symptom of the horror of water, which is peculiar to man. Probably the long time which intervenes between the injury and the development of the disease had prevented the earlier observers from attributing the disease to its true origin. Pliny also speaks of the fatal result of the bite of a rabid dog in producing hydrophobia. (*Hist. Natur.* viii. 63.) The opinions of Asclepiades, long in disrepute, were revived by Cœlius Aurelianus, who very clearly described the inability to drink, and convulsive symptoms, adding those of barking, and attempting to bite. These opinions prevailed throughout the middle ages, and since it was held that the bite, or even the contact of the saliva of the unhappy patient excited the disease in others, it became customary to put an end to the existence of those so affected.

It was not until the eighteenth century that nosologists began to classify the disease. Sauvages placing it among "perverted appetites." (1769.) Linnæus dividing it into two diseases, rabies and hydrophobia. (1763.) Vogel classing it as a fever. (1764.) Sagar as a nervous disorder. (1776.) Cullen ranking it with hysteria, among convulsive diseases of the nervous system, and subdividing it according to the presence or absence of the pretended symptom of biting.]

Concerning the antiquity of hydrophobia, however, particularly reference may be made to Dr. Hecker's observations, who thinks the fact clearly proved that the disease existed at least 400 years before Christ, and even in the most remote periods. (See *Journ. für Chir. von C. F. Graefe, &c.* vii. p. 325, &c.)

[It was an error formerly to confound under one title, and to consider as one disease, rabies in the dog, and hydrophobia in the man. Modern researches make it clear that the symptoms and course of the two diseases essentially differ: the fear of water being constantly absent in the dog, but essentially characterising the disease in man. It is the prevalent and probably the correct opinion, since all the collected facts favour that opinion, that hydrophobia in the human species can only follow the bite of a rabid dog. However, this disease, and especially the symptom from which it takes its name, may be simulated by nervous disorders arising from various causes, hence the consideration of cases recorded under the title of hydrophobia may conveniently be divided into two classes:—]

1. The first comprising all cases not ascribable to the bite of a rabid animal, or the application of some of its secretions to a part of the body.

2. The second comprehending the examples preceded by one of those occurrences.

The cases included in the first of these divisions are subdivided into the symptomatic, and idiopathic or spontaneous. By symptomatic hydrophobia is understood an aversion or dread of liquids presenting itself as an occasional symptom of various diseases, as of certain inflammatory febrile and nervous disorders, hysteria, epilepsy, injuries of the brain (*Trecourt* in *Recueil périodique, &c.* t. vi.; *Acta Naturæ curiosa*, vol. ii. Obs. 205); the operation of particular poisons (*Villermay, Traité des Mal. Nerveuses*, t. i. p. 90; *Harles, über die Hundswuth, Frankf.* 1809; *Schmiedel, Diss. de Hydrophobiâ ex Usu Fructuum Fagi, Erlan.* 1762, *&c.*), gastritis, pneumonia, hepatitis, angina, &c. &c. In many of the instances of symptomatic hydrophobia, the aversion or dread of fluids occurs on the same day as the cause upon which it depends, or a few days afterwards, and for the most part may be cured with the disease which has given rise to it, or even independently of it. On the contrary, the hydrophobia from the bite or infection of a rabid animal does not come on till a long time after the occurrence of the cause, and when once formed, has hitherto proved incurable. Whatever analogy therefore, may be imagined to exist between symptomatic hydrophobia and rabies, they differ essentially in their causes, progress, degree of curability, and also in the treatment required. (See *Dict. des Sciences Méd.* t. iv. p. 38.)

Spontaneous, or idiopathic hydrophobia denotes the questionable form of the complaint, sometimes supposed to be induced by violent mental commotion, anger, fright, &c. unpreceded by any other primary disease, to which it can be referred as a symptom.

Numerous facts upon record appear to leave no doubt concerning the reality of symptomatic hydrophobia. (*Raymond, Mém de la Soc. Royale de Méd.* t. ii. p. 457; *Roupe, Nova Acta Physico.-Med.* t. iv.; or *Pouteau, Essai sur la Rage, Lyons*, 1763; *Dict. des Sciences Médicales, &c.* xxii. p. 333; *Lond. Med. Journal*, vol. ix. p. 256.) [But in all the cases thus adduced among the earlier writers it is easy to see that the previous history has not been clearly elucidated, and that in all cases there is a high probability of a previous and forgotten bite; sometimes the very occupation and habits of the patients suggest this.] The best authorities now concur, with Dr. J. Hunter, that a disease, similar in its nature to what is produced by the bite of a mad dog, never arises spontaneously in the human subject. (See *Trans. of a Soc. for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 299—303.) Many of these symptomatic cases, however, or those in which more or less aversion, or dread of liquids, is evinced as an effect of another disease, are too well authenticated to admit of doubt. In the *Dict. des Sciences Méd.* t. xxii. art. *Hydrophobie*, may be found a great deal of information, likely to interest such readers as wish to follow up the subject of the symptomatic forms of the disease. However, in looking over some of the cases there detailed, a suspicion will now and then arise, in an intelligent mind, that the disorder was mistaken; for it will be noticed that sometimes pain shooting up the limbs preceded the general indisposition, while the rapidity of the disease and the appearances found on dissection corresponded precisely to what is usually remarked in hydrophobia. In particular, one patient is described as a man habituated to drinking, and, as a sportsman, to dogs also: he died on the third day, and on dissection, the stomach and intestines were found inflamed, and even gangrenous in several places, the œsophagus and lungs also participating in the inflammation. (*Commerc. Litter. Novemb.* 1743, *hebd.* 5.)

[Four cases in modern record are recorded as instances of spontaneous hydrophobia, which presented, according to the description, all the symptoms of true hydrophobia, and without inoculation. They are related by M. Busmout (*Lond. Med. Repository*, 1814); Dr. Momfort (*Walther and Ammon's Review. Jan.* 1849); Dr. Drake (*West. Journal, &c.* 1831); Dr. Condie (*Trans. of Philadelph. Coll. of Phys.* 1849): but in these cases, as in those of Viret and Savirotte, two at least suggest, by internal evidence, occasions of inoculation. Dr. Drake's patient was a tanner in the habit of handling recent skins, and an epizootic of rabies was at the time raging; and M. Busmout's patient was a woman taken ill on hearing the death of her husband, but, during her illness, she allowed her mouth to be licked by a dog, which speedily became rabid, and died in four days. Everything here would imply that the dog had inoculated the woman, and not the woman the dog.]

Animals of the dog kind, including the wolf and the fox, are most frequently the subject of rabies, and certain writers have maintained that, although it may be received and propagated by other animals, yet it always originates in some of the canine race. (*Hillary on Diseases of Barbadoes*, p. 246.) However, it is asserted that the disease sometimes originates spontaneously in cats, that is to say, without their having been previously bitten by another rabid animal, and such an assertion is made by Cœlius Aurelianus, Porphyrius, Avicenna, &c. not only with respect to man, but horses, asses, camels, hogs, bullocks, bears, monkeys, and even poultry. (See *Dict. des Sciences Méd.* t. xlvii. p. 45.) [Among modern observations we find an instance recorded of the asserted spontaneous origin of hydrophobia in a fox, which was tame, and being teased in its cage bit the man, who died hydrophobic. (*Smith on Hydrophobia, American Quarterly Journal of Medical Sciences*, 1855, p. 243.)]

It is interesting to inquire what animals are capable of communicating rabies, and what animals of receiving it. [Of a large series of cases collected by Tamhayn (*über Hundswuth and Wasserscheu, Schmidt, Jahrbucher*, Bd. 101), 258 persons were bitten by dogs, twenty-seven by cats, twenty-two by wolves, three by foxes, one by a bear, and one by a badger, and in all hydrophobia followed. Of animals which are subject to rabies, he enumerates the cases, in addition to the above, of seven pigs, a white bear, and a duck.] The experiment, made by Dr. Zincke, tend to prove also that birds, at least the common fowl, may have the disease communicated to them. (*Neue Ansichten der Hundswuth, &c.* 8vo. Jena, 1804.)

But though it be well known that animals of the dog and cat kinds can propagate the disorder, it is not settled whether it can be communicated by other animals. In a memoir read to the French Institute, M. Huzard explained that herbivorous quadrupeds, affected with rabies, are incapable of transmitting the disease, a position subsequently confirmed by additional experiments and observations made in the Veterinary School at Alfort. MM. Girard and Vatel inoculated, with the saliva of a rabid sheep, two other sheep, a young dog, and a horse, but none of these animals evinced any symptoms of the disease, and continued well four months after the experiment. (*Magendie in Journ. de Physiol. Expér.* viii. p. 326, &c. 8vo. *Paris*, 1828.) Professor Dupuy could never communicate the distemper to cows and sheep, by rubbing their wounds with a sponge which animals of the same class labouring under the disease had had in their mouths; though the same experiment, made with a sponge which had been bitten by a rabid dog, propagated rabies by a kind of inoculation. Dupuy has likewise seen amongst several flocks, sheep affected with rabies, yet the distemper was never communicated by them to other sheep, notwithstanding the latter were bitten in parts stripped of wool. Dr. Gillman inoculated two rabbits with the saliva of a rabid pig, but the disease was not communicated to them. (*On the Bite of a Rabid Animal*, p. 38.) [The experience, and verbally-expressed opinions of Professor Spooner, at the Veterinary College, confirm these conclusions, at the present date. (1860.)] On the other hand Mr. King, of Clifton, is stated to have communicated rabies to a fowl, by inoculating it with the saliva of an ox which had just fallen a victim to the disease. (*J. Ashburner, Diss. de Hydrophobia*, p. 29.) The author of the article *Rage* (*Dict. des. Sciences Méd.*) observes, respecting this singular case that, as it is accompanied with no details, doubts must remain whether the fowl actually died of rabies.

As for some extraordinary cases in which the disease is alleged to have been communicated to the human subject by the bite of birds, or injuries done with the claws of animals, they are generally dismissed by modern writers, with the inference that the complaint thus transmitted was not true hydrophobia or rabies. This conclusion is made with respect to the cases of this kind reported by Cœlius Aurelianus, and Bader, and the notorious example mentioned by A. Baccius of a gardener who died from the bite of a cock which, according to some, was rabid, according to others, merely enraged. Hildanus also details an instance in which a young man was scratched on the great toe by a cat, and some months afterwards was attacked with hydrophobia (*Obs. Chir. cent.* 1. *Obs.* 16); but, as a modern writer observes, if the patient were really affected with rabies, it is conceivable that the cat's claw with which the scratch was made, might have been wet with the animal's saliva. (*Dict. des Sciences Méd.* t. xlvii. p. 47.) [Dr. Wood mentions a case in which he thinks that fatal hydrophobia might be traced to the bite of a bird. This also is highly dubious. (*Wood's Practice of Medicine*, New York, 1856.)]

Another question of considerable importance is whether hydrophobia, that is to say, rabies, can be communicated from one human being to another, or whether in man the disease is infectious or contagious. Many attempts have been made in vain to communicate the distemper to several kinds of animals, by inoculating them with the saliva of patients who had perished of the disease. These experiments were made in this country by Gauthier, Vaughan, Babington, &c. but no infection was the consequence. In France Giraud inoculated several dogs with the saliva of a man in the convulsed stage of hydrophobia, but none of them afterwards took the distemper. (*Bosquillon, Mém. sur les Causes de l'Hydrophobie*, in *Mém. de la Soc. d'Emulation, cinquième année.*) M. Girard, of Lyons, collected some of the frothy saliva the instant it was discharged from a patient's mouth, and he inserted some of it into eight punctures made on the inside of a dog's four legs, yet six months after this inoculation the animal had not suffered the slightest inconvenience. (*Essai sur le Tetanos Rabiens*, p. 29.) A similar experiment was made on three dogs by M. Paroisse, who kept the animals between three and four months afterwards, during all which time they continued quite unaffected. (*Bibl. Méd.* t. 43.)

Dr. Bezard published the following experiments: pieces of the flesh of a person who had died of hydrophobia were smeared with his saliva and given to a dog, another dog was suffered to eat the salivary glands, and a third the sides of a wound. In three other dogs incisions were made, the cut parts were then inoculated and sewn up. Not one of these six animals became affected with rabies. (See *Mém. et Obs. lus à la Soc. Méd. Philanthropique, première année*, 1807, p. 17.)

The preceding experiments only furnish negative results, but there is one which tends to establish a contrary opinion. On the 19th of June, 1813, in the Hôtel Dieu at Paris, Magendie and Breschet took some of the saliva of a man who died a few minutes afterwards of hydrophobia, and, by means of a bit of rag, they conveyed this saliva to the short distance of twenty paces from the patient and inoculated with it two healthy dogs. One of the dogs became rabid on the 27th of July, and bit two others, one of which was attacked with complete rabies on the 26th of August. (*C. Busmout*, see *Collect. des Thèses*, in 4to, *de la Faculté*, Paris, 1814.) Busmout remarks in the work that the foregoing is one of the best authenticated experiments on the subject, for, in addition to the consideration of the talents and character of the experimenters themselves, the facts were witnessed by numerous medical students. And notwithstanding the objections which have been urged against the account (see *Journ. Gén. de Méd.* t. lii. p. 131), the main points are declared to be entitled to credit. (See *Dict. des Sciences Méd.* t. xlvii. p. 48, also *Journ. de Physiologie par F. Magendie*, t. i. p. 42.)

With these relations, it is proper to notice certain cases too credulously promulgated as proofs of the possibility of the disease being communicated from one human being to another. Neither the instance of the maid-servant who died merely from seeing her mistress vomit while labouring under hydrophobia (*Mich. Ettmuller, Op. Méd.* t. ii.); the case of the peasant's children, which all died on the seventh day, as is alleged, from embracing their dying father; the example of a woman contracting hydrophobia from her husband, as detailed by Mangor, (*Acta Soc. Reg. Hafniens*, vol. ii. obs. 32, p. 408); nor other cases of a similar tenor, are now regarded as proving anything more than that the patients, supposed to have caught the disease by contagion, fell victims either to violent affections of the mind and nervous system, or illnesses accidentally taking place soon after the death of a near relation or mistress. It is clear enough also, that some of the cases were, at most, only instances of symptomatic hydrophobia.

With regard to another opinion that the bite of a man or other animal, when merely enraged, may bring on hydrophobia, it is now entirely discarded as erroneous. The cases in support of it recorded by Cl. Pouteau, Mangetus, Malpighi, Zuinger, Le Cat, &c. when critically examined, only prove that the patients were affected with tetanus or symptomatic hydrophobia, not arising from any infection; for neither the mode of attack nor the progress of the symptoms, in any of the examples which are related with sufficient minuteness, lead to the inference that the patients actually died of inoculated rabies. (See *Dict. des Sciences Méd.* t. xlvii. p. 49.)

[One case only is recorded in modern times which can be supposed to favour the opinion that the human saliva is capable of communicating the disease. This case, or rather this series of cases, was published in *Silliman's Journal* for October 1832, by Rev. W. Carl, of Chester, Con. U.S. at which place the patients resided. In 1807 W. C. æt. eleven, was bitten by a dog having the symptoms of rabies, and which was soon after shot. Fifteen years subsequently the disease made its appearance. "He had a short season of strange excitement during public worship on the Sabbath. At a neighbour's house the next day, he suddenly jumped, screamed, broke windows, and ran out of the door with great nimbleness of foot. He soon became quiet and returned, and when his friends remonstrated with him for this conduct, and he said he could not avoid doing this, for he had been bitten by a mad dog. During the progress of the disease he gnashed his teeth, discharged large quantities of saliva, had distressing spasms, and was set on biting everybody and everything." He made holes in his pillow-case with his teeth, and took pleasure in attempting to spit on his attendants; when he succeeded he was seized with a fit of laughter. When he had been in this state fourteen or fifteen days death closed the scene, Sept. 1, 1820. (*Smith*, loc. cit.) L. T. C. was bitten by W. C. and three and a half years subsequently became similarly affected. "He would hop backwards and forwards, and talk incoherently for a few minutes, and then say he was sorry he conducted himself so, but he could not avoid it. He had a horror of fluid, and spurted the water which he took in the face of his attendants; he frothed at the mouth, and watched his opportunity to bite." Two other persons bitten by W. C. subsequently died with similar symptoms. It seems right to give a full account of this remarkable case here, and the more especially that it was copied into all the journals at the time of its publication. But it must be observed that the symptoms in no way accorded with those of rabies in man. The disposition to bite and spit, and the like, accord well with the popular notions of hydrophobia, and these cases must clearly be classed under those of distressing mental disorder, produced probably by the fear of hydrophobia, and ending fatally. Of this there are many other instances.]

Wrong notions, of a dangerous tendency, have been generally entertained in regard to the disease as it appears in the canine race. The writer of the article *Dog* in *Dr. Rees's Cyclopædia* appear to have had extensive opportunities of observing the disorder in dogs; from his remarks the following information may be gleaned:

The peculiar symptom which often attends the complaint in the human subject, has been applied to the disease in the dog, and has occasioned it to be called by the same name hydrophobia. This is a palpable misnomer, for in no instance does there ever exist any dread of water, on the contrary dogs are in general very greedy of it. Neither have sheep, when rabid, any dread of water, but frequently take it with great freedom, as is proved by some experiments of which an account is given in *Magendie's Journal*, t. viii. p. 328. Such unfounded supposition has often conduced to a very fatal error, for it being the received opinion that no dog is mad who can lap water, many persons have been lulled into a dangerous security. Another equally false and fatal idea has prevailed, that every mad dog must be wild and furious, but this is so far from being true, that in the greater number of instances, there is very little of that wild savage fury that is expected by the generality of persons. "Hence," says this author, "as it is evident that the term hydrophobia, characterising the affection in the dog, is a misnomer, so it is evident that the term madness is equally so. In no instance have I ever observed a total alienation of the mind; in very few have the mental faculties been disturbed. The disposition to do mischief is rather an increased irritability than absence of sense, for in most instances, even those that are furious acknowledge the master's voice and are obedient." The symptom, which is most generally first observable in a rabid dog, is a certain peculiarity in his manner; some strange departure from his usual habits. In a very great number of instances, the peculiarity consists in a disposition to pick up straws, bits of paper, rags, threads, or the smallest objects which may happen to be on the floor. This is said to be particularly common in small dogs. "Others again show an early peculiarity by licking the parts of another dog. In one instance the approach of the disease was foretold by our observing a very uncommon attachment in a pug puppy towards a kitten, which he was constantly licking; and likewise the cold nose of a healthy pug that was with him. An attachment to the sensation of cold appears in many cases, it being very common to observe them (the dogs) licking the cold iron, cold stones, &c. Some dogs early in the disease will eat their own excrement and lap their own urine." An early antipathy to strange dogs and cats is very commonly observed, but particularly to cats. As the disease advances, the affected dogs bite those with which they are domesticated, and lastly, the persons around, but, except in a moment of irritability, they seldom attack the human subject. The irritability that induces them to bite is very strong, but is devoid of wildness. It is more like peevishness than fury. A stick held up at them always excites their anger in a violent degree, and throughout the disease there is generally a wonderful impatience of control, and the animals are with great difficulty frightened. (See art. *Dog, in Rees's Cyclopœdia.*) [Mr. Youatt (*On the Dog*) describes a form of dumb rabies, of which the most characteristic sign is a paralytic condition of the lower jaw, which hangs pendulous, leaving the mouth half opened.] In sheep as well as dogs, a peculiar change of the voice is regarded as one of the most unequivocal signs of the distemper. (See *Magendie's Journ. de Physiol. Exp.* t. viii. p. 330.)

Dr. John Hunter calculated that out of every dozen of rabid dogs, about one evinces no particular tendency to bite. That these animals, and wolves also, have no particular dread of fluid is proved by facts. Thus, a rabid wolf, at Frejus, swam across several rivers. (*Darluc, Recueil Périod. d'Observ.* vol. iv.) Duboueix has seen mad dogs drink without difficulty, and plentifully. (*Hist. de la Soc. de Méd. an* 1783.) Rabid animals will sometimes eat as well as drink. Thus, the wolf which bit so many persons at Meyne, in 1718, was found in the morning devouring a shepherd's dog; and Dr. Gillman speaks of a dog, which was not deemed rabid, because it ate and drank well; but, as it seemed indisposed, it was killed, though not before it had bitten a man, who fell a victim to hydrophobia. (*On the Bite of a Rabid Animal*, p. 15.)

When a dog bites a person it should not be immediately killed, but merely chained up, because by destroying it at once, the possibility of ascertaining whether it was rabid is prevented, and great alarm is thus kept up in the minds of the wounded person and his friends. If the animal be affected with rabies, it will perish in a few days. At the Veterinary School at Alfort, when a dog has been bitten, it is usual to chain it up for at least fifty days, before it is restored to its master, about six weeks being considered the period when a dog generally becomes rabid after being bitten.

My friend Mr. St. Aubyn had a large Newfoundland dog, however, which did not become rabid till seventy days had elapsed from the period when it was bitten by another dog. As I saw this case, and am minutely acquainted with the particulars, I consider it as furnishing a useful caution against placing too much confidence in the plan adopted at the Veterinary School at Alfort.

For additional details relating to the disease as it appears in the dog, I must refer to the above-mentioned paper. It cannot be too clearly or widely known, that mad dogs are not particularly characterised by an inability to lap water, nor by any degree of fury. These animals, when actually affected with rabies, from their quiet manner have not even been suspected of having the disorder, and have been allowed to run about, been fondled, and even slept with. (See *Mem. of Swedish Acad.* 1777.)

[In the cases of hydrophobia collected by Lewis Smith, 131 in number, 15 of the dogs inflicting the wounds, whose history was known, seemed well at the time of inflicting the bite. Of these, one soon after wandered from home, and another at an interval of two weeks. Six were immediately killed; the seven remaining went mad within ten days. Six other dogs acted suspiciously, being probably in incipient hydrophobia, of which two went mad afterwards and were killed, and the other four left home or were killed. Hence it is clear that animals, before showing any symptoms of rabies, may communicate the disease.

As to the ætiology of this disease in dogs and animals, three views have been enunciated. The *first*, that the disease occurs only as an epizootic (see especially *L. Kemp, Edinburgh Med. Journal*, Jan. 1855); the *second*, that it can only be produced by inoculation (*Carusi, Osservazione sulla orig. della Rabia, Napoli. Gaz. of Lomb.* 40, 1857; *Youatt, Dupuytren, Breschet, and Magendie*, loc. cit.); the *third* admits both modes of origin. There are abundant proofs in favour of the last view. As to its occurrence in the epizootic form and spontaneously, there is a mass of evidence. Such an epizootic, carefully observed, is related by Dr. Malley (*Elliotson's Lecture, in Lancet*, Oct. 1831), and other striking instances occurred in Sir John Ogilvie's and Lady Menzies' stables. (*Kemp,* 1855.) Again, among the cases of hydrophobia collected by Lewis Smith, is one resulting from the bite of a lap-dog, in a neighbourhood where a rabid animal had not been known for years. This dog also bit a puppy, which went mad. Wagner (*Deutsche Klinik*, 26 and 27, 1856) relates a case of spontaneous rabies in a cat, which bit a dog and three men. The dog and two of the men went mad. Cold, hunger, and ill-treatment, excessive heat, the summer time of the year, especially the latter part of July—"the dog days,"—stinking and maggotty flesh as food, denial of drink, or of sexual intercourse, have, since very early times, been commonly held to cause hydrophobia.

A great mass of evidence, however, exists, which tends to disprove the direct action of these causes, although it is probable that any one of them may act as an exciting circumstance. Thus, out of 259 cases in which the date of the bite was registered (*Smith and Tamhayn*, loc. cit. *Radcliffe*, *Lancet*, 1855, p. 160 and 250, and *Adams*, *Wochenschrift für Thierheilkrankheiten*, ii. 32—36, 1858), thirty-two, the largest number, were observed in September; the next in October and November, each twenty-five cases; while in each of the months of January and February, there were twenty-one cases. These researches agree in general result with those of M. Andry (*Recherches sur la Rage*, 8vo. Paris, 1780), and it results from them that, since rabies occurs alike at all seasons of the year, if any sanitary regulation be enforced, it should be made to operate during the whole year. The investigation of the relations which hydrophobia and rabies evince to climate and country, yields results equally opposed to popularly received notions. They strikingly favour the opinion that rabies is an epizootic. After a great outbreak in Wurtemburg, in which 242 cases were observed, there was an interval from July, 1839, to June, 1843, during which only 3 real cases and 14 suspicious cases were noted. (*Voltolini*, *Deutsche Klinik*, 19—21, 1857.) At this time, precisely, it was prevailing in the north. From 1849 to 1855 it prevailed in Hamburg, Lanenburg, Mecklenburg, Pomerania, Schleswig, Jutland, Westphalia, and Leipsig, with considerable intensity. In Hamburg, for instance, 500 mad dogs were observed. In 1851-2, it broke out in the south of Europe, at Paris, Madrid, Ofen, and Pesth; and in 1854-55, in Lombardy. In 1855-56, numerous cases occurred in Augsburg, the disease soon disappearing again. (*Adam*, *Wochenschrift*, loc. cit. *Faber*, *zur Geschichte der Wuthkrankheit in Wurtemburg: Wurtemb. Corr. Blatt*, 43, 44, 1857. *Vjhrschrift, für Ges. Med.* xii. 2, 1858.) In the English Bills of Mortality, the first case recorded is in 1728—the bills begin in 1603—while the word hydrophobia is not introduced until 1819. From 1728 till 1824, the deaths never exceeded four per annum; in that year they reached seven; in 1825, and 1826, there were four deaths; in 1827, one death; 1828, one; 1831, six; 1832, three; 1833, four; 1834, eight; 1835, none; 1836, one; 1837, seven in the last six months; 1838, twelve; from 1838 to 1853 never more than four; in 1854, nine. From the Registrar General's reports, it seems that in the periods from 1838 to 1842, and from 1848 to 1852, there was a gradual increase of the disease, and especially in the first period in the rural districts, whilst in the towns at this time it was but little felt.

In the higher northern latitudes, as well as in the south, hydrophobia is extremely rare. According to J. Hunter, there was not one case during forty years in Jamaica; and so also in South America, in Madeira, in Algiers, Egypt, in Turkey, and throughout the East. This observation first made as to Egypt, by Prosper Alpinus (*Rer. Egyptiarum*, lib. iv. cap, 8), is confirmed by Savary (*Voyage en Syrie*, t. i.), Baron Larrey (*Mémoires de Chir. Militaire*, t. ii. p. 226), and by other authorities. (See *Bibl. Raisonnée*, 1750; *Van Swieten*, *Comment in Aphor.* 1129, *Portal Journal Gén. de Méd.* t. xxx. *Dr. Thomas*, *Practice of Physic.*)]

In Mr. Meynell's account, which was communicated to him by a physician, it is asserted that the complaint never arises from hot weather, nor putrid provisions, nor from any cause except the bite; for however dogs have been confined, however fed, or whatever may have been the heat of the season, the disorder never commences without a possibility of tracing it to the preceding cause, nor was it ever introduced into the kennel except by the bite of a mad dog. (See art. *Dog* in *Rees's Cyclopædia.*) [In addition, however, to the cases above cited, in which the spontaneous or epizootic origin of rabies is made evident, the writer is informed by Mr. Spooner (1860) that he has seen rabies arise among some Cape dogs, confined in cages at the Zoological Society's Gardens, in London, under circumstances which rendered it impossible that they should have been bitten by any rabid animal. He has also seen a polar bear attacked with fatal rabies in the same gardens.]

Dr. Gillman endeavours to prove, that the disease in dogs is probably excited independently of particular climates, of putrid aliment, of deficiency of water, of want of perspiration, or of the worm under the tongue, to which causes it has been at different times ascribed; and he expresses his belief that it originates somewhat like typhus in the human subject, and is not always produced by inoculation, or by means of a bite. He thinks that it may be occasionally brought on by the confinement of dogs, without exercise, in close and filthy kennels; and that the success of Mr. Trevalyan, as related by Dr. Bardsley, in clearing his kennel of the disease, by changing even the pavement, after other means of purification had failed, affords presumptive evidence in favor of the opinion; and consequently this author thinks that the method of quarantine adopted by Mr. Meynell, and recommended by Dr. Bardsley, on the supposition that the disease originates exclusively from contagion, will not be a sufficient preventive alone; and he infers, from some facts reported by Mr. Daniel, that the poison sometimes lies dormant in dogs, four, five, and six mouths, and consequently that the period of two months is not a sufficient quarantine. (See *Gillman's Diss. on the Bite of a Rabid Animal.*)

In opposition, however, to some of the sentiments contained in the foregoing passage, it should be known that Dupuytren, Magendie, and Breschet have purposely kept many dogs for a long time in the most disgusting state of uncleanliness; let them even die in this condition for want of food and water, or even devour each other, yet without exciting rabies. (*Dict. des Sciences Méd.* t. xlvii. p. 53.) Yet Professor Rossi, of Turin, is said to have produced this or some similar disease in cats, by keeping them shut up in a room. (*Mém. de l'Acad. imp. de Turin*, 1805 à 1808,

p. 93, *de la Notice des Travaux.*) On the whole, I consider it well proved that neither long thirst, hunger, eating putrid flesh, nor filth, will occasion the disease in the canine race. At Aleppo, where the animals perish in great numbers from want of food and water, and the heat of the climate, the distemper is said to be unknown. Nor is rabies found to attack dogs and cats with particular frequency during the copulating season, and therefore the œstrus veneris cannot be admitted to have any share in its production, as some writers have been disposed to believe. (See *Dict. des Sciences Méd.* t. xlvii. p. 55.)

Although most writers believe in the reality of a poison, or specific infectious principle, in cases of rabies, the fact has been questioned, or absolutely rejected, by others. Bosquillon considered the disease always as the effect of fear, or an impression upon the imagination. This view of the matter is far from being new, and has been ably refuted by many authors, and especially by M. Desault, of Bordeaux, who remarks that horses, asses, and mules, *quibus non est intellectus*, had died rabid the very year in which he wrote; and it is observed by Dr. J. Vaughan, that an infant in the cradle is sometimes attacked, while many timorous children escape. [In Smith's collection of cases, nine of the patients were five years old or under, several being infants of three years and less.]

Another notion has partially prevailed, that rabies does not depend upon any virus, but upon the continuance of an irritation in the bitten parts, affecting the whole nervous system (*Percival*, *J. Mease*, *Girard*, &c.); but this doctrine confounds rabies and tetanus together, and can only apply to the symptomatic non-infectious hydrophobia from an ordinary wound or laceration.

The facts in proof of the reality of a peculiar infectious principle in cases of rabies are too numerous to leave any doubt upon the subject. Twenty-three individuals were bitten one morning by a female wolf, of whom thirteen died in the course of a few months, besides several cows which had been injured by the same animal. How could all these unfortunate persons have had similar symptoms, and especially a horror of fluids, had they not been all under the influence of some cause besides the bites. The patients who died were bitten on the naked skin, whilst in the others who escaped infection the bites happened through their clothes, which no doubt intercepted the saliva, the vehicle of the virus. In the essay by Le Roux, mention is made of three persons bitten by a rabid wolf, near Autun, in July, 1781, and notwithstanding mercurial frictions, they all died of hydrophobia. Of ten other individuals bitten by a wolf, nine died rabid. (*Rey*, *Mém. de la Soc. Royale de Méd.* p. 147.) Twenty-four persons were injured in the same manner, near Rochelle, and eighteen of them perished. (*Andry*, *Recherches sur la Rage*, ed. 3, p. 196.) On the 27th January, 1780, fifteen individuals were bitten by a mad dog, and were attended at Senlis by the commissioners of the French Royal Society of Physic. Ten had received the bites on the naked flesh, and five through their clothes. Of the first ten only five lost their lives, three of them dying of decided rabies between the 27th of February and the 3rd of April, and the other two between the 29th of February and the 18th of March. Unless the opinion be adopted that the disease is caused by an infectious principle, a sort of inoculation, it would be impossible rationally to explain the cause of so many deaths from the bites of rabid animals. If the idea that rabies originates from fear, or nervous irritation, were true, how could we account for there being such a difference between the usual consequences of the bite of a healthy dog, and those of the bite of one afflicted with rabies? Healthy dogs are incessantly quarrelling and biting each other in the streets, yet their wounds are not followed by rabies; and, as a modern author remarks, if hydrophobia were referrible to nervous irritation derived from the wounded part, how does it happen that amongst the thousands of wounded after a great battle hydrophobia is not seen instead of tetanus? (*Dict. des Sciences Méd.* t. xlvii. p. 61.) But if it were yet possible to entertain a doubt of an infectious principle in hydrophobia, this possibility would be removed by the reflection, that the disease may be communicated to healthy animals by inoculating them with the saliva of certain other rabid animals. In fact, as I have stated, the bites of such animals are, in every point of view, only an inoculation, and the same remark may be extended to the numerous instances on record, in which the disease arose in the human subject as a consequence of a rabid dog or cat (not suspected to be in this state at the time) having been played with, fondled, or suffered to lick the naked skin, in which there was at the moment some slight scratch entirely overlooked.

Many of the ancient writers not only believed in the hydrophobic virus, or infectious principle, but even in its diffusion through the blood, flesh, and secretions in general; and this hypothesis was professed by Boerhaave, Van Swieten, Sauvages, F. Hoffman, &c.; but in proportion as the humoral pathology lost ground, the foregoing idea was abandoned, and the opinion adopted that the infection is confined to the saliva, and wounded part, in which it has been inserted.

The tales of some old authors would lead one to think, that hydrophobia may be communicated by eating the flesh of a rabid animal. (*Fernelius*, *De Obs. Rer. Caus. et Morb. Epidem.* lib. ii. cap. 14. *Schenckius*, *Mangetus*, *&c.*) But respecting these accounts it is remarked that they are not entitled to much confidence; for it is certain that rabies never begins, as is stated with regard to some of the cases in question, a few hours after the application of its cause, and its early stage is never characterised by any fury or disposition to bite. And, besides, how can such relations be reconciled with the practice of the ancients, who, according to Pliny, employed the liver of the mad dog or wolf as a remedy? Palmarius also fed his patients for three days with the dried blood of the rabid animal. (*Mém. de la Soc de Méd.* p. 136, *et le nº* 178.) The flesh of a bullock which had been bitten by a mad dog, and afterwards died rabid, was sold to the inhabitants of Medola, near Mantua, yet none of them were attacked with hydrophobia (*Andry*, *Recherches sur la Rage*, *&c.* p. 30.) Dr. le Camus informed Larrey that he had eaten the flesh of animals which had died rabid, but he suffered no inconvenience from the experiment; and it is stated in the letter of Dr. L. Valentin that certain negroes in the United States of America had no illness from eating the flesh of pigs which had died of rabies. (*Jour. de Méd.* t. xxx. p. 417.) As for the question whether the blood is infected, it is generally considered to be settled in the negative, notwithstanding the account given by Lémery of a dog which was attacked with rabies, as is said, from lapping the blood of a hydrophobic patient who had been bled. (*Hist. de l'Acad. Royale des Sciences,* 1707, p. 25.) Dupuytren, Breschet, and Magendie were never able to communicate rabies by rubbing wounds with blood taken from mad dogs; and they even several times injected such blood into the veins of other healthy dogs, yet none of these latter animals were attacked with rabies, though they were kept for a sufficient length of time to leave no doubt upon the subject. (See *Dict. des Sciences Méd.* t. xlvii. p. 63.)

A point of greater practical interest than the former is, whether the drinking of the milk of an animal labouring under rabies is attended with any risk of communicating the disease? It is asserted by Timæus that a peasant, his wife, children, and several other persons were seized with hydrophobia in consequence of drinking the milk of a rabid cow; and that the husband and eldest child were saved by medical treatment; but that the wife and four of the children died. It is further stated that three or four months afterwards, the maid and a neighbour who had partaken of the milk of the same cow, also died of hydrophobia. (*Cons.* vii. *Obs.* 33.) In opposition to this account, however, several facts reported by other writers of greater credit, tend to prove that hydrophobia cannot be communicated by the milk of a rabid animal. (*Nova Acta Nat. Cur.* vol. i. obs. 55; *Baudot, Mém. de la Soc. Royale de Méd. an* 1782, t. ii. p. 91.)

The cases reported by F. Hoffman and Chabert, with the view of proving the possibility of infection through the medium of the semen, are of no weight, because, on a critical examination of them, it will be found that the infection of the women is stated to have taken place very soon after their husbands had been bitten, which is quite at variance with the established character of the disease, as it never commences, and of course cannot be propagated in any manner, soon after the bite. Besides, these histories are refuted by others of greater accuracy. (See *Baudot, in Mém. de la Soc. Royale de Méd. an* 1782, *&c.* p. 92; *Rivallier,* vol. cit. p. 136, 241; *Bouteille,* p. 237; *Boissière, in Journ. Gén. de Méd.* t. xvii. p. 296.)

Neither can hydrophobia be imparted by the breath, notwithstanding the statements of Cœlius Aurelianus, and some other old writers. A nurse mentioned by Dr. J. Vaughan, repeatedly kissed a hydrophobic infant, which she had suckled, and exposed herself incessantly to its breath, but without the least ill effects. The fear which has also been entertained of the disorder being receivable from the application of the patient's perspiration, is not founded upon any authentic facts.

Does the infectious principle of rabies reside in the salivary secretion, or in the mucus of the trachea and bronchi? The common belief is, that in hydrophobia, the salivary glands are considerably affected. But it has been remarked by a modern writer, that if these glands exhibit no morbid alteration during the whole course of the disorder; if they are found healthy after death; if the air passages are the seat of inflammation; if the saliva does not constitute the frothy slaver about the lips; and if such slaver, wherewith the disease may be communicated by inoculation, is derived from the inflamed windpipe and bronchi, and consists of mucus converted into a kind of foam by the convulsive manner in which the patient breathes; there is some reason for questioning whether the saliva, strictly so called, undergoes the alteration generally supposed. (See *Dict. des Sciences Méd.* t. xlvii. p. 66.) However, this writer is not exactly correct when he describes the frothy secretion about the mouth, as being altogether composed of mucus from the trachea, since a great part of it is unquestionably true saliva and mucus secreted in the fauces and mouth. In the stomachs of dogs which died rabid, Dr. Gillman constantly observed traces of inflammation, and he once tried to communicate the disease to two rabbits, by inoculating them with matter taken from the pustules found in the stomach of a rabid dog, but no infection took place. (*On the Bite of a Rabid Animal*, p. 32.)

According to Professor Rossi, of Turin, the nerves before they grow cold, participate with the saliva in the property of communicating rabies. He asserts that he once imparted the disease by inserting in a wound a bit of the sciatic nerve immediately after it had been taken from a living rabid cat. (See *Mém. de l'Acad. imp. de Turin, Sciences phys. et mathém. de* 1805 *à* 1808, part xciii. *de la Notice des Travaux*.)

After all which has been stated concerning the hypothesis of the infectious principle of hydrophobia being more or less diffused through the solids and fluids of a rabid animal, and not being restricted to the saliva, perhaps the safest conclusion to be made is, not to reject the opinion altogether, but to consider it at present requiring further proof. And from observations of what happens in the human subject, the same inference should not always be drawn as from experiments on animals which are liable to be attacked with spontaneous rabies of a decidedly infectious character. (See *Dict. des Sciences Méd.* t. xlvii. p. 67.) [That no unexceptionable instance has been afforded of the communication of hydrophobia by man to man, although the devotion of friends and relatives in so many hundred cases must have offered so many opportunities, must be taken as a strong ground for the belief that the human saliva in hydrophobia is not hurtful to our species.]

Although many cases are to be met with in the records of Medicine and Surgery, tending to convey an idea that the mere application of the saliva of a rabid animal to the sound entire skin of the human subject, may give rise to hydrophobia, the assertion is contrary to general experience, and liable to a reflection which must overturn the hypothesis, viz. the slightest prick, scratch, abrasion, or broken pimple on the surface of the body, such as would not be likely, in many instances, to excite notice, may render the application of the saliva to the part a positive inoculation.

Instances are also reported, the tenor of which is to prove that the hydrophobic virus may take effect through a sound mucous membrane. (*Palmarius de Morbis Contag.*; *Portal, Obs. sur la Rage,* p. 131; *Matthieu,* in *Mém. de la Soc. Royale de Méd.* p. 310, &c.) But, that this does not happen in the human subject, is tolerably well proved, by the consideration that formerly a class of men made it their business to suck the wounds caused by the bites of rabid animals, yet none of them contracted hydrophobia from this bold employment. (*Bosquillon, Mém. de la Soc. d'Emulation,* t. v. p. 1, 7.) The example of the nurse who repeatedly kissed a child without the least ill effect, while it was dying of rabies, as recorded by Dr. J. Vaughan, has already been noticed. However, if hydrophobia were apparently to arise in any rare instance from the application of the slaver of a rabid animal to the inside of the lips, no positive inference could be drawn from the fact, unless the means were also possessed of ascertaining that there were no slight abrasions about the gums, or within the mouth previously to such application. [Out of upwards of 400 cases in the collections of Hamilton, Smith, Netten Radcliffe, Wagner, and Adam, it will be found that the disease is, with very few and rare exceptions, due to a bite. In one case (*Hutchinson, Lancet*, Dec. 1838.) the dog barked so furiously against its mistress' mouth as to loosen a tooth. In another (*N. Y. Med. Report*, vol. i.) the dog was allowed, the day before it became rabid, to lick a sore on the ear, and hydrophobia, after an incubation of four weeks, began in this patient, by a pricking pain in that organ. A third person had been licked on a wound. (*Sigg. Tetanus Traumat. et Hydrophobia, Inaug. Diss. Zürich*, 1855.) A fourth was said only to have been licked on the naked foot. This case appears to be highly doubtful, although Neumann puts credence in it. Finally, in a fifth case, a lady allowed her dog to lick her nose.]

For the hydrophobic virus to take effect, therefore, it is generally, probably always, necessary that the infectious saliva be either applied to an abraded, wounded, or ulcerated surface. In the case of a bite, the teeth are the envenomed weapons which at once cause the solution of continuity, and deposit the infection in the part. But the mere abrasion of the cuticle, and the application of the infectious saliva to the denuded cutis, will often suffice for the future production of the disease. As the mode of communication, therefore, is a true inoculation, it follows that the danger must depend very much upon the quantity of infectious matter conveyed into, or applied to the part, the effectual manner in which the saliva is lodged in the flesh, the extent and number of the wounds, and particularly the circumstance of the teeth of the rabid animal having passed through no clothes, by which the saliva might possibly be effectually prevented from entering the wound at all. Hence, bites on the hands and face are known to be of the most dangerous description, especially those on the face, the hands being sometimes protected with gloves. [Of the series of recorded cases of hydrophobia above alluded to, in 52 cases the part bitten is not stated; 141 persons were bitten on the most various parts of the upper extremities, 70 on the lower, 50 on the head and face, 12 on the head and trunk, and 2 on the scrotum. This, it may be observed, does not accord with Hunter's opinion, that only wounds of parts which are rich in nerves are likely to be followed by hydrophobia.]

From what has been observed, however, it is not to be concluded that the disease always follows, even when the animal which inflicts the bite is decidedly rabid, and some of its saliva is actually applied to the wounded or abraded parts. On the contrary, experience fully proves that out of the great number of individuals often bitten by the same mad dog, and to whom no effectual prophylactic measure is extended, only a greater or lesser number are afterwards attacked with hydrophobia. [Out of 339 persons bitten by mad dogs, about 65 per cent. are stated to have died of hydrophobia.] When this difference in the fate of the individuals cannot be explained by the intervention of their clothes, the thickness of the cuticle at the injured part, the small size and superficial nature of the bite, the ablution of the part, or some other mode in which any actual inoculation may have been rendered ineffectual, it can only be referred to some unknown peculiarities or differences in the constitutions of the several individuals. The latter conjecture seems more probable when the fact is recollected that some animals are more susceptible of rabies than others, and some appear to resist the infection altogether.

Dogs are more susceptible of the infection than the human species. Four men and twelve dogs were bitten by the same mad dog, and every one of the dogs died of the disease, while all the four men escaped, though they used no other means of prevention but such as we see every day fail. There is also an instance of twenty persons being bitten by the same mad dog, of whom only one had the disease.

[The period of incubation, or space of time elapsing between the receipt of the bite and the appearance of the symptoms of hydrophobia, varies greatly. In 222 cases in which it has been observed, the outbreak occurred 11 times before the 10th day, 21 times between 10 and 20 days, 20 times from 3 weeks to 6 weeks, 89 times from 7 weeks to 7 months, 89 times, also, from 7 months to 27 months, once after 4 years, and once after 5½ years. In Hamilton's table, it occurred in 17 cases between 18 and 30 days, in 63 cases between 30 and 60 days, in 13 cases between 3 and 6 months, in 17 between 6 and 12 months, and in 4 from 10 up to 20 months, after the receipt of the bite. In both these series it will be observed that the period of incubation was most frequently between the 3rd and 8th week. The two cases of highly-prolonged incubation may be thought suspicious. That of 4 years is described by Dr. Wendenburg (*Corr. Blatt. des Ver. der Aerzte in Reg. Bez. Merseburg*, Sept. 1856), and it was so well marked a case that it cannot well admit of disbelief. That of 5 years is related by Breva, and would seem to rest upon a good basis. On the 11th of November, 1804, a wolf having descended from the Bergamasco Alps, attacked and bit successively 13 persons of different age and sex. Of these 9 were attacked with hydrophobia which proved fatal, and 4 escaped. One case was developed, and proved fatal after a period of ten months: another, the ninth, after a period of *five years and a half.* (*British and Foreign Med. and Surg. Review*, vol. iv. pp. 344—49.)]

Dr. Bardsley, of Manchester, has recorded a case in which the most careful inquiries tended to prove that the patient had never suffered the least injury from any animal, except the bite inflicted 12 years previously to the commencement of hydrophobia, by a dog apparently mad. (*Mem. of Liter. and Phil. Society of Manchester*, vol. iv. part ii. p. 431.)

A merchant of Montpellier is also stated to have been attacked with hydrophobia 10 years after the bite of a rabid dog, which also bit the patient's brother, who died hydrophobic on the 40th day after the accident. (See *Dict. des Sciences Méd.* t. xlvii. p. 75.) Here may also be found references to cases in which the interval is alleged to have been 18, 20, and even 30 years. It is certainly difficult to attach any credit to these very late periods of attack, [but so many well-authenticated cases exist in which the disease has broken out after an incubation of many months, that it is difficult to fix the precise period at which all fear of the outbreak can be dismissed.] Exposure to the heat of the sun, violent emotions of the mind, and fear, are believed to have considerable influence in accelerating the commencement of the symptoms. That mental alarm is also of itself sometimes capable of bringing on a simple hydrophobia, totally unconnected with infection, is incontestable, a case which has not always been duly discriminated. A most convincing proof of this fact is recorded by Barbantini, in the Italian *Journal of Physic, Chemistry, &c.* for Jan. and Feb. 1817. A young man was bitten by a dog which he fancied was mad, and on the 5th day he evinced symptoms of hydrophobia, of which he was nearly dying, when the dog which had bitten him was shown to him, perfectly well, and the intelligence tranquillised him so effectually that he was quite well four days afterwards. Mr. John Hunter is said to have mentioned in his lectures a very similar case, in which he believed the patient would certainly have died if the dog which inflicted the bite had not been found, and shown to the patient, perfectly well. (See *Journ. gén. de Méd.* t. xli. p. 215.) It is to the effects of terror that several modern writers are disposed to refer the instances of attacks of hydrophobic symptoms, very long after the period when the patients were bitten, though, unless the intellect be changed in the meantime by other causes, it is difficult to conceive why the alarm should not have the greatest effect earlier, while the impression of the danger is undiminished by time. [The frequent concurrence of some exciting cause of the disease appears very evident from the examination of modern recorded cases, which usually are more carefully observed, and therefore more reliable than those of the earlier writers. One patient appeared to bring on the attack by exposure to wet, and another by eating fish having a strong odour. He continued talking of this food throughout his sickness, and just before his death vomited a portion of it. Four were taken with the disease immediately after drunken revels. In one instance, witnessing the execution of a murderer; in another, a fall; in another (a child), fright from seeing some one playing the ghost, ushered in the attack. Again, a patient struck his foot against a nail with such a force that he nearly fainted from the pain. Immediately the precursory pain arose in the limb. This is a point of some practical importance, and points to the propriety of a person, in danger of hydrophobia, leading a quiet life, avoiding all excesses, and, as far as may be, sources of anxiety and alarm. (*Radcliffe and Smith*, loc. cit.)]

The idea that the symptoms begin sooner after the bite of a wolf than that of a dog, is not adopted by a writer who has taken great pains to collect information on the present interesting disorder. (See *Dict. des Sciences Méd.* t. xlvii. p. 77.) [Dr. Mason Good inclined to the belief that rabies, resulting from the bite of a cat—of which he made a distinct variety, rabies felina—was of a milder form than that from the bite of a dog. But Marochetti, Christison, Pickells (*Sanitary Review*, Jan. 1858), and Colles were of a directly opposite opinion.]

Cullen has divided the disease into two stages, the hydrophobia *simplex* and *rabiosa*, or the melancholy and raving stages of some other writers. But as the early stage is frequently unattended with anything like melancholy, it is best merely to adopt the distinction of the *first* and *second* stages —one comprehending the effects of the disorder previously to the occurrence of a dread of, or decided aversion to, liquids; the other, the subsequent changes. The wound, if treated by common methods, usually heals up at first in a favourable manner. At some indefinite period, and occasionally long after the bitten part seems quite well, a slight pain begins to be felt in it or the neighbouring parts, now and then attended with itching, but generally resembling a rheumatic pain. If the bite took place on the finger, the pain successively extends from the hand to the fore-arm, arm, and shoulder, without any redness or swelling in these parts, or any increase of suffering from pressure or motion of the limb. In a great number of instances, the trapezius muscle, and the neck on the same side as the bite, are the points to which the pain principally shoots. The cicatrix, in the meanwhile, sometimes begins to swell, inflames, and often festers, and discharges an ichorous matter. These uneasy, painful sensations recur from time to time, and usually precede any dread of water several days, and they are a just reason for apprehension. Sometimes pains of a more flying, convulsive kind, are felt in various parts of the body. As the disease advances, the patient complains of the pain shooting from the situation of the bite towards the region of the heart. Sometimes, instead of pain, there is rather a feeling of heat, a kind of tingling, or even a sensation of cold extending up to the chest and throat. Occasionally no local symptoms take place; thus Sabatier, in giving an account of several cases, remarks it as worthy of notice that the bitten parts did not become painful previously to the accession of the fatal symptoms, nor did any swelling or festering occur. (See *Mém. de l'Institut National*, t. ii. p. 249, &c.) [In fourteen cases in which hydrophobia occurred with the wound not closed, the surface of the wound was seven times of a healthy appearance, and on the point of slowly healing. During the progress of the disease it usually became dry and painful. In two cases out of the fourteen it was nearly closed, once it was black and dry, four times painful and swollen. Of ninety-five cases in which a detailed description is given of the cicatrix; in sixty-six instances it had a normal appearance; five times no sensation whatever was noted; once it was extremely sensitive to pressure; seven times it was inflamed; nine times it presented a reddish or blue tint, but was painless; once it was very dark; once white, but with vascular streaks; once marked by ecchymoses; once projecting; once "ill-looking," but not discolored. In all but four cases the surrounding parts were apparently healthy. Of these, in two the glands of the groin were healthy; once the lymphatics were inflamed which led from the wound; and once the bitten arm became livid.]

Dr. Marcet particularly observes that the pain follows the course of the nerves rather than that of the absorbents. In the case which he has related, as well as in one of the cases detailed by Dr. Babington, there was pain in the arm and shoulder but without any affection of the axillary glands; and in the other case (see *Medical Communications* vol. ii.) the pain occasioned by a bite in the leg was referred to the hip and loins, without any affection in the inguinal absorbents. (*Medico-Chir. Trans.* vol. i. p. 156.) Of the accuracy of the foregoing statement by Dr. Marcet there is no doubt; the observation, however, in regard to the irritation not affecting the absorbents, was long ago anticipated by several authors, who urged the freedom of the lymphatic glands from disease, as an argument that the disorder did not depend upon the absorption of any virus. It is also noticed by others who incline to the belief in the absorption of the infectious principle :—" Resorptionem virus ope systematis lymphatici fieri verisimillimum videtur; neque tamen nec vasa lymphatica, nec glandulæ vicinæ stimulo morboso, vel tumore adfici videntur, quod in aliis resorptionibus virulentis fieri solet." (*Callisen, Syst. Chirurgiæ Hodiernæ*, vol. i. p. 595. *Hafniæ*, 1798.)

[In three cases, only, we find it recorded that the lymphatics were inflamed. The most exceptional case is that recorded by Mr. Abernethy, who noticed two red lines extending up the arm, apparently inflamed absorbents; and in two other cases the glands above the wounded part were found in a swollen state when hydrophobia commenced. (*G. Pinkard, Lond. Med. Repository*, 1815. *Dr. Urbane, Bibl. Prac. Heilung.* 1827.) Exceptions so rare, in so large a mass of cases, tend only to prove the general rule. Nevertheless, some difference of opinion has arisen as to the mode in which this subtle poison of rabies is absorbed, and the channel by which it is conducted through the system. Briefly to sum up long discussions, the questions raised are these :—Is the poison received immediately, or does it lie long latent in the system? Is the blood, are the nerves, or are the lymphatic vessels conductors of the poison? Voltolini ingeniously opposes the theory of the rapid absorption of the virus into the human organism, which Hecker (*Rust. Abhandlung, &c.* 2a bd. s. 345) supports. Hecker held that the poison remained innocuous until excited into action by an outbreak of hydrophobia; but it is sufficiently obvious that the outbreak of the hydrophobia must follow the activity of the poison. The comparison of the poison of rabies to vaccine matter is not very logical, since the cases in which the activity of the latter is deferred are very rare and abnormal; while with the hydrophobic poison, unlike all other animal poisons, the venomous action is normally spread over weeks and months. Voltolini finds an analogue for the deferred action of this germ of hydrophobia in the deferred activity of the ovum, which recent researches on generation have demonstrated. Sabatier suggests that it undergoes changes while in the wound which fit it for absorption. (*L'Union*, 28, 1856.) Faber thinks that it becomes encysted by a pathological process in the blood, until excess or some mechanical influence force it into activity (!) (*Zur Geschichte der Wuthkrankheit, Wurt. Corr. Blatt.* 1851.) Wittcke points out (*Pr. Ver.-Zeit.* 29,30,1857) that a latent poison is not necessarily localised, that it might long have existed in the blood without being called into activity. But when it is remembered that cauterisation of the wound, even after six weeks, has seemed to have a good effect in protecting the system, the balance of probability will rest with the opinions held by Voltolini and Sabatier.

The precursory symptoms have been noted with great care by Netten Radcliffe, in his valuable collection of 103 cases, and by Lewis Smith, to whose papers the reader may be referred for an interesting and minute detail. It may suffice here to say that, in addition to the local symptoms of pain, pricking, uneasiness, stinging and tingling sensations in the wound, together with the changes in the aspect of the cicatrix already described, there were general symptoms in the great majority of cases, which indicated the approach of the true hydrophobic stage. The sensations generally passed from the cicatrix towards the central parts. In one case, only (*C. Dawson, London Med. Gazette*, 1849), the patient complained that the pricking sensation rushed *to* the tips of his fingers. In thirteen cases was recorded, in the preliminary stage, general malaise; twelve, irritability; twenty, restlessness; nineteen, drowsiness; fourteen, chilliness; five, feverishness; eleven, languor; five, anorexia; six, some affection of respiration, by sobbing, sighing, &c.; seven, difficult deglutition; one, excitement of the venereal passion. In nearly all cases the general indisposition, combined with the local pain at the cicatrix, sufficed to indicate the approach of the hydrophobic condition, which they ushered in. Voltolini, however, records a case in which the precursory symptoms were mistaken for those of rheumatism.

The above symptoms precede the second stage, or that of decided hydrophobia, by a period of time varying from a few hours (eight cases) to several weeks (one case); but averaging most commonly from twelve hours to two days.]

The second stage of hydrophobia commences with the first manifestation of the dread of liquids. The ungovernable agitation and distressing sense of suffocation, excited by the sight of liquids, by the attempt to drink, or even the mere idea of drinking, is unquestionably the most remarkable symptom of the disorder. The patient is also frequently attacked with the same kind of commotion and suffering from other causes, such as the least agitation of the air, or exposure to a strong light. Indeed, some patients are so much affected by a blast of wind, that they have been known to endeavour to elude it by walking with their backs towards it (*Hist. de la Soc. Roy. de Méd.* p. 157), while others scream out whenever the window or door of their room is opened. (*Morgagni, De Sed. et Caus. Morb.* Epist. viii. No. 28.)

[The most terrible sufferings of the patient, and those which make the disease most distressing to the feelings of the beholder, are paroxysmal in character. The spasm affects chiefly the muscles of deglutition, and especially also those of respiration. It is difficult to say which are the muscles engaged in this action. The muscles of the throat, the chest, the thorax, and the abdomen, have been especially observed to be affected. Some physicians have thought that the diaphragm was also attacked. The extremities are exempt, but opisthotonos and emprosthotonos have been noted. In no authenticated cases were fluids tolerated, so that the disease, contrary to the opinion of some, is well named hydrophobia. In thirteen cases the mere thought of liquids, in thirty-five the sight of them, and in sixteen the sound produced by splashing, produced paroxysms of convulsion terrible to see. Tepid drinks could more easily be swallowed than cold; this is a point worthy of note. Not even solids could be swallowed in most cases. In seventy-two instances it is noted that the nervous sensibility was so extreme that these terrible attacks were brought on by anything which produced a current of air, blowing, breathing, brushing away flies, or opening doors. In eighteen cases a light, a polished surface, or a bright colour induced the same distress. In other instances it followed such causes as a sudden noise, pungent odours, the vapour of chloroform and ether. The intellect remained clear until the last, when long suffering and debility brought delirium. But the mind was filled with the most gloomy forebodings, the countenance exhibited extreme distress and anxiety, and in the intervals of the attacks the patients sank into the deepest dejection. They rarely slept unless under the influence of powerful opiates. The intervals between the paroxysms became gradually shorter as the disease advanced; commonly they lasted but a few moments; sometimes, however, much longer. Meanwhile the pulse became progressively more frequent and weaker in the seventy-eight cases in which it is recorded. It presented frequently a remarkable irregularity of rhythm. For instance, in one case the number of beats in a quarter of a minute, were 32, 28, 25, and 24; and in another case, in the third of a minute, 34, 34, and 27; and again, 40, 25, and 21. (*Smith, N. Y. Journal of Med.* vol. xvi. N.S.) There was extreme thirst, distension and constipation, of the intestinal system, and in twenty-eight cases *vomiting*, usually within a few hours of death, and of a dark, coffee-like substance, probably spoiled blood. This symptom shortly preceded death, and at this stage the paroxysms have often ceased, the patient has become calm, sometimes delusive hopes have entered his mind, and the mind of his attendant; but it is the calm of exhaustion, and immediately precedes death. This should not be forgotten in the estimation of the effects of medicines administered. Hawking and spitting of a viscid saliva are symptoms rare in the first stages of this disease, but of common occurrence in the last.]

It is not altogether uncommon for a period to occur when the horror of liquids undergoes a considerable diminution, or even entirely ceases, the patient quenching his thirst, and this sometimes as well as if he were in perfect health, and so as to raise doubts of the existence of rabies. But after a few hours, the dread of fluids comes on again, and with it the convulsive paroxysms, which now become general, violent, and incessant. Dr. Cayol attended a girl labouring under rabies, who was never affected with any great dread of liquids, nor an absolute inability to swallow them, though she certainly disliked them, and swallowed them with difficulty. (*Journ. de Méd. Chir. &c.* Avril 1811, p. 241.) Nay, patients are sometimes seen who can manage to swallow red wine and broth, though their aversion to water is already beyond all control, and other patients can sometimes look at a liquid in a black pot without inconvenience, though any fluid offered to them in a glass will bring on a violent paroxysm of spasm and sense of suffocation. The sight of tears has even been enough to bring on the attack. (See *Dict. des Sciences Méd.* t. xlvii. p. 79.)

[An inclination to bite was described in the case recorded by Dr. Powell, and also in another reported by Magendie, as well as in that reported in Silliman's Journal, and above alluded to. Yet this disposition never presented itself in any of the cases which fell under the observation of the author of the article RAGE in the foregoing publication, or of P. Desault, Duchatel, Dr. J. Vaughan, Sabatier, Dupuytren, Smith, Radcliffe, Tamhayn, Wagner, Wittcke, Voltolini, Adam, &c. &c. And even when the patient's imagination is so disordered that he cannot help biting, he commonly warns the bystanders to avoid the danger. The weight of evidence does not allow us to admit the *tendency to bite* as a real symptom of hydrophobia. The cases in which it has been observed are for the most part doubtful instances of the disease, or cases in which the imagination has been disordered, and the patient has yielded to its diseased suggestions. The frothy saliva which is voided with considerable and repeated efforts, is a symptom which is said not to commence before the respiration begins to be convulsive. As the disease advances there is no remission of the sputation necessary to clear the throat of that viscous secretion, and at the approach of death, when it cannot be expelled, it collects in the mouth and covers the patient's lips.]

The symptoms of what is termed cerebral excitement become stronger and more marked in the second stage of the disease. The eyes, the brightness of which is still further increased, appear, as it were, inflamed, the patient never shuts them again, and as the daylight and brilliant colours are offensive, he prefers darkness. The hearing becomes very acute, and, as well as the sight, is troubled with hallucinations. The touch is extremely fine, the speech abrupt and rapid, and the conversation energetic, and often expressive of the most touching sentiments. (*Dict. des Sciences Méd.* t. xlvii. p. 12.)

Dr. Marshall Hall made a very just distinction between the real convulsions which came on towards the termination of the case in death, and the strong, sudden action of the muscles excited in the course of the disorder by the light, the sight of liquids, and the feel of the air. (*The Morbid Anatomy of the Brain, &c.* p. 38.) Convulsions and hiccough, in fact, are the symptoms of dissolution.

Delirium is far from being a constant symptom, and only happens on the last day of the disorder; neither is it always without remissions, for the patients affected with it sometimes give rational replies. Most cases upon record, where delirium is described as being one of the first symptoms, or as first coming on with the dread of liquids, are set down on good authority not as true rabies, but as symptomatic hydrophobia, attended with mania. [But three undoubted cases of early delirium have been noted in modern days. In one the patient was under the influence of Cannabis Indica, and in two others the patients were in a public institution, and subject to annoyance and excitement from being surrounded by students and the curious.]

The dread of swallowing liquids, though the most singular symptom of the disease, constitutes but a small part of it. It is true that none, or very few, recover who have this symptom, yet they certainly do not die in consequence of the difficulty of swallowing liquids, for the human body could easily exist double the time, at the end of which the disease usually proves fatal without food or drink. Besides, the sick can often swallow substances that are nourishing in a pulpy state, without their lives being thereby at all prolonged.

It is not, therefore, the difficulty or impossibility of swallowing liquids, but the effects of the poison upon the constitution at large which occasion death. (*Dr. J. Hunter in Trans. for the Improvement of Med. Knowledge*, vol. i. p. 305.)

In the *second stage*, the epigastrium, as well as the chest, is the seat of considerable pain; the patient is constipated, but the urine is plentiful and high coloured. [In 25 cases the *temperature* was normal: 3 patients were bathed in sweat: in one the sweat was fœtid: in one it was cold. The *pupils* were dilated to a variable degree in 50 cases, a point of some diagnostic value; 5 times they were contracted; once rapidly nictitating. (*Teale, Med. Times and Gazette*, Sept. 1856.) Once there was spasm of the pupil. (*Wagner.*) The symptom of *barking*, to which the popular mind clings with tenacity, was never authentically developed; but Wagner notes that, under the influence of respiratory spasm, raucous cries were uttered, which heightened imagination might so interpret. Three times a hoarse spasmodic hiccough was especially noted.

The duration of life from the appearance of hydrophobia till death varies from twelve hours to seven or even nine days. Of upwards of 200 patients in whom the duration has been noted, 36 per cent. died on the second day, 14 per cent. died on the third day, and 9½ per cent. died on the first day. Death takes place by asphyxia during violent convulsions, or sometimes quietly by exhaustion and blood-poisoning after the ability to swallow has returned.

The diagnosis of hydrophobia, when once the disease is fully manifested, ought never to be difficult. It has been thought to resemble tetanus, but from this it is distinguished by the horror of fluids, the excessive sensibility to draughts of air, sound or touch of fluids, the excessive reflex action and general psychical symptoms, together with the history of a bite. Undoubtedly, however, many cases have been recorded as hydrophobia, especially among the earlier narratives, in which these symptoms were very imperfectly developed, and which did not deserve that title. And even in modern times, out of 333 recorded cases, Tamhayn is disposed to eliminate 37, observing that hypochondriasis alone produced 12: in 25 others no bite was proved. In 2, laryngitis acuta was found. Hysteria in 1, and several spinal and cerebral affections in various cases. Romberg (*Nervous Disorders, translated for Sydenham Society*) is of the opinion that hydrophobia, as a symptom of other affections, essentially differs from other diseases in the fact that, in the former, paroxysms take place spontaneously both day and night, when the patient is sleeping or waking, and that such paroxysms depend far more upon respiratory spasm than upon impediments in swallowing.]

On the subject of prognosis, with respect to the bite inflicted by a rabid animal, and its effects, as evinced in the decided form of rabies, there are several things worthy of attention. According to some writers, small wounds are not less dangerous than others, and an attempt is made to account for the fact, by the more copious hæmorrhage from larger wounds, and the frequent neglect of lesser injuries: perhaps another reason is, that the virus is more likely to be confined in a wound with a small orifice, than in one which is ample and admits of being more frequently washed. The more numerous the wounds are, the greater is the risk. If it be inquired what is the average number of persons attacked with rabies out of a given number who have received bites, the question can only be answered by referring to the extremes. Thus Dr. J. Vaughan speaks of between 20 and 30 individuals bitten by a mad dog, of whom only 1 was afterwards attacked with rabies, and Dr. J. Hunter tells us of an instance, in which out of 21 persons bitten, only 1 became affected. (See also *Fothergill, On Med. Obs. and Inq.* vol. v. p. 195.) On the other hand, out of 15 persons bitten by a mad dog, and taken care of at Senlis, 3 at least were seized with the disorder. (*Hist. de la Soc. Roy. de Méd.* p. 130.) Of 17 others bitten by a wolf, 10 were attacked (*ib.* p. 130), and of 23 bitten by a she-wolf, 13 died of rabies. (*L. F. Trolliet, Nouveau Traité de la Rage, &c. Obs. Chir. &c.* No. 25.)

Two important facts should also be recollected; viz:—the disease may often be prevented; it can hardly ever be cured. Experience has fully proved, that when hydrophobia once begins, it generally pursues its dreadful course to a fatal termination; the records of medicine furnishing very few unequivocal and well authenticated cases to the contrary. [As to the question of prognosis it may be observed, after minutely examining the recorded cases, that in many instances the occurrence of hydrophobia has been prevented after unequivocal precursory symptoms have appeared, and occasionally the threatened attack has been more than once averted in the same patient. On this point the remarks of Dr. Elliotson (*Lancet*, May, 1829), may be consulted with profit. He relates two cases which seem in themselves perfectly satisfactory. Youatt has satisfied himself of the same fact in treating rabies canina. (*Youatt, On the Dog*, Table III.) Smith quotes six cases, in which he considers that the most cautious statistician must admit that in a part, at least, genuine hydrophobia was present and yet recovery followed. In the first case (*W. Grant, G. Doane, Med. Gaz.* July 10, 1830), the treatment was by purgatives, stimulants, &c.; in the second (*T. Tompkin, E. G. Varenne, Lancet*, Aug. 1835), by purgatives, arsenic, and local incision; in the third, by purgatives, leeches, and opiates (*De Heaume, Med. Gaz.* Dec. 1837); in the fourth, purgatives, calomel, and opiates (*Dr. Hooper, Med. Times*, May 17, 1847); in the fifth, by calomel and incision (*Haines, Lancet*, 1847); in the sixth, by opiates, anæsthetics, and excision of the cicatrix. (*Prof. Jackson, Amer. Journ.* 1849.)

These cases are described carefully by independent observers; they presented the most striking identity of symptoms with other cases of hydrophobia. In all six the part bitten was the centre from which the symptoms took their origin, and in four there seems no doubt that the dogs which inflicted the bite were rabid. We may then probably from this deduce that, although hydrophobia is fatal in so overwhelming a majority of cases as to leave no reasonable hope for those affected, yet in rare instances recovery may occur.] Hence, too, there may be deduced the imperious necessity of using every possible means for the prevention of the disorder.

Probably, however, many things which possess the character of being preventive of hydrophobia, have no real claim to such reputation. I would extend this observation to all internal medicines, mercurial frictions, and plunging the patient for a considerable time under water.

The instances in which a prevention is inferred to have taken place by different writers, in consequence of such means, may all be very rationally ascribed to other circumstances. Facts, already cited, sufficiently prove that out of the great number of persons frequently bitten by the same dog, only a limited proportion is commonly affected. The hydrophobic poison is known to reside in the saliva of the animal, consequently the chance of being affected must greatly depend upon the quantity of this fluid which is insinuated into the wound, and if the teeth of the animal should have previously pierced a thick boot or other clothing, before entering the skin, the danger must obviously be much diminished. Many persons wash and suck the wound immediately after its occurrence, and thus no doubt very often get rid of the poison. Even when it is lodged in the wound, it may not be directly absorbed, but be thrown off with the discharge. All prudent patients submit to excision of the bitten part. Now under each of the above circumstances escapes have frequently occurred, while internal medicines, half drowning or salivating the patients, had also not been neglected, so that all the efficacy of preventives has too often been most unjustly ascribed to means which probably never yet had, and never will have, any beneficial effect whatever. What confirms the truth of the preceding statement is these facts; that persons bitten by the same animal have sometimes been treated exactly on the same plan; some of them escaped the disease; others had it, and of course perished; on other occasions some of the patients bitten by the same animal have been treated in a particular way, and have escaped hydrophobia; while others, bitten at the same time by the animal, also never had any constitutional effects, although they took no medicines, nor followed any other particular plan.

If to these reflections be added the consideration, that it is frequently doubtful whether the bite has actually been inflicted by a truly rabid animal, and that the mental alarm will sometimes bring on a symptomatic hydrophobia, it is easily conceivable how mistaken a person may be, who believes that he has prevented the disorder; and how unmerited is the reputation of the means which he has employed for the purpose.

The bite of a naturally ferocious beast has often been thought to be attended with more risk than that of an animal naturally tame; and hence the bite of a wolf is said to be more frequently followed by rabies than that of a dog. This proposition is admitted to be true; but the explanation is erroneous. The true reason of the difference is that a wolf usually seizes the face, and inflicts a deeper bite; while a dog only snaps as he runs along, and mostly bites through the clothes. (See *Dict. des Sciences Méd.* t. xlvii. p. 88.) The bite of a rabid animal may be rendered much more dangerous by being situated near a part or an organ which increases the difficulty or risk of adopting an effectual mode of removing the whole of the flesh in which the virus may be lodged. Thus bites near the large arteries, the eyes, the joints, &c. are of a more serious description than others. Dr. J. Hunter rated the hazard in some degree by the vascularity of the bitten parts. The prognosis will always be more unfavourable when no proper measures have been applied to the bite soon after its infliction; and perhaps the risk may be increased by certain causes not having been duly avoided, which, as already stated, are thought to have a tendency to accelerate the attack of rabies. The exact time after a bite, when the prevention of rabies is no longer practicable, is quite an undetermined point; but every fact known on the subject evinces, in an urgent manner, the necessity of adopting preservative measures without the least delay.

[Although the pathological condition of patients, who have died with hydrophobia, has been extensively and minutely studied by observers who number among their rank names not less illustrious than those of Rokitansky, Key, Bright, and Hughes Bennett, among the moderns; and by the most illustrious of physicians and pathologists in bygone days; yet the collection of upwards of a hundred of the post-mortem reports affords little else than a varied mass of symptoms, common to other nervous and blood disorders, and fails to throw any clear light upon the pathology of the disease.

Fraignaud recently announced (*L'Union Médicale*, 28, 1856) that cadaveric rigidity did not occur after hydrophobia. But subsequent observers (*Pickells*, *Sanit. Review*, 1858) do not give a similar result. As the most characteristic appearances, an inflammatory condition of the fauces, larynx, pharynx, and stomach has been reported. On this point, in analysing the existing records, it is found that the pharynx was twenty-nine times highly vascular. The stomach was commonly congested, and the larynx nineteen times was highly vascular. Smith thinks that these have been most usually cases of passive congestion. For the blood is commonly found to be dark and fluid, and the congestions noted are for the most part apparently hypostatic. This is especially so with the lungs. Nevertheless Trolliet, coupling the vascularity of the lungs and larynx with the presence of tenacious mucus in the bronchi, has put forward a theory that, in this bronchial secretion, the characteristic virus of rabies is to be sought. He points out that the salivary glands are not pathologically affected; but it must be remarked, that but little time is commonly allowed by the disease for any organic change in these organs; and, in subsequent cases, engorgement and swelling of the submaxillary and sublingual glands is several times recorded.

The dissections of rabid animals afford no support to his views. (*Youatt.*) In several of his records it is stated that the papillæ upon the tongue were unusually prominent.

The lungs were emphysematous in many cases, and this symptom may be noticed in connection with an emphysematous swelling of the anterior part of the neck and chest, extending into the anterior mediastinum, which was found in ten recorded cases, and has given rise to various speculations. In one instance (Prof. Jackson's case) even the right arm was involved. The emphysema has been connected with the oppression of breathing and respiratory spasm, which are notable symptoms of the disease, and attributed to rupture of the bronchus. But it has been observed to increase after death, and in one case, dissected by Dr. Brandreth, that physician inflated the lungs after death, and believed that he established their integrity. It must be observed also, that bubbles of gas have been seen in the cerebral vessels, and that Prof. Lawrie found similar little vesicles filled with gas, in the submucous tissue of the stomach. These modern observations confirm the records of Trolliet and Morgagni (*De Sedibus et Caus. Morb.* Epist. vii.), Louis and Lescure (in *Méd. Mém. de l'Académie de Chir.* t. iv. p. 538 ; t. v. p. 527), who speak of gas escaping from the heart and aorta. This suggests the supposition, favoured by the weight of evidence, that the emphysema is due to the decomposition of the blood, which in hydrophobia is found so dark and fluid. The stomach has several times been found to contain altered and extravasated blood, such as would explain the coffee-coloured matters vomited in the last stage of the disease; the mucous membrane often ecchymosed, and once eroded. In a careful microscopic and chemical examination of the blood (*Schmidt's Jahrbucher*) the globules were found to be destitute of nuclei, or tendency to agglomerate. A solution of muriatic acid rapidly disorganised the globules, and "disengaged numerous bubbles of gas."]

The lungs were commonly of a deep red colour in all the six subjects dissected by Trolliet, and they were observed to be gorged with blood in cases reported by numerous writers ; as Bonet (see *Van Swieten*, t. iii. § 1140); Boerhaave (*Op. Omn.* p. 215); Morgagni (*De Sedibus et Caus. Morb.* Ep. viii. art. 23, &c.); Mead, Darluc (*Recueil périod. &c.* t. iii. and iv.); Faure (*Hist. de la Soc. Roy. de Méd.* p. 33); De la Caze (*ib.* p. 69); Portal, Oldknow, Ballingall (*Edinb. Med. and Surg. Journ.*); Marshall (*Morbid Anatomy of the Brain, &c.* p. 69.); Gorey (*Journ. de Méd. Chir.* t. xiii. p. 83); Ferriar (*Med. Hist. and Reflections, &c.*) "Pulmones in quinque nigri ex toto, aut magnâ parte, (says Morgagni,) in quatuor magnâ item ex parte sanguine pleni." In a case examined by M. Ribes, the larynx, trachea, and bronchi, besides presenting traces of inflammation, were everywhere lined with a thick white frothy mucus. (*Magendie's Journ.* t. viii. p. 232.)

[Of the cerebro-spinal organs, the dura mater was 20 times more or less congested, the arachnoid 11 times, the pia mater 36 times. Opacity of the arachnoid was observed 18 times, and it was twice adherent to the dura mater : in all the arachnoid was dry. The cerebrum was 38 times congested; 7 times it was softened in places; 15 times it was natural. Once the pia mater had undergone blue discoloration; once there was extravasation in the corpus striatum. In the majority of cases, the lateral ventricles did not contain more than the usual quantity of fluid. On the other hand, in about one-third of the cases they were more than naturally full; in one extreme case containing an ounce and a half of serum. The choroid plexuses were 9 times congested, and twice showed small bubbles of gas. The medulla oblongata was 5 times natural, twice softened, and 9 times congested. The spinal membranes were in 13 cases congested, 3 times ecchymosed in patches, twice opaque. The medulla spinalis presented in 10 cases no unusual appearance; in 6 it was in a varying degree vascular; in 4 softened. But in interpreting these appearances, the fluid condition of the blood and tendency to hypostatic congestion after death must be borne in mind. All the cerebro-spinal fluid was opaque and puriform. The condition of the cranial nerves was examined in ten of these cases; once their origins were vascular; once the vagus, where it gives off the laryngeal branch, was congested; once the sheath of the 8th and 9th nerves was congested at their origin. The peripheral ends of the nerves were frequently examined. The nerves in the neighbourhood of the cicatrix gave 11 times a negative result; once they had the appearance and colour of muscular tissue. It is a remarkable point, however, in connexion with the respiratory spasm, that the *vagus* was generally congested, and its sheath injected with blood: so also with the 4th and 7th nerves. (See *Tamhayn, Lewis Smith, Radciffe* and *Adams,* loc. cit.)]

Hufeland conjectured that in hydrophobia the medulla spinalis is the part originally affected, whence the effects of the disease are propagated to the nerves of the trunk. (*Bibl. Méd.* t. iv. p. 395, &c.) Dr. R. Read believed that an alteration of the spinal marrow was essentially concerned in the disease. (*On the Nature, &c. of Tetanus and Hydrophobia*, 8vo. Dublin, 1817.) A case was also published by M. Matthey, of Geneva, in which a quantity of serum was found within the spinal canal. (*Journ. gén de Méd.* t. liv. p. 279.) See on this subject some observations by Dr. Abercrombie (*Edinb. Med. and Surg. Journ.* vol. xiv. p. 66). In one instance dissected by M. Ribes, the vessels of the pia mater, brain, and medulla spinalis, were gorged with dark blood, but without any appearance of inflammation. (See *Magendie's Journ.* t. viii. p. 32.)

The cases recorded [by earlier writers] in which the digestive organs presented considerable morbid appearances are numerous. Thus, Joseph de Aromatarius, Darluc, (*Recueil périod.* t. iii. p. 189, et t. iv. p. 270), Sauvages (p. 107), Professor Rossi, M. Gorci (*Journ. de Méd. Chir. &c.* t. xiii.) and Dr. Powell (*Case of Hydrophobia*) found inflammation either in the pharynx or the œsophagus, or both these tubes. Dr. Powell's words are "The œsophagus was rather redder than natural, and covered with a thin layer of coagulated lymph." A similar coat of lymph was also found by Oldknow (*Edinb. Med. and Surg. Journ.* vol. v. p. 280), Ballingall (op. cit. vol. xi. p. 76), Dr. Ferriar (*Med. Hist. &c.* vol. iii. p. 27). In dogs, Dr. Gillman found the pharynx and œsophagus in a state of inflammation. (*On the Bite of a Rabid Animal*, p. 13, 23, 26, 44.) M. Ribes found the pharynx and soft palate slightly inflamed.

It is conjectured in many of these instances that the inflammation extended to the œsophagus from the trachea and bronchi. (*Dict. des Sciences Méd.* t. xlvii. p. 98.) Inflammation of the mucous membrane of the stomach and small intestines has likewise been very generally noticed, as may be seen by referring to the accounts published by Morgagni, Powell, Oldknow, Ferriar, Ballingall, Marshall, &c. In dogs the same fact was remarked by Dr. Gillman (p. 13, 31, 44). Sometimes, however, according to this last author, no vestiges of inflammation, nor any other morbid appearances, are discoverable in the examination of animals that have died of rabies (p. 83). Dupuytren is stated to have found the mucous membrane of the stomach and bowels inflamed in small places, and even almost gangrenous. (*Dict. des Sciences Méd.* t. xlvii. p. 98.) By M. Ribes the gall bladder was found empty, the mucous coat of the stomach, jejunum, and ileum inflamed, and these organs much contracted. (See *Magendie's Journ.* t. viii. p. 233.)

From recent investigations made at the Veterinary School at Alfort, by Professor Dupuy, the following are the usual morbid appearances noticed in the dissection of dogs, horses, cows and sheep, destroyed by rabies. 1. The lungs and brain universally gorged with blood. 2. Greater or lesser marks of inflammation in the mucous membrane of the bronchi, trachea, larynx, throat, œsophagus, stomach, and frequently even in that of the bowels, vagina, uterus and bladder. Yet in two dissections more recently recorded, no particular changes were discoverable in the pharynx and œsophagus. (*Magendie's Journ.* t. viii. p. 331, 332.) 3. The air passages filled with frothy mucus. 4. A collection of serum in the ventricles of the brain, and sometimes even between the membranes covering the spinal marrow. 5. An unusual redness of the investment of the pneumogastric and trisplanchnic nerves. (See *Dict. des Sciences Méd.* t. xlvii. p. 99.)

Happily, surgery possesses one tolerably certain means of preventing hydrophobia; when it is practised in time, and in a complete manner. Every reader will know that the excision of the bitten parts is the operation to which I allude. Indeed, as hydrophobia is often several months before it begins, the wounded parts should, perhaps, always be cut out, even though they are healed and some weeks have elapsed since the accident, provided no symptoms of hydrophobia have actually commenced. The operation should be done completely; for a timorous surgeon, afraid of cutting deeply enough, or of removing a sufficient quantity of the surrounding flesh, would be a most dangerous one for the patient. All hopes of life depend on the prevention of the disorder, for in the present state of medical knowledge, none can rest upon the efficacy of any plan except the extirpation of the part. For this purpose caustics have sometimes been employed. However, as their action can never be regulated with the same precision as that of the knife, and as, consequently, they may not destroy the flesh to a sufficient depth, excision should always be preferred. The latter method is also the safest for another important reason, viz. the part and poison lodged in it, are removed from the body at once; but, when the cautery or caustic is used, the slough must remain undetached. Some surgeons are not content with cutting out the part, but after the operation, fill the wound with the liquor ammoniæ, or cauterise its surface for the sake of greater security. How late excision may be done with any prospect of utility, I am not prepared to say, but there are practitioners who deem excision right, even when heat, irritation, or inflammation is observed in the bitten part. (See *Med. Repository*, vol. iii. p. 54.)

Cases present themselves in which it is even preferable to amputate the limb, than attempt to extirpate either with the knife or cautery the whole of the bitten parts; — an endeavour which could not be accomplished with any degree of certainty. Thus, as Delpech observes, when the hand or foot has been deeply bitten in several places, it is obvious that it would be impossible to make caustic (or the cautery) certainly reach every part which the saliva of the rabid animal may have touched. Besides, the mischief resulting, both from the injury and the other proceedings together, might be such as to afford no prospect of saving the limb, or at least of preserving it in a useful state. (See *Précis élém. des Mal. Chir.* t. ii. p. 133.) I have known of one or two cases in which the patients lost their lives, in consequence of the excision or destruction of the bitten parts not having been attempted, on account of the surgeon's reluctance to cut tendons, or wound a large artery, as one of those at the wrist. In such cases, however, the fear of rendering a muscle useless, or of wounding an artery, is no justification for leaving the patient exposed to a danger so surely fatal as that of the hydrophobic virus, if it once affect the constitution. The artery should be exposed for a sufficient length, and secured with two ligatures, when the requisite extirpation of the parts between them may be safely performed.

[Besides, or in place of, excision, the application of energetic caustics has been highly recommended by many experienced authorities. The whole range of destructive caustics have been employed. (See *M. Bouchardat's Report to the Minister of State upon the different Remedies proposed for the prevention of la Rage. Bulletin de l'Académie de Médecine*, vol. xviii. p. 6. Paris, 1852-3). Potassa fusa seems to receive the greatest support, as being more destructive than either sulphuric acid (*Zeidler, Rust's Mag.* 1838, p. 261), butter of antimony, nitrate of silver, or gunpowder. (See *Wittcke, Preussiche Vereins-Zeitung*, 29, 30, 1857.) Faber relates a case in which such local applications checked the progress of disease, after it had clearly shown itself, six weeks subsequently to the bite. But we may probably safely apply to the prophylaxis of hydrophobia that axiom of Hippocrates, "Quæ ferrum non sanat, non sanantur." Wittcke washes out the wound first with an alkaline solution, and then applies potassa fusa. After separation of the slough, Voltolini applies a cantharidine or savin ointment to induce a free suppuration. He also indicates the use of mercurials, strychnia and belladonna, as prophylactics, but of their capability to act in this sense there is no proof; and this is especially one of those diseases in which "nefaria nocent." It might indeed be desirable to keep the wound open, and allow it to suppurate freely during some weeks, since this nature seems to indicate; for in all those cases in which the cicatrix reopened spontaneously, the course of the disease became milder. Thus it would seem prudent to reopen artificially the wound should anything suspicious occur, were it only a marked change in colour of the cicatrix, a circumstance often preceding the outbreak of the attack.

No point seems more important in the prophylaxis than the diversion of the mind from dwelling on the subject by all possible means; never even allowing the name to be mentioned before the patient. The avoidance of excesses *in baccho et venere*, exposure to cold, agitation, excitement, and the other exciting causes mentioned above, is evidently indicated. Among newly suggested medical prophylactics, Lustig (*Preussiche Ver.-Zeitung: N.F.I.* 24) strongly advises a decoction of that innocent plant the scrophularia nodosa, much employed in Poland, while Illinsky (*Med. Zeit. Russ.* 44, 1857) advises a compound of suboxide of lead and copper. But such remedies can only prove in any sense prophylactic, if the patient could be persuaded to put great faith in them; and then the first would be preferred as being a harmless adjuvant to the necessary treatment by destruction of the part bitten.]

When once the hydrophobic symptoms have commenced, there is little or no hope of saving the patient, the disease having almost invariably baffled every plan of treatment, which the united talents of numerous medical generations have suggested. All the most powerful medicines of every class have been tried again and again: mercury, opium, musk, camphor, arsenic, the nitrate of silver, cantharides, belladonna, ammonia, plunging the patient in the sea, bleeding, &c. &c.

The inefficacy of opium is now generally acknowledged. In the space of fourteen hours, Dr. J. Vaughan gave one patient fifty-seven grains of opium, and also half an ounce of laudanum in a glyster, but the fatal termination, of the disease was not prevented. Dr. Babington even prescribed the enormous quantity of 180 grains in eleven hours, without the least amendment, or even any narcotic effect. (*Med. Records and Researches*, p. 121). On the very first day that rabies decidedly showed itself, in a man who had been bitten by a mad dog, Dupuytren injected into the vena saphæna, by means of Anel's syringe, two grains of the extract of opium dissolved in distilled water, and as a degree of calm appeared to be the result, four grains more were thrown into the cephalic vein. The patient remained perfectly tranquil three hours longer, but the symptoms afterwards recurred with increased violence. The next morning about six or eight grains more were dissolved and thrown into the circulation; but all was in vain, as the patient died in three quarters of an hour after the last injection. (See *Dict. des Sciences Méd.* t. xlvii. p. 131.) By Dr. Brandreth, a solution of the acetate of morphia has been more recently tried, without success. (See *Edin. Med. Jour.* No. lxxxii. p. 76.)

As for belladonna, its employment for the prevention and cure of hydrophobia is very ancient; its external use for this purpose having been mentioned by Pliny, and its internal exhibition, with the same view, by Theod. Turquetus, in a posthumous work published in 1696. (See *Praxeos Medicœ Syntagma, &c.*) In 1763 belladonna was recommended by Schmidt, as a remedy for hydrophobia, and in 1799 by J. H. Munch. (See *Richter's Chir. Bibl.*) It has so frequently failed, that, in this country, very little confidence is now put in it; but in Italy it is still employed, and in some cases published by Brera, where it was exhibited in very powerful doses, in conjunction with the warm bath and mercurial friction, tend to show that it will sometimes arrest the disease in its incipient state. (*Mém. Soc. Ital. Scienza Modena*, t. xvii.)

Some years ago the public hope was raised by the accounts given of hydro-chlorine or oxymuriatic acid. Wendelstadt even published the story of an Englishman, who allowed himself to be bitten several times by a mad dog, and then saved himself by washing the bites with this acid. And still more recently, Brugnatelli (*Italian Journal of Physic and Chemistry*, &c. t. ix. p. 324), has published some observations tending to prove its efficacy. The bites are washed with it, and then covered with charpie wet with it; and when the symptoms commence, if it cannot be swallowed in a fluid form, Brugnatelli gives bread pills imbued with it. For a child eight years old the dose is ℈ij, four or five times a-day, but gradually increased. According to Orfila, hydrochlorine was long since recommended by Cluzel, as an internal remedy for hydrophobia. (*Secours à donner aux Personnes empoisonnées, &c.* 8vo. Paris, 1818, p. 153.) With regard to Brugnatelli's cases, they are said to be so destitute of precision that no inference can be drawn from them. (*Dict. des Sciences Méd.* t. xlvii. p. 119.) In order to give hydrochlorine a fair trial, it was used internally and externally on seven patients, in the Hôtel Dieu at Lyons, in 1817. The bites were washed and bathed with it, and some of them also cauterized, and each patient took daily a drachm of the acid, made into an agreeable sweetened drink. All these unfortunate individuals afterwards died of rabies, though the treatment was begun the day after the receipt of the wounds. (*L. F. Trolliet, Nouveau Traité de la Rage, &c.*) The excision of the bites seventy hours after their infliction, and washing the wound with oxymuriatic acid did not, in Dr. Johnson's case, prevent the disease. (See *Edinb. Med. and Surg. Jour.* vol. xvi. p. 212.) In America the plant scutellaria laterifolia has been greatly extolled as a certain specific for hydrophobia. (See *A History of Scutellaria laterifolia as a Remedy for preventing and curing Hydrophobia, by Lyman Spalding, M.D.* New York, 1819.) And M. Marochetti, of Moscow, has described a new treatment, which consists in giving large doses of genista tinctoria or butcher's broom, and pricking with a lancet, and then cauterizing with a hot needle, some little pustules, said by him to form at the orifices of the submaxillary glands, between the third and ninth day from the period of the bite, the mouth being afterwards well washed out with a decoct. genistæ.

M. Magendie, West, and various English practitioners, however, have not been able to discern these sublingual pustules, possibly in consequence of their having looked for them too late, that is, after the accession of the constitutional disorder; for it appears that M. Magistel, of Saintes, has noticed such pustules in several patients. Some arose on the sixth day, others later, and the latest on the thirty-second day. Of ten persons bitten whom M. Magistel attended, five died, notwithstanding the strict adoption of Marochetti's treatment. (See *Journ. gén. de Méd.*) M. Villermé also observed a transparent pustule under the left side of the tongue, in the case of a female, on the eighth day from the bite. (*Revue Méd. Anderson's Quarterly Journ.* vol. i. p. 124.) In relation to this part of the subject, it merits notice that the vesicles were particularly sought for in two rabid sheep at the Veterinary School at Alfort, but could not be detected. (*Magendie's Journ.* t. viii. p. 328.) Hydrocyanic acid has likewise been proposed on account of its reputed antispasmodic properties; but some experiments made with it on dogs by Dupuytren, Magendie, and Breschet, furnish no results in favor of its being likely to prove useful in the present disorder. (See *Dict. des Sciences Méd.* t. xlvii. p. 132.) Indeed, the following statement, if correct, leaves little hope that any effectual medicine for hydrophobia will ever be discovered. "The most active substances, the most powerful narcotics (says Magendie), have no effect upon man or animals attacked with rabies. I do not merely speak of substances introduced into the stomach, and the operation of which may be prevented or diminished by so many circumstances, I speak of substances injected into the veins, and the effect of which must be equally prompt and energetic. For instance, I have several times introduced into the veins of rabid dogs very strong doses of opium (ten grains) without producing the least narcotic effect, while a single grain of the watery extract, injected into the veins of a healthy dog, immediately makes him fall asleep, and often continue so eight or ten hours. The same phenomena are remarked in our own species. M. Dupuytren and I injected into the radial vein of a young man labouring under hydrophobia, about eight grains of the gummy extract of opium, without any apparent result. We have also seen mad dogs bear the introduction of prussic acid into their veins without an instant's remission in the progress of their disorder." (*Journ. de Physiologie*, t. i. p. 41.) M. Magendie frequently noticed in his experiments that an artificial aqueous plethora manifestly enfeebles all the functions of the animals subjected to it, and especially those of the nervous system. Hence he was led to think that some benefit might arise from it in this disease where the activity of the nervous system is its greatest height. His idea received encouragement also from considering that in hydrophobia the patient takes no drink to replace the fluids separated from the circulation by the cutaneous and pulmonary perspiration, and that after venesection the blood seems as if it hardly contained any serum. The experiment was first tried on a rabid dog, from which about a pound of blood was drawn, and then sixty ounces of water injected into the left jugular vein, about ten or twelve ounces of blood, mixed with water, however, being purposely allowed to flow out during the latter part of the operation. The animal, which had previously been quite furious, now became quite tranquil; but five hours afterwards it was attacked with difficulty of breathing, which ended fatally in half an hour. (Vol. cit. p. 44, &c.) On the 15th of October, 1823, M. Magendie injected a Paris pint of water, heated to thirty degrees Reaumur, into the veins of a man's arm, who was labouring under hydrophobia in an advanced and violent form. Directly after the operation, the patient, from being furious, became tranquil, the pulse fell from 150 to 120, then to 100, and in twenty minutes to 80. The convulsive motions ceased, and the patient drank a glass of water without any difficulty. Notwithstanding hæmorrhage from the bowels, he continued to improve till the fifth day, when he was seized with acute pains and swelling of the wrists, knees, and elbows, and threatened with an extensive abscess of the leg, the consequence of the lodgment in the foot of two pieces of lancets broken in the attempt to bleed him, while he was suffering violent paroxysms in a previous stage of the disorder. Despondency and mental agitation again came on, and he died early on the ninth day from the experiment. On dissection, the swelled joints were found filled with pus, the mucous membrane of a part of the small intestines reddened by the expansion of veins, several small ulcerations in the ileum where it joins the cæcum, the blood in a decidedly putrefied state, the heart and large vessels distended with gas, air under the peritoneal coat of the stomach and intestines, posterior part of the lungs a little swelled, trachea sound, but the bronchi red. Magendie considers this case on the whole very favourable to the practice; and when it is reflected that the patient underwent directly after the experiment a great and sudden change for the better, lived eight days after the injection, and then possibly died rather from other accidental complaints, it must be acknowledged that the method seemed well deserving of further trials. I would also particularly recommend its adoption in an earlier stage, and while the patient is less reduced, than the one on whom the experiment was made and failed in one of the Borough hospitals.

By Dr. Rossi of Turin, the trial of galvanism was suggested (*Alibert, Nouveaux Elémens de Thérapeutique*, t. ii. p. 436, ed. 4); yet the only fact brought forward as an encouragement to persevere with the last means, appears to a modern author, from its symptoms and progress, not to have been a true case of rabies. (Dict. cit. t. xlvii. p. 126.) The rapid and powerful effects of the bite of a viper on the whole system, and perhaps the idea that the operation of this animal's venom might counteract that of the hydrophobic virus, led some experimenters to try what would be the result of subjecting patients affected with rabies, to the bite of that kind of snake. The project however was attended with no success. Three cases of this description were communicated to the Royal Society of Medicine. (*Hist.* p. 201.) Two additional ones were recorded by Dr. Gilibert, physician to the Hôtel Dieu at Lyons. (*Advers. Med. Pract.* p. 257), and Viriœl, surgeon of the same hospital, repeated the experiment on a child, which yet fell a victim to hydrophobia. Other trials are also said to have been made in France and Germany with no better success. Dr. De Matthiis, in the year 1783, let a viper bite a rabid dog on the throat. The dog's head was attacked with considerable swelling, the hydrophobia ceased, and according to some accounts the animal perfectly recovered, but according to other statements, though it drank freely as soon as its head had swelled, it only survived the experiment a few hours. (See *Dict. des Sciences Méd.* t. xlvii. p. 126.)

Some facts which occurred a few years ago in the East Indies, tended for a time to raise an expectation that a copious abstraction of blood might be the means of preserving patients actually attacked with this fatal disorder. Mr. Tymon, assistant surgeon of the 22nd Light Dragoons, tried successfully the method of taking away at once an immense quantity of blood from the patient. "I began by bleeding him (says Mr. Tymon) until scarcely a pulsation could be felt in either arm." Opium was afterwards given and the patient salivated with mercury. (See *Madras Gazette, of Nov.* 23, 1811.)

[But blood-letting has been employed in thirty-four cases which ended fatally. In the six cases in which tranfusion of warm water has been employed, it induced either high fever or great prostration; two of the patients died very soon after the application of these proceedings, all the cases ended fatally. Common venesection, according to the observation of the greatest number of physicians, sometimes lessened the power of the spasmodic fits, probably by depressing the vital power, while it not unfrequently increased the rapidity of their recurrence. Teale performed amputation of the bitten arm thirty hours after the bite, and removed once a finger from which intolerable, pains radiated; temporary relief resulted, but the case ended fatally. Cauterisation of the wound under chloroform, (and of both sides of the neck and chest, *Wagner*,) have also been tried without favourable results. The treatment by chloroform has been much canvassed. Reynolds (*New York Journal*, July, 1856), Sabatier, and Pickells (loc. cit.), have observed it to increase the respiratory spasm, and muscular convulsions. But Wagner, in an able article, defends its employment, as at least promoting euthanasia. (*Deutsche Klinik*, 1856.)]

Dr. Mead, who was very confident that he had found an infallible preventive of the disease in a little *liverwort* and *black pepper*, aided by bleeding and cold bathing before the commencement of the course of medicine, says: "As to all other ways of curing the hydrophobia, I own I have not been so happy as to find any success from the many I have tried. Bathing at this time is ineffectual. I have taken away large quantities of blood, have given opiates, volatile salts, &c. All has been in vain, because too late." Notwithstanding his disappointment, he concludes: "If any relief could be expected in this desperate state I think it would be from bleeding, even ad animi deliquium, &c."

The doctrines of Boerhaave also led him and his pupils to recommend and to practise bleeding in hydrophobia. "The distemper (says he) is to be treated as one highly inflammatory, upon the first appearance of the signs which denote its invasion, by blood-letting from a large orifice, continued till the patient faints away, and soon after by enemata of warm water and vinegar," &c.; and he adds, "that this practice is supported by some small number of trials." But the particulars of the success alluded to are not given.

Dr. Shoolbred finds that a trial of it was made at Edinburgh, more than sixty years ago, by Dr. Rutherford, who took away gradually sixty ounces of blood from a patient who had already been bled the same morning. As the patient lived forty-eight hours after the large bleeding, the method was probably tried somewhat early in the disease, and the case may therefore be set down as a fair instance of the failure of the practice. The trials which have been made in this country of the practice of bleeding in cases of hydrophobia, since the receipt of the above reports from India, I am sorry to say, have not confirmed its efficacy.

Bleeding was also recommended in cases of hydrophobia by Poupart. (See *Hist. de l'Acad. Royale des Sciences pour l'année* 1699, p. 48.) The practice is likewise mentioned in the *Medical Essays of Edinburgh*, vol. v. part. ii. § 5; and in the writings of *Dr. Rush*. (See also *Dr. Burton's case, Phil. Mag.* Aug. 1805.)

[Marochetti's treatment by the genista tinctoria has had no success. The pustules under the tongue of which he spoke have not been discovered, even when looked for as he directs, *not* during the hydrophobic attack, but within a few days after the receipt of the bite.

Among the latest remedies advised are the cetonia aurata, on which a committee of the French Academy reported in 1857, and which Eulenberg considers to possess nervine tonic properties (*Preus. Ver.-Zeit. N.F.I.* 2, 1858); a decoction of the leaves of stramonium, and finally *woorara*. The latter has been employed by Dr. Sibson, in a case which occurred at St. Mary's Hospital, without success, but with results which he considered to be somewhat encouraging.

The review of all the means hitherto employed in the cure of hydrophobia, and of all the deductions from accumulated observations of its symptoms and pathology, unhappily yields us no positive indications for any really curative treatment. The prophylaxis by excision of the wound, and the application of the cupping glass, as recommended by Sir David Barry, is the most important proceeding. Heroic general remedies, such as transfusion, bleeding ad deliquium, and salivation, have not yielded results equal to the hopes excited by the narratives of the physicians who have recommended them. The treatment which is alike indicated by the symptoms and pathology, and favoured by the records of the six successful cases, would avoid violent measures of all kinds, and, while endeavouring to keep this side of stimulation, would seek to support the rapidly failing vital power by injections of nutritious fluids, under chloroform, while the anæsthetic and other narcotics were carefully administered. Purgatives have in all these six cases been administered with benefit. It unfortunately remains yet for some future student of disease to discover a reliable remedy for hydrophobia.] *Ernest Hurt.*

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HYDROPHTHALMIA (ſrom ὑδωρ water, and ὀφθαλμὸς the eye.) *Dropsy of the Eye. Hydrophthalmus; Hydrophthalmos.* According to Beer, dropsy of the eye is seldom entirely a local disease, but at least is generally combined with an unhealthy constitution, or is a mere symptomatic effect of some other dropsical affection, anasarca, hydrocephalus, &c. Sometimes, it appears as a symptom of chlorosis. On the other hand, Mr. Lawrence informs us, that the facts which have come under his observation have not afforded the slightest support to the doctrine, that the disease owes its origin to a morbid state of constitution, or requires the use of antihydropic remedies. (*On Dis. of the Eye,* p. 653.) Dropsy of the eyeball seems also to Mr. Middlemore to be a local defect not arising from constitutional causes, or metastasis. (*On Dis. of the Eye,* vol. ii. p. 475.)

The disease may originate either from a preternatural accumulation of the aqueous humour; from that of the vitreous humour; or from an immoderate accumulation of both these humours together. (*Lehre, von den Augenkr.* b. ii. p. 616. Wein, 1817.) When the vitreous humour collects in this manner, it usually loses its natural consistence, and becómes thinner and more watery. (*Richter, Anfangsgr.* b. iii. p. 392.)

It is sometimes conceived, however, that in general, dropsical affections of the eye "depend entirely on some local cause, which has operated, not so much in directly increasing the fluid contents, as in weakening the resisting power of the tunics of the eye-ball, and especially of the cornea and sclerotica." (See *Mackenzie, On Dis. of the Eye,* p. 627, ed. 2.)

Beer states, that in the case proceeding from a morbid quantity of the aqueous humour, the first indication of the disease is an increase in the dimensions of the cornea, attended with a manifest enlargement of the anterior chamber. The cornea may become, in this manner, two, three, or even four times wider, than natural, without bursting, or losing its transparency; for, though a turbid appearance is discernible, this depends rather upon the state of the aqueous humour itself. The iris, which, in the very commencement of the disease, begins to lose its mobility, soon becomes completely motionless, and acquires a duller colour; the pupil always remaining in the mid-state between contraction and dilatation. In the eyeball an annoying sense of pressure, tension, and heaviness is felt, rather than actual pain. In the beginning of the disease, there is a considerable degree of far-sightedness, or presbyopia, which soon changes into a true amaurotic weakness of sight, but never terminates in perfect amaurosis. The free motions of the eyeball are more and more interrupted, in proportion as the organ grows larger, and it has invariably a hard feel, while the sclerotica, to the distance of two lines from the margin of the cornea, is as blue as it is in the new-born infant.

Respecting the precise cause of the accumulation of the aqueous humour, Beer offers no observation worthy of repetition, excepting perhaps that in which he reminds us, that a similar collection happens apparently as an effect of the conical staphyloma of the whole cornea. (See also *Wardrop's Essays on the Morbid Anatomy of the Eye,* vol. v. p. 19.) Mr. Lawrence has seen dropsy of the anterior chamber remain as an effect of internal acute inflammation which had destroyed sight. Long-continued syphilitic inflammation of the cornea, is attended with increased secretion of the aqueous humour. After the termination of the inflammation, near-sightedness is produced; there may be, however, a cloudy state of the cornea, and a corresponding imperfection of vision. Mr. Lawrence is unable to state whether this dropsy of the aqueous humour from scrofulous corneitis is ever removed. (*On Dis. of Eye*, p. 655.)

Perhaps, so far as our knowledge yet extends, it is impossible to say, whether the changes of the cornea are, in the present disease, to be regarded as the cause, or the effect, of the increased quantity of the aqueous humour, or, whether, as seems to me most probable, both phenomena are only effects of one and the same cause. The examples, somewhat repugnant to this idea, are those referred to by Beer, as symptomatic of other dropsical affections. On the other hand, Mr. Wardrop has never seen a preternatural collection of the aqueous humour, without its being accompanied with disease of the coats of the eye. (Vol. cit. p. 20.)

In hydrophthalmia, the prognosis is generally unfavourable; and, when the sight is nearly or quite lost, scarcely any hope can be entertained, either of restoring vision, or preserving the shape of the eye. Yet, according to Beer, things are not always quite so unpromising in the preceding form of the disease, especially when the surgeon is consulted in time, and the patient's constitution is not exceedingly impaired. He had never seen any instance in which the eye spontaneously burst; on the contrary, when the habit was decidedly bad, and the treatment ineffectual, the disease became gradually conjoined with the second species of dropsy of the eye, and terminated in a frightful disfigurement of the whole organ, and death. On dissection, the innermost textures of the part were found spoiled and disorganised, and sometimes even the orbit itself carious. (Vol. cit. p. 619.)

With respect to the treatment, Beer thinks, that this must depend very much upon the nature of the primary disease to which the dropsical affection is ascribable. He has known great benefit sometimes produced by the chloride of mercury, combined with digitalis, and a drink containing bitartrate of potash, and borax. This practice is manifestly connected with the notion, that this affection of the eye may depend upon the same causes as dropsy in general; a view at present renounced. Now, as a modern writer remarks, we do not "expect any material benefit from the adoption of any plan of treatment, which does not include the evacuation of a certain part of the augmented contents of the globe, or some other surgical proceeding, having for its object the production of a diminished plenitude of the eyeball." (See *Middlemore, On Dis. of the Eye*, vol. ii. p. 476.) But, when the disease has made considerable progress, and vision is either weak, or nearly lost, while the sclerotica near the cornea is not much discoloured, and there are no appearances of a varicose affection of the blood-vessels of the organ, Beer recommends making a puncture with a small lancet, in the lowest part of the cornea, half a line from the sclerotica, so as to discharge the aqueous humour. The anterior chamber is then to be kept empty for several days, or weeks, if possible, by reopening the small wound every day with the point of the lancet. (See also *Richter's Anfangsgr.* b. iii. p. 403.) After the operation, the eye is to be dressed in the same way, as after the extraction of a cataract. (See CATARACT.) Previously to paracentesis, Beer has often seen every general and local means perfectly useless, but highly beneficial as soon as that operation had been practised. Even when the paracentesis fails in bringing about a permanent cure, it may still be resorted to as a palliative with great advantage, and be often beneficially repeated, if care be taken not to make the puncture too large. However, when the blood-vessels are generally varicose, and the constitution very bad, such operation is apt to excite violent inflammation, suppuration, and even sloughing of the organ, attended with imminent danger to the patient's life. (*Beer*, vol. cit. p. 620, 622.)

With regard to the second species of hydrophthalmia, or that depending upon a preternatural accumulation of the vitreous humour, Beer states, that, in this case, it is chiefly the posterior part of the eyeball which is enlarged, so that the whole organ acquires a conical shape, in which the cornea very much participates. The latter membrane remains unaltered in regard to its diameter; but it is more convex than natural, and its transparency is perfect. It is observed by Mr. Wardrop (*On the Morbid Anatomy of the Eye*, vol. ii. p. 126), that an increase in the quantity of the vitreous humour happens not unfrequently in staphyloma, in which disease, he says, the enlargement of the eyeball will generally be found to arise more from an increase in the quantity of the vitreous, than of the aqueous humour. One character of staphyloma is often absent in hydrophthalmia; I mean, opacity of the cornea. In the case which consists in an immoderate collection of the aqueous humour, the anterior chamber is always enlarged; on the contrary, in the present form of the disease, that cavity is manifestly lessened, for the motionless iris is gradually forced so much towards the cornea, that at length the chamber in question almost completely disappears. However, the colour of the iris undergoes no change, and the pupil is always rather diminutive. Around the cornea, the sclerotica is rendered bluish by distention, with a somewhat smutty tinge. In the early stage, the patient is affected with shortsightedness, *myopia;* but his power of vision is always seriously diminished, and, at last, is so totally destroyed, that not a ray of light can be perceived. The motions of the globe of the eye and eyelids are lessened, or impeded, at a still earlier period than in the first species of hydrophthalmia, and to the touch, the organ seems like an egg-shaped stone. The very commencement of the disease is attended with pain, which daily becomes more and more severe, and, at length, is not confined to the eye and its vicinity, but affects all the side of the head, the teeth, and neck, being sometimes so violent as almost to bereave the patient of his senses, who urgently begs the surgeon to puncture the eye, or even is driven by desperation to do it himself, as Beer once knew happen. Even while the pain is less afflicting, the patient is deprived of his sleep and appetite. (*Beer*, vol. cit. p. 623.) Though an increase in the quantity of the vitreous or aqueous humour has generally been treated of as a distinct disease, and denominated hydrophthalmia, Mr. Wardrop has never seen a dropsy of the eye, without an accompanying disease of the sclerotic coat, or cornea. (*Morbid Anatomy of the Eye*, vol. ii. p. 126.) Beer's opinion is, that, when the disease has made such progress that not a ray of light can be discerned, and the pain in the eye and head is so violent, by day and night, that the sleep, appetite, and even the senses are lost; it is fortunate, if only the most perilous symptoms can be obviated by palliative treatment; for the preservation of a good-shaped eye is then quite out of the question. And even in the most favourable cases, the utmost which can be expected, is to stop the further advance of the disease, a perfect cure being extremely rare.

According to Beer, the first indication is to improve the state of the health by medicines and regimen. For this purpose, a long time will be requisite; and as for local treatment, in this case, little or nothing can be accomplished by it. Hence, the disease often continues to grow worse and worse; and, when the pain becomes violent, the best thing which the surgeon can do, both with the view to the functions of the organ and its form, is to let out the aqueous humour. But Beer reprobates, in the strongest terms, the plan sometimes recommended, of plunging a trocar through the sclerotica into the vitreous humour, and keeping the tube introduced until a certain quantity of that humour is discharged. The method preferred by him, is that which is mentioned by Richter (*Anfangsg.* b. iii. p. 400), and consists in opening the cornea and capsule of the lens, as in the extraction of a cataract, discharging the lens and vitreous humour, and letting the coats of the eye collapse; but, in order to prevent any re-accumulation of fluid, he afterwards cuts away a little bit of the flap of the cornea. The eye is then to be dressed in the same manner as after the extraction of a cataract. (See CATARACT.)

In one case from injury, where the lens was opaque and displaced, Dr. Mackenzie succeeded in curing the vitreous dropsy by repeatedly tapping through the cornea. (*On Dis. of the Eye,* p. 632, ed. 2.)

The third species of hydrophthalmia, or that produced by an accumulation both of the aqueous and vitreous humours together, is excellently described by Scarpa. He observes, that in every case on which he has performed the operation, and in other examinations of the different stages of the disease, made on the dead subject, he has constantly found the vitreous humour, more or less altered in its organisation, liquefied, and converted into water, according as the disease was ancient or recent. In some instances he could not distinguish whether the increased quantity of the vitreous, or aqueous humour, had most share in the formation of the disease.

In every eye affected with dropsy of the vitreous humour, which Mr. Middlemore has had an opportunity of examining, the reticular arrangement of the hyaloid membrane was destroyed. (*On Dis. of the Eye*, vol. ii. p. 482.)

The eyeball at first assumes an oval shape, ending in a point at the cornea; it enlarges in all dimensions; and in the end, projects from the orbit in such a manner, that it cannot be covered by the eyelids, disfiguring the patient's face as much as if an ox's eye were placed in the orbit.

This disease (says Scarpa) is sometimes preceded by blows on the eye, or temple; sometimes by an obstinate internal ophthalmia. In other instances, it is preceded by no inconvenience, except an uneasy sensation of tumefaction and distention in the orbit, a difficulty of moving the eyeball, and a considerable impairment of sight. Lastly, it is sometimes preceded by none of these causes, or no other obvious one whatever, especially when the complaint occurs in children of very tender age, from whom no information can be obtained. As soon as the eye has assumed an oval form, and the anterior chamber has become preternaturally capacious, the iris seems situated further backward than usual, and tremulates in a very singular way, on the slightest motion of the eyeball. The pupil remains dilated in every degree of light, while the crystalline is sometimes brownish from the very beginning of the disease; and sometimes it does not become cloudy till the affection has arrived at its highest pitch. The complaint then becomes stationary; and as the crystalline is not deeply opaque, the patient can distinguish light from darkness, and, in some degree, the outlines of objects, and brilliant colours. But when the eye has acquired a larger volume, and the whole crystalline lens has become opaque, the retina at last remains in a state of complete paralysis.

In the last stage of the disease, to which the term *buphthalmos*, or ox-eye, is properly applicable, when the dropsical eye projects from the orbit, so as not to admit of being covered by the eye-lids, with the inconveniences already enumerated, says Scarpa, others associate themselves, arising from the friction of the ciliæ, the secretion of gum, the flux of tears, the ulceration of the lower eyelid, on which the eye rests, and the excoriation of the eye itself. Hence, the dropsical eye is gradually attacked with violent ophthalmia, attended with intolerable pains in the part affected, and in the whole head. The ulceration, also, does not always confine itself within certain limits, but continues to spread; first, depriving the cornea of its transparency; next, consuming the sclerotic; and, lastly, destroying progressively the other component parts of the eyeball.

At the first appearance of dropsy of the eye, many surgeons recommended mercurials, and cicuta; astringent collyria; a seton in the nape of the neck; and compression of the eye. However, Scarpa has never yet met with a single well-detailed history of a dropsy of the eye, cured by these means. With regard to externals, he has learned, from his own experience, that when the disorder is manifest, astringent and corroborant collyria, as well as compression of the protuberant eye, are highly prejudicial. In such circumstances, making a seton in the nape of the neck, frequently bathing the eye in a lotion of mallows, and applying to it a poultice, composed of the same plant, have enabled him to calm, for a time, that disagreeable sense of distention in the orbit, and over the forehead and temple of the same side, of which patients in this state make so much complaint, especially when they are affected with a recurrence of ophthalmia. But as soon as the eyeball begins to protrude from the orbit, and project beyond the eyelids, he thinks there is no means of opposing the very grievous dangers which the dropsy of the eye threatens, except an operation, which consists in evacuating by incision the superabundant humours, then exciting gentle inflammation of the membranes, and suppuration within this organ.

Beer's prognosis in the third species of hydrophthalmia is at least as discouraging as that made by Scarpa; for the rapidity of the disease is said to be such as to leave scarcely a possibility of benefit being effected by any mode of treatment, and the case usually terminates in an exophthalmia, and death. These melancholy events are said, by Beer, to be accelerated by paracentesis of the eye, however executed; and he thinks that the sole chance of stopping the progress of the disease depends upon an endeavour being made in its very commencement to improve the general health, though he owns that success is to be regarded as a rare occurrence. The same author has no faith in any local treatment; and when the disease is advanced, he considers the extirpation of the eye the only rational expedient, though precarious in in its result. (*Lehre von den Augenkr.* b. ii. p. 628, 629.)

The main point on which Scarpa differs from Beer, is that respecting the effects of discharging the humours of the eye; a practice which the former represents as useful, even in cases where the hydrophthalmia combines an accumulation both of the aqueous and vitreous humours. In former times, says Scarpa, paracentesis of the eyeball was greatly extolled. Nuck, one of the promoters of this operation, punctured the eye with a trocar, exactly in the centre of the cornea. (*De Duct, Ocul. Aquos.* p. 120.) It has since been thought better to puncture the sclerotica about two lines from the junction of this membrane with the cornea, that such a small quantity of the vitreous humour may be more easily discharged at the same time with the aqueous, as may be deemed adequate to effect a diminution of the eyeball.

According to Scarpa, paracentesis of the eye, performed so as merely to discharge the humours, can never be a means of curing dropsy of the eye, unless the puncture made with the trocar excite inflammation and suppuration, and afterwards a concretion of the membranes composing the eyeball.

Scarpa condemns the plan of making a circular incision through the sclerotica, as being constantly followed by the most aggravated symptoms, particularly frequent hæmorrhages, an accumulation of grumous blood at the bottom of the eyeball, vehement inflammation of the eye, eyelids, and head, obstinate vomitings, convulsions, delirium, and the most imminent danger. Such modern surgeons, as have faithfully published the results of their practice on this point, namely, M. Louis (*Mém. de l'Acad. de Chir.* t. xiii. p. 289, 290); Marchan (*Journal de Méd. de Paris*, Janvier 1770; *Sur deux Exophthalmies, ou Grosseurs contre Nature du Globe de l'Œil*) and Terras (*Ibidem*, Mars 1776; *Sur l'Hydrophthalmie*), have ingenuously declared that, after performing the circular recision of dropsical eyes in the sclerotic, they had the greatest motives for repenting of what they had done. Scarpa prefers making a circular section, about three lines in breadth, at the summit or centre of the cornea of the dropsical eye, as directed by Celsus for staphyloma.

The safest and quickest treatment consists in the entire removal of the eye.— See article Eye (excision of the eye). *C. Bader.*

Consult *Mauchart*, De Paracentesi Oculi; Tub. 1744. *Conradi*, Handbuch der Pathol. Anat. p. 523. *Ficliz*, in Hufeland's Journ. iv. b. p. 208. *Flagani*, Collezione d'Osservazioni, t. i. obs. 43. *Gendron*, Mal des Yeux, t. ii. *Louis*, in Mém. de l'Acad. de Chir. t. v. 4to. *Marchan*, in Journ. de Méd. t. xxxii. p. 65. *Terras*, Op. cit. vol. xlv. p. 239. *Scarpa*. Sulle principali Malattie degli Occhi, cap. 13. *C. P. Beger*, De Hydrophthalmia. *Haller*, Disp. Chir. i. 575. *A. Sarwey*, De Paracentesi Oculi in Hydrophthalmia et Amblyopia Senum; *Haller*, Disp. Chir. i. 587. Tub. 1744. *Benedict*, De Morbis Humoris Vitrei. *Luke*, Diss. de Hydrophthalmia; Jan. 1803. *Richler*, Anfangsgr. b. iii. p. 392, &c. Göt. 1795. *Beer*, Lehre von. den Augenkr. b. ii. Wien, 1817. *J. Wardrop*, Essays on the Morbid Anatomy of the Human Eye, chap. 18 and 40, vol. ii. 8vo. Lond. 1818. *A. Smith*, in Edin. Med. Journ. No. 73. *B. Travers*, Synopsis of the Diseases of the Eye, p. 195, p. 200. &c. 8vo. Lond. 1820. *W. Lawrence*, On Dis. of the Eye, p. 653, 8vo. Lond. 1833. *R. Middlemore*, On Dis. of the Eye, vol. ii. p. 475, 8vo. Lond. 835; and *W. Mackenzie*, on Dis. of the Eye, ed. 2, p. 627—633, 8vo. Lond. 1835. *Dr. Stellwag von Carson* (Die ophthalmologie vom naturwissenschaftlischen Standpuncte, &c. 1855).

HYDROPS. (From ὕδωρ, water.) A dropsy, or morbid accumulation of water. For *hydrops articuli*, refer to Joints, Diseases of; for *hydrops oculi*, see the foregoing article. With regard to *hydrops pectoris*, *hydrothorax*, or *dropsy of the chest*, as it is altogether a medical case, an account of its symptoms, and treatment will hardly be expected in this Dictionary. The only concern, which a surgeon has with the disease, is being occasionally required to make an opening for the discharge of the water. (See *Paracentesis Thoracis.*)

HYDROSARCOCELE. (From ὕδωρ, water; σάρξ, flesh; and κήλη, a tumor.) A sarcocele, attended with a collection of fluid in the tunica vaginalis.

HYMEN, IMPERFORATE. The inconveniences brought on by such a cause, and the mode of relief, are explained in the article Vagina.

A continuation of the hymen over a part of the orifice of the meatus urinarius may produce great pain and difficulty in making water, and symptoms which may gave rise to suspicion of stone. For a case illustrating the truth of this observation, see *Warner's Cases in Surgery*, p. 276, ed. 4.

HYOID BONE, Fracture of; see Larynx.

[HYPERÆMIA. (From ὑπερ and αἷμα.) *Excess of blood. Congestion.*—General fulness of blood has almost uniformly been designated "plethora," and is treated of under that head in the present work. We restrict the term "hyperæmia" to excess of blood in a part of the body, affecting principally the capillaries and smaller vessels, which are at the same time dilated. To this must be added, when used synonymously with "congestion," retardation of the blood-current and disordered function. The term does not necessarily imply any qualitative deterioration; but hyperæmia is a very frequent consequence both of blood diseases and of impressions made primarily on the nervous system. The vital fluid can remain but a very short time indeed in a congested part without undergoing important changes.

Hyperæmia has been distinguished as *active*, *mechanical*, and *passive*. It is also either *transitory* or *abiding*. Any part of the body may become hyperæmic, the blood in its general mass being normal as respects quantity and quality, or in excess, or deficient, or when the proportions of its nutrient principles are augmented or diminished, or it is in any other way diseased.

Hyperæmia occurs physiologically during the functional activity of organs, as in blushing, and is induced by all those causes which lead to a healthy *determination* of blood. The excitement of lactation produces enlargement of the vessels and an increase of the quantity of blood in the mammæ; the functional activity of the ovaries, uterus, testes, and glands generally; of the stomach during digestion; of the brain during the operation of the mental faculties; and of the limbs in exercise; is attended with a similar effect. In all these cases the hyperæmia is more or less transient, and the accumulation of blood, with its consequences, is checked by the exercise of the function of the part and the absence of any stasis, or obstruction to the onward current. Increased nutrition and secretion are promoted by habitual physiological hyperæmia.

Organs and tissues are prone to morbid hyperæmias in proportion, in a great degree, to their vascularity, to their functional activity, and to their general consistency, and the distensibility of their vessels. As a pathological condition it occurs under numerous circumstances, and presents several well-marked varieties. 1. Plethora or general hyperæmia implies, to a certain extent, local hyperæmia of all the organs and tissues; but this fulness also predisposes to an unequal distribution, and to partial accumulations or determinations of blood from causes which would otherwise prove too slight to produce such effects. 2. Hyperæmia arises from the irritation of the arteries appertaining to a part, and probably of the veins also, as from friction on the surface of the body, exposure to a high temperature, or such stimulant applications as a mustard poultice, or excitants taken into the blood. The same result follows from various influences operating on internal organs and tissues. This is the active determination of blood, or the active or sthenic hyperæmia or congestion of authors. 3. Mechanical obstruction to the return of blood by the veins. As the arteries in the former, so the veins are primarily affected in this variety. When the principal venous trunk of a limb is compressed, as in tying up the arm for venesection, no adequate collateral channel being established, the capillaries become loaded and dilated, and the limb simply hyperæmic. The erect posture acting mechanically, particularly in certain states of debility involving the vascular tunics and their supports, produces the same effect; and we have another very familiar instance in the posterior part of the lungs from the recumbent posture. 4. Hyperæmia e vacuo. This is another form, in its nature mechanical, as where produced by atrophy of the brain within the unyielding skull, or in the gravid uterus after rapid delivery (*Rokitansky*, *Syd. ed.* vol. i. p. 108); also, in the skin by the operation of cupping, or in abscesses or cysts from the evacuation of fluids. 5. Hyperæmia occurs where there is no evidence of excitement of the part, or of any previous increased force or velocity of the blood in the arteries, or of defective nutrition of the vessels, or mechanical obstruction or pressure. This constitutes the passive hyperæmia or congestion which attends various nervous affections, asthenic inflammations, and low fevers produced by poisons in the blood; and is probably dependent on influences exerted primarily on the nerves of organic life. 6. Malnutrition and atony of the vessels of a part, which become distended with an unusual quantity of blood, although there may be no obstruction to its return, is another form of passive hyperæmia; in tuberculous subjects many of the tissues are particularly liable to hyperæmia of this nature.

Great differences of opinion have prevailed as to the nature of the changes in the vascular system which attend some of these forms of hyperæmia, and particularly the more active, and as to the sequence of the phenomena. According to some of the best observers, a stimulus or exciting cause applied to a part acts directly upon the arteries, increasing their action, and inducing them to supply to the capillaries an excess of blood, but this excess can reach only to a certain extent, and then the capillaries contract. If the effect terminate here, the hyperæmia is but transient, and the part recovers its healthy condition. If, on the one hand, the capillary plexus becomes loaded and distended, the veins failing to return the blood as rapidly as it is supplied, the change from the arterial to the venous character of the fluid passing through, and particularly of that accumulating in the part, is interfered with and diminished. This condition cannot continue long. If the change be slight the capillaries return to their original calibre, the contraction beginning at the centre of the hyperæmic part, and extending to the circumference, and, either with or without effusion of some of their fluid contents, the hyperæmia, as in the first case, vanishes. If, on the other hand, the altered condition be more intense, or prolonged, the current of the blood is retarded, the corpuscles become grouped together in masses, applying themselves to the walls of the capillaries, and displacing the parietal layer of the liquor sanguinis, changes of composition then occur in the liquor sanguinis, with exudation, and the motion of the blood becomes gradually weaker, until, frequently, a complete stasis is formed. The congestion passes into inflammation. (See INFLAMMATION.)

Various and even contradictory theories have been adopted in explanation of these phenomena. According to the neuro-pathological view, all the effects, in active hyperæmia, result from an irritation of the sensitive nerves of the part, producing an antagonistic palsy of the nervi vasorum; hence dilatation is the primary change and the accumulation of blood secondary. According to another theory, the stimulus applied to the fluids of the parenchyma increases the attraction exerted between them and the blood, retarding the current and causing the blood corpuscles to crowd together; hence, the accumulation of blood is primary and the dilatation of the vessels secondary. By another theory the stimulus is supposed to produce contraction of the veins and retardation of blood in the capillaries. By some pathologists it is thought that the phenomena of hyperæmia cannot be explained without admitting with Pflüger that a set of nerve-fibres exist, whose sole function is to arrest or diminish action.

Perhaps the most satisfactory explanation is that of Virchow, who states that the arteries are contracted by a stimulus applied to their muscular tissue, and the contraction is succeeded by a state of relaxation from exhaustion, the persistence of the relaxation being in proportion to the degree of previous stimulus; and that, in active as well as in passive hyperæmias, we have to deal with a kind of paralysis of the walls of the vessel, the condition of the vessel being a completely passive one. "The more active the vessel the less the supply of blood." (*Cellular Pathology.*)

Mechanical hyperæmia is a more simple process. Some pathologists consider that the effects of pressure and venous obstruction, producing serous effusion but not exudation of liquor sanguinis, ought not to be confounded with true hyperæmia. Effusion may undoubtedly take place without any augmentation of the quantity of blood, or dilatation of the capillaries, but wherever it is produced by venous obstruction and pressure there is always an increased quantity of blood in the capillaries, and accordingly hyperæmia.

Passive hyperæmia appears, more clearly, to be the result of impressions made directly or primarily on the nerves of a part; but that the surgeon may take a comprehensive view of the effects produced on the vascular system in disease, through the agency of the nervous system, certain experimental results have to be borne in mind. Claude Bernard has shown that by destruction of the influence of the sympathetic nerve, as in extirpation of a ganglion or section of a filament, the part which it supplied is rendered hyperæmic and its temperature elevated. Dr. C. H. Jones repeated the experiments with similar results. On dividing the sympathetic, in the neck of a rabbit, the ear on the same side becomes immediately distended with blood and quite red, its temperature, as well as that of the whole of the same side of the face, being considerably elevated; and it is a curious fact, not yet explained, that the hyperæmia, in these experiments, often subsides in a day or two, but the elevation of temperature may remain even for months. The blood itself which returns from the part so heated has also a higher temperature. Walther, Brown-Sequard, and others, explain this by an increased afflux of blood resulting from paralysis of the blood-vessels, thus assimilating it with the passive hyperæmias. Bernard, on the other hand, thinks it is an active determination of blood, as when a secreting organ is excited from a state of repose to an active discharge of its functions. Division or disease of the trifacial nerve destroying its function produces hyperæmia of the various structures of the eye. Direct palsy of the nervi vasorum, whether produced at the periphery or originating in the centres, has the same result.

Hyperæmia is said to be induced also by what Mr. Lister has termed "inhibitory action." This gentleman lays it down as a fundamental truth, that one and the same afferent nerve may, according as it is operating mildly or energetically, either exalt or depress the functions of the nervous centre on which it acts. (*Proceedings of the Royal Society of London*, vol. ix. 1859.) He rejects Pflüger's view of the existence of distinct nerve fibres. Dr. C. Handfield Jones has illustrated this inhibitory action by the visceral hyperæmias which result from burns, which generally bear a relation to the extent of surface irritated, and are accounted for on this theory in the same way as paralysis of the heart and sudden death; that is to say, by inhibitory paralysis of the coats of the blood-vessels. Dr. Jones thus explains the inhibitory influence of cold on the cutaneous nerves: "The morbid influence, let us say in a case of stiff neck, strikes the afferent cutaneous nerves, and through them affects the spinal and sympathetic centres, producing in them some abiding alteration in their molecular constitution. This state is reflected outwards on the vaso-motor nerves on the same side, occasioning their paralysis, and therewith inducing hyperæmic and disordered nutrition of the part which they influence; in fact, a condition not remote from inflammation. At the same time the motor nerves may be so stimulated, that tonic contraction of the muscles takes place." (*British Medical Journal*, Feb. 5, 1859, p. 104.)

The experiments here referred to show the direct agency of the nervous system in the circulation of the blood and the production of hyperæmia; and the same thing is seen in the effects of the moral emotions; as in the blush of shame, the suffusion of anger, and the pallor of fear, which show that the capillary vessels may be distended and overloaded, or contracted and emptied, by impressions made on and reflected from the nervous centres. But passive hyperæmias are in innumerable instances the results of direct impressions made by the blood itself, whether on these centres or on the periphery of the nervous system, by virtue of the quantity of its supply, its qualities, or the materials it contains. When the supply of blood to the brain is defective, the functions of the brain and nerves becoming disordered, the balance of the circulation is deranged, and morbid hyperæmias are produced in various parts of the system; persons endowed with great sensibility and irritability, are peculiarly liable thereto. Poisons in the blood produce direct palsy of the nervi vasorum, whether in the centres or at the periphery; and thus are produced, according to the views at present entertained by some of the best pathologists, the hyperæmias so common in mucous membranes, with mucous and muco-purulent discharges, as in chronic bronchitis, gleet and leucorrhœa, and the passive hyperæmias of the skin, intestinal canal, and other structures, occurring in low fevers, and as the effects of poisons; the most remarkable circumstance attending the reception of acrimonies and poisons into the blood being that every substance has its special effect, and that hyperæmias are not produced generally or promiscuously, but specially by each substance in particular structures. (See Toxhæmia.)

The phenomena of hyperæmia continually under the eye of the surgeon cannot be interpreted correctly without attention to the following circumstances. The various forms frequently occur in combination; thus,—mechanical pressure or obstruction combined with general plethora, frequently produces hyperæmia, resulting in œdema or dropsical effusion, as in pregnancy. The force of gravity, with debility of the vessels, combine to produce hyperæmia of the posterior portion of the lungs, in persons restricted to a supine posture—the "engorgement of position." Many diseases described in this Dictionary afford instances of the coexistence of passive hyperæmia, from the action of poisons and mechanical hyperæmia. Mal-nutrition of the vessels, diminishing their elasticity, with the mechanical influence of gravity, combine to form the hyperæmias of the lower limbs incident to old people and debilitated subjects, producing an habitual purplish or violet hue on the surfaces of old scars, and large, livid, flabby granulations in indolent ulcers. The various forms of hyperæmia also frequently occur consecutively; nowhere better illustrated than in the eye, where active is so often rapidly succeeded by passive hyperæmia. (See Ophthalmia.) When organs have been exhausted by excess of functional activity, or by active congestion or inflammation, particularly in debilitated individuals, after the active disease has been subdued, the weak and dilated vessels do not readily resume their natural calibre. One form of hyperæmia also frequently lapses insensibly into another form, and there may be every intermediate degree.

However excited, hyperæmia under any of these circumstances may prove transient, and be followed by no ulterior lesion, or it may constitute the first stage of the most obstinate or fatal disease or complication of disease. Parts which have once been affected are more liable to be affected again, and hyperæmias, whether active or passive, are liable to frequent recurrence. Their recurrence may become habitual, as in the brain or its membranes, producing habitual headaches; or periodic, as in the hyperæmias incidental to the paroxysms of fever, or in those occurring with hæmorrhage, as in the mucous surfaces of the chest vicariously to the menstrual or hæmorrhoidal flux.

The exciting causes of hyperæmia are extremely numerous. The most obvious are,—Operations and injuries of all kinds; the subjection of the body, or any part of it, to sudden violent changes of temperature, or to the continual impression of cold, or excessive heat; excessive moisture or dryness of the atmosphere, or changes in its pressure or electric condition, or of the electric tension of the body; excessive fatigue from violent or continuous exertion, or sedentary occupations and want of exercise; excessive, defective and unwholesome ingesta, solid or fluid; sleep, prolonged or deficient; violent mental exertions; venereal excesses and irregularities; the suppression of the secretions and excretions; the direct action of numerous general and special stimulants, and also of various narcotics and sedatives; the violent physiological action of organs, as of the heart, lungs, or uterus; ligatures; constrained postures; the pressure of tumors, aneurisms and foreign substances, and diseased organs. Every impulse which excites or diminishes the action of the heart, as excess or deficiency of blood, anxiety, the moral emotions, and the exciting and depressing passions; also every influence which so modifies the constitution of the blood as to disturb the physiological relations between the liquor sanguinis and the various tissues, or the molecular actions and interchange of materials between the blood and blastemata; and especially hyperinosis, or inflammation of the blood, or poisons in that fluid; any influence which produces atony or atrophy of the vessels of a part may also become an exciting cause. Thus, it will appear that the customs and occupations of civilised life tend to produce this pathological lesion, and not only the external surface, but the vital organs, as the brain, the spinal cord, the lungs, and the liver, are continually subjected to the causes of hyperæmia.

The symptoms of hyperæmia in external parts are sufficiently apparent. There is distention of the capillaries and small vessels, which can be emptied by pressure, but soon fill again. The colour of the part is augmented, and the tint varies from a bright scarlet to a deep red, violet, purple, or chocolate, according to the nature of the hyperæmia and the condition of the blood. Distended vessels, otherwise invisible to the naked eye, become obvious, and may pervade the part uniformly or in irregular patches. A bright scarlet colour is indicative of excess of arterial blood, the circulation remaining free; and a dark venous colour, of retardation or stasis. When the blood itself is dark, as in cyanosis or asphyxia, or when inspissated, as in cholera, the hyperæmias produced are dark; as also for the most part are those occurring in typhoid fever, and as the result of poisons. When numerous vessels are involved, and especially when effusion of any kind takes place, there is swelling. Active hyperæmia produces pain of a dull aching character, and tenderness or acute pain on pressure, and heightens the temperature of the part; but in passive hyperæmia there is not necessarily pain, increased heat, or swelling. The blood-vessels of the conjunctiva and sclerotica are bright scarlet in active, but distended, tortuous, almost varicose, and of a brown or purplish tint in passive hyperæmia.

Hyperæmia is so frequent an occurrence in the practice of surgery, and its consequences are so serious and even often fatal, that its production cannot be too closely studied. In the cellular tissue it leads to inflammation and abscess. When produced by varicose veins it is often the cause of hypertrophy of the lower limbs. In the mucous membranes active hyperæmia results from direct irritation, from morbid conditions of the blood, or from the existence of materials in this fluid having some special relation to those composing the membrane, or to the molecular changes which occur in the performance of the functions of particular parts; and passive hyperæmia occurs as a consequence of atrophy, adynamia, and debility, in exhausted and poisoned states of the blood. It may be produced, mechanically, by diseases of the heart, lungs, or liver, in large portions of the respiratory or intestinal mucous membrane, and lead to chronic inflammation and ulceration. In herniæ strangulation produces hyperæmia of the portion of intestine constricted. Hyperæmia of the cheeks, lips, and eyes, often inducing ecchymosis, as exhibited in the conjunctiva, is produced by prolonged expiration in whooping-cough, diminishing the capacity of the chest, or in running hard. Temporary cerebral hyperæmia occurs in the same way. Hyperæmia of the lungs results from obstructive valvular disease of the left heart, or obstruction of the pulmonary veins from any cause. The pressure of aneurisms, indurated glands, and various tumors, or diseases of the lungs, obstructing the return of blood from the brain, may produce hyperæmia of this organ generally, or of some portion of it or of its membranes. Obstruction of the right heart, or causes interfering with the healthy action of the lungs, as vesicular emphysema, and the various causes of asphyxia, produce hyperæmia of the portal system and of the liver; and diseases of the liver may lead to hyperæmia of any part of the capillary system beyond the vena portæ. The evacuation of the contents of abscesses and cysts, if unaccompanied with pressure, produces hyperæmia of their walls. Partial varicose dilatation of minute venous trunks is attended with diminution of the current of blood, and when in this state, obstruction of the vessels, by coagulated blood, pus corpuscles, tubercle, or cancer cells, are so many mechanical causes of hyperæmia. It is also often propagated through the nervous system indirectly, as where pressure of the corpus striatum, from extravasation or other causes, with paralysis of the muscles of voluntary motion, leads to hyperæmia of the limb on the opposite side.

The existence of hyperæmia in internal parts, and its nature, are often not easily determined. When it occurs to any considerable extent in vital organs it disturbs their functions; but here it is often very difficult to draw the line between the phenomena of simple hyperæmia and those of inflammation or of serous or sanguineous effusion. In the secreting organs and surfaces generally, it produces increased, diminished, suppressed, or vitiated secretions, according to the nature, extent, and stage of the hyperæmia, and the condition of the blood. In the brain, slight hyperæmia leads to morbid sensations of the most varied nature, headache, vertigo, hallucinations, restlessness, sleepiness, or lethargy. When active, with increased action of the heart and arteries, and accumulation of blood in the cerebral vessels, it produces a flushed countenance, pressure on the encephalon, vertigo, somnolency, and loss of consciousness; when mechanical, from obstruction to the return of blood and distension of the veins—the weak action of the heart and arteries at the same time even diminishing the flow of blood—it still produces pressure on the brain and a similar train of symptoms; and passive hyperæmia, from poisons, produces similar effects, from the slightest vertigo to the most profound coma. Partial hyperæmia of the brain or spinal cord may coincide with either morbid excitement or paralysis, or the suspension of the function of one part and the excitement of that of another, with many diseases referrible to the cerebro-spinal axis, as epilepsy, spinal irritation, hysteria, hallucinations, and errors of sense and motion.

The results of hyperæmia are as multifarious as its causes, varieties, and symptoms. They depend on its nature, seat, extent, duration, the condition of the blood, and not only upon the organ, but the particular part of the organ affected. When it constitutes only an increased supply of healthy blood, as already stated, it promotes nutrition, secretion, and healthy function. Thus, in a marked manner, it increases the growth of hair and of the nails, the nutrition and power of the muscles, and the elongation of bone. It promotes also the healing of wounds. It is right to state, however, that it has recently been maintained by Virchow that hyperæmia alone does not exercise a direct regulating influence on nutrition. When produced artificially, for days, weeks, or months, by section of the sympathetic in the neck, no nutritive disturbance arises necessarily therefrom. A greater quantity of blood in a part promotes the attraction of a larger quantity of material from the blood, but according to the pathologist last quoted it is not thereby compelled to take up more; for this purpose, it is essential that the part itself should exist in a particular state, as of increased activity or irritation, or that specific substances should be present in the blood, upon which definite parts of the tissues are able to exercise a particular attraction.

One of the most important considerations relating to hyperæmia, however produced, is, that the current of blood being retarded to any considerable degree, not only do the corpuscles accumulate and become grouped together, taking on a retrograde and oscillating motion, and displacing the parietal layer of the liquor sanguinis, as already stated, but the latter fluid becomes denser from transudation of its more liquid portion; delicate, transparent, fibrinous coagula form, by which the corpuscles are impacted, and a stasis or stagnation of blood occurs. This stasis may lead simply to coagulation, particularly in passive and mechanical hyperæmias, as in the case of aneurism or the ligature of an artery, or as sometimes found in hæmorrhidos; but in active hyperæmia it has two most important bearings. On the one hand, it constitutes a primary feature in local inflammation (see INFLAMMATION); on the other, it may lead to inflammation of the blood, or inflammatory fever (see HYPERINOSIS). The moment the blood becomes stagnant in a congested part transformations occur, especially in the liquor sanguinis. Its condition having previously been that of health, the formative process is exalted and oxygenation probably increased; in an unhealthy state combinations of a totally heterogeneous nature are generated. Hence the exudations which follow differ from the nutritive blastemata, and, also, in the various forms of hyperæmia, from each other. And again, the exuded materials being re-absorbed, or the modified blood within the capillaries ebbing back to the roots of the veins, and being carried directly into the current, a modification of the entire mass of blood is produced, with excited or depressed action of the heart, according as the blood may have been rendered more stimulating by an increase of its fibrinous quality, or may have attained noxious qualities by admixture with a septic poison. It is most important in the practice of surgery to study the character of every hyperæmia, not alone as respects its nature and causes, but as to its tendency to produce either inflammatory or low fever.

Rokitansky lays down the principle, that every hyperæmia may attain the point of inflammatory stasis. Owing to the comprehensive sense in which the term is now employed, this requires qualification. Active hyperæmia is the preliminary stage, and is very frequently developed into active or sthenic inflammation, passive hyperæmia into asthenic inflammation, and mechanical hyperæmia into inflammatory œdema; but certain asthenic hyperæmias, occurring in morbid conditions of the blood, are incompatible with inflammatory action, and complete mechanical obstruction will produce hyperæmia and gangrene without the intervention of inflammation. Repeated or abiding hyperæmias lead to true hypertrophy, as of the heart or kidneys, or to false hypertrophy (infiltration), or heterologous growths, as poisons or acrimonies may or may not exist in the blood; hence hyperostosis, fatty developments, goitre, the deposit of tubercle, probably cancer, gouty and rheumatic deposits, and various specific infiltrations of the organs and tissues. In the serous membranes, as in the pleura or peritoneum, when permanent or frequently recurring, it produces opacity and thickening, or gives rise to the deposit of calcareous materials, or serous collections. Intense hyperæmia, however produced, and even when a simple physiological action, may lead to laceration of the capillaries and hæmorrhage, and when this occurs in vital organs, often proves suddenly fatal by effusion of blood. In a minor degree it produces dropsy of serous cavities and œdema. Mechanical hyperæmia leads to varicosity of the blood vessels, and is the precursor of a large proportion of dropsical effusions. Hence abiding hyperæmia of the brain leads to serous or sanguineous apoplexy, and sudden death. Opacity, thickening, infiltration and hypertrophy of the arachnoid and pia mater, and the production of the Pacchionian bodies are attributed to habitual hyperæmias from the abuse of alcoholic fluids, of mental exertions, of sexual propensities, and other causes; and they are often attended with consequences fatal to reason and to life. Mechanical hyperæmias, from the removal of fluids from cavities, may be immediately followed by hæmorrhage from rupture of vessels caused by the sudden diminution of pressure on their walls. A somewhat similar result occurs when the evacuation of the aqueous humour of the eye is followed by hyperæmia and minute extravasation of blood from the vessels of the ciliary processes. Hyperæmia of the lungs, also, is the anatomical basis of many sudden deaths; it is often produced very rapidly by exertions which overtask the respiratory function, sudden shocks, rarefaction of the atmosphere, or mechanically, from hypertrophy and dilatation of the heart, and may prove speedily fatal as simple hyperæmia or with acute œdema, hyperæmia of the brain and effusion into the ventricles being a frequent consecutive complication. It may also pass rapidly into stasis and inflammation, and produce apoplexy of the lungs and hæmoptysis.

Hyperæmia of the spinal cord is a concomitant of many acute and chronic diseases, being met with in those who die of tetanus, hydrophobia, convulsions, and many poisons; also, in diseases of the vertebræ, as exostoses, luxations, or morbid growths, producing pressure and irritation. Sometimes hyperæmia pervades the whole spinal cord and brain, especially in children, and has all the characteristics of an idiopathic disease. The central ganglia of the sympathetic system are often hyperæmic. The affection here appears to be most frequently passive, and occurs particularly in acute diseases of low type, as in typhus and cholera. Many affections of sense are the results of hyperæmia, as muscæ volitantes from hyperæmia of the choroid coat of the eye, and tinnitus aurium from hyperæmia in the organ of hearing.

Hyperæmia of the liver may result, as already intimated, from valvular diseases of the heart obstructing the circulation, or any of those affections of the lungs which greatly impede the respiration by contraction of the vena cava inferior above the opening of the hepatic veins, or of the hepatic veins themselves at their opening into the cava, as from the pressure of tumors. In such cases the branches of the hepatic veins in the liver are mechanically distended and the organ enlarged. Hyperæmias of the liver are also often developed independent of any obstruction to the circulation. They are sometimes active, being produced by alcoholic fluids, spices, and condiments, and a too stimulating diet generally; and often passive, produced by atony of the vessels, or debilitated action of the heart. They are frequently dependent on the influence of a high temperature and miasmatic infection of the blood, or the suppression of habitual discharges. Hyperæmia of the liver constitutes the starting point of almost all the structural diseases of the organ, as atrophy of the parenchyma, suppuration, hepatitis, cirrhosis, apoplexy of the liver, and hæmorrhagic softening. It is attended with unequally distributed hyperæmias of the mucous membrane of the stomach and bowels, impeding the absorption of the nutritive fluids. It is usually attended with tightness or fulness of the right hypochondrium. This condition of the liver is often associated with surgical diseases of the rectum and lower extremities.

Febrile phenomena are not essentially connected with hyperæmias, but the latter are among the most constant symptoms of fevers and diseases of a malignant type generally, and of poisons received into the blood. In the cold stage of ague the malaria appears to produce congestion of the liver and spleen. The whole surface of the body is often covered with patches of congested vessels, in the form of petechiæ and vibices, in low fevers; and hyperæmias in different parts of the nervous system, in the mucous membranes, and in the parenchymatous organs generally, are among their most serious complications.

The special symptoms and sequelæ of hyperæmia, as it occurs in morbid states of the blood, as in gout, syphilis, typhus, tuberculosis, and other diseases, are fully described in various parts of this dictionary, or in the standard works of the day on the practice of physic, and can be advantageously studied only in connection with the general pathology of the respective diseases. Metastasis, so frequent an event where hyperæmia exists, is most probably the result of a materies morbi, generated in a part, being either re-absorbed from the blastema, or ebbing back into the blood, and producing its effects in distant parts, where hyperæmia may have been induced; as in the suppression of gout of the extremities, when any influence capable of producing hyperæmia of the stomach, as drinking cold fluid, will also occasion an attack of gout of that organ.

Hyperæmia may exist, on the one hand, in any structure during life without leaving the slightest *post mortem* trace, and may even continue until dissolution takes place, and not be detectable on examination afterwards. On the other hand, both hyperæmia and stasis may be produced during the death struggle, as the consequence of unequable palsy of the smaller blood-vessels and capillaries; and this is particularly the case in the mucous membrane of the intestines and in the lungs; occurring in distinct patches of capillary vessels of variable extent. (*Rokitansky.*) The subsidence of all appearance of the lesion is common in serous and mucous surfaces, and attributable to the rapidity with which the vessels empty themselves after death, if they have not altogether lost their tone; a portion of their thinner contents at the same time exuding and the remaining fluid passing into the veins of the congested part. The post mortem hypostatic hyperæmias of dependent parts have to be carefully distinguished from those existing before death. In hyperæmic organs and textures generally the capillaries and veins are found engorged, and if the affection has been considerable, they are swollen, of loose texture, friable and lacerable, and the blood being darker than natural, they present different shades of a dark red colour. In the mucous membranes, for instance, every degree of change, from distension of the veins and capillaries, or congestion of the membrane, to swelling, œdema, and even hæmorrhage is observable. There are often effusions of serous or sanguineous fluids from the hyperæmic surfaces, ecchymoses of a deep red colour in the skin, and in mucous, serous, and parenchymatous parts; and rust-coloured, slate-grey, or bluish-black effusions, produced by the admixture of blood-pigment with the fluid effused, in the lungs and the intestinal canal.

Treatment.—There is no part of the practice of surgery which more seriously demands the exercise of a correct judgment, than the treatment of hyperæmia. In any particular case, its existence and seat may be easily determinable, its nature and causes remaining doubtful; but the surgeon has to form his indications from the view he entertains on all these points, and has to regard, also, the stage at which the morbid condition may have arrived. Sometimes the removal of a ligature, or of the influence of gravity, or of pressure, however induced, is sufficient for a cure. Relief is afforded, in hyperæmias of the upper extremities, by a properly adjusted sling; in the lower extremities, by the horizontal posture, the feet and legs being elevated; in the head, by the sitting posture; in the uterine system, by the inclined plane; and in the lungs and other organs, by frequent change of position. In local determinations from excess of blood in the system, the general condition is the primary object of treatment. (See PLETHORA.) In active hyperæmias in the earliest stage, soothing applications and local depletion are clearly indicated, most violent and injurious effects being sometimes witnessed as the consequence of an opposite plan of treatment, as in the eye, the ear, and the limbs. But when the lesion has been produced by an irritant, and has continued for a sufficient time to fatigue the muscular fibres, "they may be excited to persistent contraction, so as to resist the increased rush of blood by the application of a higher degree of irritation." This requires the most discriminating judgment, and not only the local but the constitutional symptoms must be regarded. Where hyperæmia results from the capillaries having lost their natural elasticity and tonicity, rendering them too easily dilatable under the pressure of their contents, which accumulate in consequence, as often happens in the limbs, bandages and compresses are indicated, and friction with stimulating liniments is of great service. In indolent ulcers, where the granulations are large, flabby, and livid, from weakness of the blood-vessels, these may be made to contract and unload themselves by similar measures; under the use of local stimulants the ulcer assumes a better colour, and heals. In more active hyperæmias of the cellular tissue, which have persisted for a certain time, stasis and exudation may be inevitable, and the treatment must be regulated accordingly. (See INFLAMMATION.)

In internal organs, active or abiding hyperæmia passing into inflammation, on the one hand, or degenerating into passive hyperæmia, on the other, and the increased tendency to these results, by its persistence or frequent repetition, owing to the original or superinduced atony of the coats of the vessels, leads to two rules of practice: 1. To subdue the active disease as quickly as possible. 2. Not to carry the measures adopted for this purpose too far, or to continue them too long, so as to increase the resulting debility. Active hyperæmia of vital organs, in otherwise healthy subjects, with good blood and average nervous power, imperatively demands general blood-letting. It behoves the surgeon not to be influenced by the existing popular prejudice against bleeding, which there is too much reason to fear, in many instances, has led to the sacrifice of life. By this measure, adopted early, the quantity of blood sent to the congested part is diminished, the return of the excess of blood in the capillaries of the part, by the veins, is promoted, and a complete stasis prevented. Inflammation may thus either be superseded, or very materially limited. Passive hyperæmia, particularly where great susceptibility of the nervous system exists, is liable to be aggravated by general blood-letting. The tendency to unequal distribution of the blood from disorders of the nervous system, is also aggravated by depletion, as often observed in hysteria; and it is one thing to diminish the mass of blood when this fluid has an excess of superoxygenated fibrin, and another when it is deficient in fibrin, and otherwise impoverished, as in these opposite states of the system. Local blood-letting, sometimes adopted very freely, or several times repeated, is one of the most direct means of relieving hyperæmia. In the less active forms it may be resorted to in conjunction with general stimulants internally; but in this the greatest caution is necessary not to convert simple hyperæmia into inflammation, particularly when it affects vital organs. Derivatives, that is to say, measures by which a flow of blood or revulsion is produced to another part, constitute an extensive class of remedies for hyperæmia. On the sudden invasion of hyperæmia of vital organs, sometimes emetics and purgatives, the warm or vapour bath, diaphoretics, fomentations, pediluvia, and sinapisms to the extremities, are resorted to for the purpose of equalising the circulation, determining to the periphery, and restoring the healthy circulation of the affected part by enabling it to unload its vessels. When local blood-letting can be applied so as to produce revulsion from the part affected, it is the more efficacious. Purgatives or turpentine enemata are administered on this principle, to relieve congestion of the brain. So also various stimulating applications to produce counter-irritation, as blisters, sinapisms, and rubefacient embrocations. The actual cautery, moxas, issues, setons, friction, dry-cupping, lotions of nitro-hydrochloric acid, electricity and galvanism are resorted to as derivatives. The active hyperæmia of secreting organs is sometimes relieved by exciting their secretions, which diminishes the quantity of blood in their vessels, and enables them to contract on their contents, by which the circulation may be restored; but where the flux of blood is the consequence of atrophy and debility, with increased secretion, a different mode of treatment is indicated.

In all cases of internal hyperæmia, the surgeon has to consider the special action of the various remedies at his disposal, since the success of his treatment may depend entirely on the remedy selected. In many affections of the lower limbs, consisting of convulsions, cramps, twitchings, erections, formication, itching, pricking pain, abnormal sensations of cold, heat, tightness and pressure, or paraplegia with diminution of temperature, wasting of muscles, œdema, bed sores, alkalinity of urine, &c., depending on irritation of the motor, sensitive or vaso-motor nerve fibres, from hyperæmia of a part of the spinal cord, or of the roots of some of the spinal nerves or their membranes, remedies have to be resorted to which, received into the blood, and conveyed to the tissues, exert a special elective affinity in the part affected and the modified blood, producing a change in the action of the capillary vessels. Thus, belladonna, ergot, stramonium, or hyoscyamus, which act as powerful excitants of the blood-vessels, and diminish the amount of blood in the vertebral canal, and in so doing produce a relative diminution of the vital properties of the spinal cord and its nerves, should be employed (*C. E. Brown Séquard, in the Lancet*, 1860); and opium, strychnine and other remedies which occasion hyperæmia of the contents of the vertebral canal should be avoided. (See art. TOXÆMIA.)

The treatment of passive hyperæmia involves some important principles in therapeutics. It is found, experimentally, that where hyperæmia has been produced by division of the sympathetic nerve, galvanizing the upper end of the divided nerve causes not only the disappearance of the hyperæmia, but an opposite state of the vessels. Where hyperæmia has been produced by depressing influences applied to the skin, stimulating the sensitive organ originally affected is frequently curative. Where pain and passive hyperæmia coexist, as in some sore throats, stiff necks, intestinal pains and diarrhœa, the *Linimentum Saponis cum Opio*, or the *Linim. Ammoniæ cum Opio*, is often curative. If the theory of palsy in hyperæmia be admitted, the beneficial action of these stimulants, and of copaiba in vesical catarrh, turpentine in hæmorrhage and asthenic iritis, and arsenic in skin diseases, is explicable on the principle of their exciting the contractility of the capillaries, and diminishing the supply of blood to the part. For the purpose of exciting the contractility of the capillaries, 'and diminishing morbid hyperæmia, quinine and iron are administered; and being received into the blood, are conveyed to the seat of the disease; hence the beneficial effect of quinine in scrofulous ophthalmia.

In the general treatment of strictly passive hyperæmia, stimulants, astringents, and tonics, are employed. In the worst forms, occurring in low fevers and malignant diseases, with a dissolved state of the vital constituents of the blood, atony of the vessels, and great debility, the most powerful diffusible stimulants, as the ethers, alcohol, ammonia, bark and camphor, are indicated. In all such cases the general condition of the system must be considered, and in addition to the principle of directing the application of stimulants to the vessels of the affected part, every measure must be resorted to for the purpose of restoring strength and vigour to the circulation. Where, in such diseases, there is a tendency to hyperæmia of the lungs, and other dependent organs, from the gravitation of the blood, attention to appropriate changes of position, with the administration of the most powerful internal stimulants, will often produce the most beneficial results, and even preserve life. Where habitual hyperæmia has existed for some time, or has been produced by repeated inflammatory attacks, or excessive functional activity, and great debility has ensued, it is often very difficult to restore the contractility of the vessels, hence the obstinacy of chronic hyperæmia of the urethra, vagina, or bronchial tubes, which cannot strictly be regarded as cases of urethritis, vaginitis and bronchitis, the exudations being referrible to this pathological condition or to exaggerated function of the respective parts. These cases also often admit of the use of the most powerful general and local stimulants, and particularly such as have a specific action on the part affected—hence the use of cubebs, copaiba, cantharides, turpentine and the resins, ergot, strychnia, mercury, alcohol, and many other powerful medicines. Hyperæmias, whether active or passive, which result from poisons or acrimonies circulating with the blood, as in gout, rheumatism, syphilis, lepra, with the local treatment which each case specially requires, demand the use of antidotes and evacuants. If these general remedies were resorted to before the hyperæmia merges into inflammation with all its consequences, the latter would often be superseded. (See HYPERINOSIS; INFLAMMATION; SYPHILIS; TOXÆMIA; TUBERCULOSIS; URÆMIA; &c. &c.)]

Henry Ancell.

In addition to the references appended to the article on the Pathology of the Blood consult—*Copland's* Dictionary of Medicine and the Cyclopædia of Practical Medicine, art. *Congestion;* A Manual of Patholog. Anatomy, by *C. Handfield Jones*, M. B. and *E. H. Sieveking*, M. D. 1854; *C. Handfield Jones*, Lancet, July 1855; Feb. 1859; *J. Drummond*, Cyclop. Anatom. and Physiol. art. *Sympathetic Nerve*; Leçons sur la Physiol. et la Patholog. du Système nerveux, par *M. Claude Bernard*, Paris 1858; *Lister*, Transactions of the Royal Society, No. 32, p. 367.

[HYPERINOSIS (from ὑπὲρ and ἲς, ἰνὸς, the fibrine of flesh). *The fibrinous crasis of the blood. Diathesis Phlogistica* (*Cullen, First Lines*, vol. i. p. 105, 206). *Inflammation of the blood* (*Auc. var*).

This morbid state of the blood is so well defined, and is involved in so many surgical diseases, and the term is now so generally employed by pathologists, that we have thought it necessary to treat it separately, and *in extenso*, under the present head. In this, as in other articles on the blood, but little regard can be paid to the conventional distinction of its medical and surgical relations. (See BLOOD, PATHOLOGY OF; FEVER; HYPERÆMIA; INFLAMMATION; TOXÆMIA; WOUNDS, *&c.*) In hyperinosis the blood is of a high temperature, being frequently two or three degrees above the natural standard, and having been known to reach 112° Fah.; its volume is, in a corresponding degree, augmented; it reaches the veins of a bright colour, and is more highly oxygenised than ordinary, and the whole of its molecular actions, and accordingly its vitality are increased. The liquor sanguinis contains an excess of fibrine, and is more viscid than natural; the white corpuscles are very frequently, and the fatty matter is occasionally, increased; the red corpuscles are diminished in proportion; the solid constituents taken together are diminished, and the specific gravity is below the natural standard. (*Animal Chemistry, by J. F. Simon*, vol. i. p. 251.)

Examined microscopically the red corpuscles are smaller, flatter, darker, and of a higher specific gravity than in health (*J. P. Hennessy, Dublin Hosp. Gaz.* Nov. 15, 1857); they exhibit an increased attraction for each other, with a tendency to run together in rouleaux, and to form wider meshes than in healthy blood (*Wharton Jones*); and the increase in the proportion of white corpuscles is often found to be very great. A film of such blood spread on glass often presents a mottled appearance of red and white to the naked eye (*John Hunter*).

Drawn from a vein, hyperinotic blood does not so soon lose its natural translucency, and the process of coagulation commences later, although it has sometimes been found to proceed more rapidly, so that it becomes complete as soon as usual. The clot, if not large, is rarely small, and the fibrine being highly contractile is very firm and consistent, with its edge often turned up, rendering the surface according to its diameter more or less concave. The serum is of a pure lemon colour, free from any tinge of red, and of an alkaline reaction. Such blood is extremely prone to the formation of a firm, tough, buffy or pseudo-membranaceous coat, in which the fibrous network is very distinct; this coat being intimately connected with the substratum of the clot, and often containing a large number of colourless corpuscles in its meshes.

That a buffy coat is formed in blood possessed of very various qualities, and in different, and even opposite states of the system, has been stated in a former article (see BLOOD, PATHOLOGY OF). The explanation at present admitted of its formation in hyperinosis is as follows:—The blood preserves its perfect fluidity long enough to permit the red corpuscles, by virtue of their gravity, and before coagulation commences, to subside partially in the liquor sanguinis; after which, the clot, consisting of an upper portion, composed of fibrine and white corpuscles, and a lower portion into which the red corpuscles have descended, forms. The process is promoted by the tendency of the red corpuscles to arrange themselves in columns, like rolls of coin, the resistance of the plasma to their downward passage being thereby diminished; and also by the specific gravity of the corpuscles. The coagulum becoming concave in the centre, and raised and puckered at the edges, is said to be cupped, a result of the large quantity of highly contractile fibrine which it contains; the contraction commencing as the blood cools, and continuing for some days. The clot, in well-marked cases, is very loose at the bottom, owing to the excess of red corpuscles collected there, each of which must have supplanted its bulk of fibrine; but excepting so far as produced by this cause, there exists no more fibrine in one part than in another.

The buffy coat has been a subject of controversy in all ages. It is occasionally absent even in inflamed blood, since the process by which it is formed may be interfered with by many agencies, after, or during the time the fluid is being drawn from the vessels. It may be produced, also, during circulation in the vessels, in blood which has its normal quantity of fibrine, or even in blood which has less than its normal quantity, and none of the characteristics of inflamed blood; hence, it cannot be regarded as a certain sign of hyperinosis; but the well-marked buffy coat indicates more clearly than anything else, that the molecular activity of the circulating blood has been increased, and although occasionally absent, it is unquestionably the most characteristic circumstance in an inflammation of the blood.

The increased viscidity, which accompanies the increase of fibrine, has been frequently insisted upon in explanation of symptoms, and as a cause of the sequelæ of general inflammatory action, and as frequently denied. This quality was for a long time rejected, on the authority of Cullen, but we find more modern observers reverting to it. Dr. Carswell remarks, that various degrees of fluidity of blood occur, from a watery thinness to a state of inspissation approaching to coagulation. The consistence depends principally on the fibrine, and varies with the quantity and quality of this constituent, "since coagulation is no other than the solidification of fibrine, and hæmorrhage renders the blood thin, chiefly in consequence of the removal of fibrine." A certain degree of viscidity is indispensable for free circulation, and there are numerous facts and experiments which show that, whether the blood loses its natural viscidity, or becomes inordinately viscid, its passage through the capillary system may thereby be prevented. This increased viscidity is the "inflammatory spissitude," which Boerhaave laid down as a predisposing cause, of a pleurisy, for instance. More frequent morbid results would attend it but for counteracting agencies; as the increased temperature of the blood; the increased force of the circulation; and, probably, an increase in the proportion of the alkaline salts.

The co-existence of an excess of fibrine and a deficiency of corpuscles has been so frequently observed, and it has been so often found that the two conditions bear a proportion to each other, as to lead to the inference, that the fibrine is produced by the disintegration of the corpuscles; but whether so or not, the rapid loss of red corpuscles which takes place during the continuance of inflammatory action in the blood, is a sure proof of the destructive activity of the molecular changes. The fibrine ("coagulable lymph") coagulating more slowly than natural, and at the same time becoming firmer when coagulated, led John Hunter to observe that inflamed blood possesses the living principle in a greater degree than usual. Wharton Jones makes the remark that the aggregation of the corpuscles shows "an exaltation of their natural attraction."

Hyperinosis may be produced artificially by the inhalation of oxygen gas. Dr. Gairdner, who believes, with Mülder and Simon, that "by means of respiration the amorphous albumen of the blood is raised into the plastic fibrine," and that "oxygenation and fibrillation are identical," proved experimentally that the fibrine of the blood is increased in quantity by making an animal, while at rest, breathe a very highly oxygenated atmosphere. (*On Gout*, edit. 4, p. 200.) Dr. Richardson's experiments confirm this fact, and the train of symptoms attending a hyperinotic condition, thus produced, corresponds with the diseased condition arising from other causes. (*On the Coagulation of the Blood*, p. 70.) Among the most frequent causes are those by which the respiratory function is inordinately excited; but their modus operandi cannot be understood without adverting to the physiology of the blood. Dr. Gairdner examined the blood of a horse before and after sharp exercise, and found that the quantity of fibrine had undergone no change. This gentleman, in allusion to this experiment, remarks: "It is quite evident that whatever increase of fibrine may take place in the arterial side of the heart, the blood must, in a state of health, return to its ordinary standard in the veins, otherwise, the balance of the system would soon be overturned, and fever be engendered." This latter result is prevented by the general effects of the exercise, the active metamorphosis of the muscles, and the increased function of the skin especially. Nevertheless, the respiration of cold, sharp, or highly oxygenised, or very hot air, where the compensating processes are not brought adequately into play, will produce an inflammation of the blood. The action of powerful irritants received into the blood, some one or more of the secreting organs being at the time in an abnormal condition, and the sudden and intense impression of cold on the surface, under similar circumstances, are also frequent causes.

When an inflamed condition is set up by such causes, one of its earliest effects is a more or less decided chill or rigor, which appears to be followed very quickly by a sudden rise of temperature, and is apparently produced by the morbid blood circulating in the nervous centres, since it is most marked where a remora of blood has been forced on those centres by the impression of cold on the skin or pulmonary mucous membrane. Whether preceded by this rigor or not, the increased molecular activity of the blood is attended by the phenomena of, and forms part of, an inflammatory fever; increased action of the heart and arteries, accelerated respiration, the fixation of an increased quantity of oxygen in the lungs, augmented temperature over the whole body, increased force and frequency of the pulse, redness of the surface of the body and of the tongue and lips, and fulness of the capillaries generally, being the most prominent symptoms. There are sometimes erratic chills, followed by heats, but without any regular periodicity. The appetite is often destroyed, the heated blood excites thirst, there is a sense of general lassitude or oppression, aversion to motion, sometimes slight delirium or want of sleep, and at other times somnolency, and often a very great tendency to hyperæmia in particular organs or structures. During the course of an active attack there is increased vaporisation, both from the skin and the lungs. The urine is scanty, it deposits a red or brick-dust sediment; the uric acid, urea, and extractives, the products of the active metamorphoses of the blood corpuscles and of other nitrogenous substances, and of the waste of the tissues permeated by the inflamed blood, being increased. The uræmatine or pigment is greatly increased, and, measured by this constituent alone, the quantity of red corpuscles broken up in the blood, in a given time, amounts to four or five times the amount broken up during the healthy state (*Vogel*). This is particularly the case where hyperinosis attends pneumonia or acute rheumatism, although more marked in some forms of toxæmia producing rapid dissolution of the blood. In some of the latter cases the destruction of red corpuscles, for several days in succession, as measured by the urine, occurs at twenty times the usual rate. When a large quantity of blood is lost spontaneously during an inflammatory commotion, as in certain fevers, the excess of urea becomes shortly afterwards diminished; increasing again in the course of a day or two; and that this diminution is owing to the loss of red corpuscles, is shown by its not taking place when the other constituents of the blood are drained away without the corpuscles, as in albuminous excretions. (*Dr. Warncke; Dublin Med. Press*, 1859, *from Bibliothek für Layer.*) Biliary discharges from the bowels are also very common, and the cholæmatine, or colouring matter of bile, also probably derived from their disintegration, still further indicates the rapid destruction of the red corpuscles. The chloride of sodium becomes rapidly diminished in the urine, and in many cases disappears, in consequence of effusions and exudations taking place which are rich in chlorides, and of the diminished amount ingested, the liquor sanguinis having a tendency to preserve its integrity as respects this salt; but there is an increase of the compounds of phosphorus and sulphur, from waste of tissue, although not so constantly as the increase of urea. The whole of these symptoms are accompanied or followed by more or less copious sweats. As long as the urine continues very scanty, say reduced to one half its normal quantity, the intensity of the disease continues; but when symptoms, deemed critical, are fully established, and particularly the sweats and the deposits in the urine, the inflammatory action subsides. A constant increase in the quantity of urine attends the subsidence of the commotion, and when this subsides the quantity of urea becomes normal. During convalescence, owing to the diminution of the red corpuscles, the morbid disintegration having subsided, the uræmatine diminishes in quantity, and is often much below the healthy standard. When the patient is put on nourishing diet, the proportion of the corpuscles becomes gradually restored, but it usually takes from three weeks to a month to raise it to the standard of health, and during this period the proportion of fibrine may be even below that standard. (*Simon, Animal Chemistry.*) A sinister prognosis from reddish brown and brownish black urine in inflammation, and in all those diseases attended with "inflammatory commotion" of the blood, pointed out by the older authors, is thus explained. (See *Vogel, as quoted by Thudichum, Pathology of the Urine,* 1858, p. 138.)

John Hunter entertained the opinion that sizy and cupped blood, corresponding so frequently with a quick, hard, and vibrating pulse, mutually explain each other; but being totally unacquainted with the chemistry of the blood, he was staggered by the fact, that such blood sometimes occurs without either a quick or hard pulse, both being, perhaps, below the standard of health, and there being no visible fever or inflammation. The increased action of the heart and arteries, and accordingly the increased quickness and hardness of the pulse, are probably explained by the circulation through the coronary vessels and vasa vasorum, of blood of a higher temperature than natural, in which the vital molecular actions are increased and which contains an increased quantity of oxygen. The vibration of the pulse depending upon a difficulty in dilatation, the diastole, instead of being regular, uniform, and smooth, proceeds by a vast number of stops or interruptions so quick as to give the sensation of a vibration or thrill, and may be referred to the same cause. The chemical pathology of the blood indicates, clearly, that the exceptional cases have been too much insisted upon; admitting that sizy and cupped blood corresponds with very different states of action of the heart and arteries, this circumstance rather tends to prove that the causes of inflammation act directly upon the blood, and that the effects produced upon the nervous system, the heart, and other organs, depend partly upon the functional and organic conditions of these at the time the blood becomes inflamed.

The increased vitality and metamorphosis of matter, both in the blood and the tissues, and especially in parts affected with hyperæmia, during an inflammatory condition, must necessarily produce an increased quantity of effete materials, and although such materials are, to a greater or less extent, evacuated during the crisis, renewed portions of the materies morbi may continue to be conveyed from an inflamed part through the veins and lymphatics into the general mass of blood. These materials act as foreign matter, and produce a continuance of the inflammatory action, or an imperfect crisis with repeated paroxysms, and frequently those ulterior changes in the blood which lead to its complete dissolution and loss of vitality. (See NECRÆMIA; PYÆMIA; TOXÆMIA.)

In hyperinosis exudation is very easily produced, it may occur in a part without any hyperæmia, or may be very easily produced by the slightest determination of blood, taking place simultaneously with this occurrence, although no proportion may exist between the degree of hyperæmia and the quantity of exudation. It may be sufficiently abundant to diminish the quantity of fibrine in the blood very rapidly, and to alter its character. It represents various gradations in the morbid state of the blood and of its protein and morphological constituents. In the more simple and slighter cases, before ulterior changes have taken place in the blood, the exudations are fibrinous and organisable, and favourable to the adhesive process. The coagulable lymph forms tough, elastic coagula, analogous to the buffy coat; or fibrinous layers; or false membranes. In severe cases, or after the inflammatory condition has continued for some time, with the modifications which occur in the blood itself, the exudations lose their disposition to become organised and have a tendency to liquefy and degenerate. In an ordinary cut, in a previously healthy subject, the slight local inflammation tends to adhesion, the effusion becomes permeated with blood-vessels and organised; but extreme or long continued hyperinosis prevents the process of development. The inflammation of the part also takes place in excess, and the healing of wounds, and the reparation of injuries is often thereby altogether prevented. The exudations often become too copious, of a yellowish or yellowish-green colour, devoid of fibrillation, and exhibit a tendency to break down spontaneously. When taken from the tissue and examined microscopically, they exhibit nuclei or imperfect cell formations, in a faintly striated basement membrane, more or less reddened by extravasated blood corpuscles; as often observed in pneumonia; or they may run rapidly into puriform liquefaction. They have a corroding solvent effect after they have been applied some time to the tissues, occasioning fresh inflammation, ulcerous loss of substance, secondary phlebitis, visceral abscessess or they may be reabsorbed, or undergo fatty or cretaceous transformation, or solidification, the more liquid portion being absorbed. Mr. Paget well remarks. "We may truly say, the conditions most favourable to the abundant production of lymph, are among the most unfavourable to its development, *i. e.* to its complete and higher organisation."

One of the most serious results of a state of hyperinosis is the tendency to the formation of fibrinous concretions in the heart and vessels during life. The special characteristics of concretions from this cause are, that forming gradually they are modelled to the containing vessel or cavity, they are generally adherent mechanically to the parietes, or grooved by currents of blood that have passed along them, or they are formed into tubes resembling an inner additional coat and admitting a current of blood. (*Richardson*, lib. cit. p. 65.) They sometimes fill one of the cavities of the heart. The formation of these concretions is often the immediate cause of death in croup, pneumonia, acute laryngitis, and other diseases. Fibrinous concretions were found in 23 fatal cases from acute inflammation of the respiratory organs, with rapid sinking. (*Richardson*, lib. cit. p. 19.) (See BLOOD, COAGULATION OF, DURING LIFE.)

Hyperinosis attends all active inflammations, but it is most marked in pneumonia, croup, acute rheumatism, acute bronchitis, and acute pleurisy. In blood drawn in these diseases, the firmness of the clot, the tenacity and thickness of the buffy coat, and the concavity of its surface, that is to say, the quantity and the contractile power of the fibrine, has very generally been found to bear a relative proportion to the degree of inflammation. It attends peritonitis, inflammation of the uropoietic viscera, and erysipelatous diseases, so commonly occurring in surgical practice, but less constantly, and not in so well marked a form. It is one of the most common, and often the primary effect of the introduction of poisons into the blood, and it occurs in the early stage of most eruptive fevers, and especially in small-pox. From the buffy coat, and the general characteristics of the blood, Sydenham regarded the distinct small-pox as an inflammation of the blood, and the confluent form as the result of a more intense inflammation. (Op. sec. iii. cap. ii. 30, 49.) The exudation in this disease is a local deposit, resulting from an elective affinity of certain structures, as the corium, for some of the products of the inflammatory and poisoned blood; the epidermis being elevated at each point of the exudation, in the first place as a vesicle; and, as Mr. Paget remarks, "the morbid material is incorporated in the products of the inflammation, which are evolved within the characteristic vesicle." (*Lectures on Pathology*, vol. i. p. 441.) Pus corpuscles ultimately form in the fluid and multiply, until the aqueous part is absorbed, and the pustule dries. Hyperinosis is a frequent effect of the syphilitic virus.

Whether an inflamed state of the blood is ever a primary effect of the agencies which produce disease, or is not always a secondary affection, has given rise to much difference of opinion. The increase of fibrine is regarded by some pathologists as so certain a sign of local inflammation, that if more than five parts are contained in 1000, in the course of any disease, it may be positively affirmed that local inflammation exists. (*Handbook of Physiology, by Kirkes and Paget*, p. 57.) Andral found that the augmentation commenced at the very outset of a local inflammation; its minimum proportion was 5, its average he estimated at 7, and in one case he found as much as 13·3 parts in the 1000; the fibrine increasing with the progress of the inflammation, varying with its varying intensity, and decreasing when the local disease abated. The hyperinosis occurs not only when the proportion of fibrine has been previously normal, or in excess, but in opposite states of the system; and in diseases with a deficiency, or morbid state of the fibrine, as in typhus, tuberculosis, or chlorosis. Hence an inflammatory commotion may supervene upon many other diseased conditions of the vital fluid.

Professor Virchow, who traces almost all pathological change to the cellular elements of the tissues, takes a different view, and maintains that fibrinous exudations cannot be produced by any pressure or alteration of the current of the blood. Local irritation, alone, is capable of producing it, and some local change in addition to the disturbance in the circulation is always required. On this view of the case it could not be affirmed of a person who has an excess of fibrine in his blood, that there is also a greater tendency to fibrinous transudation. The excess of fibrine in hyperinosis, according to Virchow, is derived from different structures, and conveyed into the blood by the lymphatics, and is a product of the local inflammation. Those organs which have inherent in them in the highest degree, the power of producing fibrine, and are abundantly supplied with lymphatic vessels, as the lungs, pleura, and bronchial glands, increase the fibrine in the blood when inflamed; whereas inflammation of the brain, in which organ there are no lymphatics, is unattended with increase of fibrine in the blood. According to Virchow, again, when a part produces a large quantity of fibrinous exudation, this is conveyed into the blood by the current of the lymph, and it is not until the local production becomes excessive that a local accumulation takes place in addition to the hyperinosis.

In support of this view, Professor Virchow remarks, that in every irritation of a part abundantly supplied with lymphatics and freely connected with lymphatic glands, together with the hyperinosis there is the introduction of a large number of lymph corpuscles, and it is very rare that an increase of fibrine takes place without a simultaneous increase of the colourless corpuscles of the blood, which he believes to be lymph corpuscles. Every erysipelatous and diffuse phlegmonous inflammation early affects the lymphatic glands, and an increase in the number of white corpuscles of the blood takes place, but no considerable formation of fibrine in the diseased parts, and there is no hyperinosis. The same thing occurs in typhus where there is a hypinotic state of the blood.

But the excess of fibrine is not the only important modification presented by blood in a state of inflammatory commotion, and the increased temperature and the rapid destruction of the red corpuscles cannot be referred to the agency of fibrine absorbed. That some local irritation is necessary to the localisation of the morbid action, and that the local and general disease are often set up simultaneously are highly probable. (See art. Fever.) That local disease is often followed by hyperinosis is also certain. (See Hyperæmia, Inflammation, Pyæmia.) But that a pre-existing inflammatory state of the blood is often the *fons et origo* of local inflammatory attacks, appears to be equally clear. The causes which produce these attacks are often not local in their operation, but general, as atmospheric, epidemic, and climatic influences, and poisons. General symptoms frequently precede local effects of any kind, and all general morbid conditions of the blood have a tendency to localise themselves. Even acute pneumonia with a fibrinous product, the general symptoms of which are so intimately related to the functions of the lungs, is almost invariably a localisation of a pre-existing inflammatory state of the blood. There is no difficulty whatever in comprehending how an inflamed state of the blood produces this disease, or pleurisy, peritonitis, pericarditis, acute rheumatism, and other local diseases. The altered condition of the *liquor sanguinis*, as respects its viscidity and temperature, and the increased activity of the changes in the principal morphological elements of the blood, leads to obstructions of the capillaries and hyperæmias. The development of effete and acrimonious molecules more rapidly than they can be separated by the secreting organs, promotes this effect. The stasis which occurs, as the first stage of inflammation, is often also the result of the increased attraction of the corpuscles to each other, and to the walls of the vessels, and of the elective affinity which exists between the fluids and cellular elements of the parenchyma and definite substances in the blood. When the velocity of the circulation is reduced below the natural standard, the consistency of the blood is always increased, as seen by placing a ligature on a vein; and, in accordance with this law, when a large quantity of inflamed blood is forced on an organ where the circulation in the capillaries is more or less retarded, and particularly if the capillaries have been dilated by any influence exerted on the nervous system, the result must be hyperæmia, stasis, and inflammation.

The relations which subsist between an inflamed organ and an inflamed condition of the blood are rendered more intimate by the circumstance that during hyperæmia, stasis, and inflammation, new products are often developed in the part affected, and are carried into the blood current, and that such products are capable of exciting inflammatory commotion in the blood. In this way hyperæmia of the internal coat of the blood-vessels may produce inflammatory fever. The degree in which the mass of the blood becomes affected is in proportion to the extent of the local inflammation, or the magnitude and number of the parts inflamed, and the amount of the products of the stagnant blood received back by the general mass, very small quantities merging into the general metamorphosis of the blood, or being separated with the secretions. This contrasts with the effects of contagious and fermentible principles, respecting which the converse is to a great extent true. (*Rokitansky.*) These intimate relations are illustrated in bronchitis, when the proportion of fibrine diminishes and the fever subsides as the acute passes into the chronic form (*Simon*, p. 257); and also in acute rheumatism, where the fibrine diminishes, and the fever subsides with the pain, and if the pain returns the fibrine and the fever again increase, the acuteness of the pain corresponding with the increased quantity of fibrine. (*Andral and Gavarret.*) In painful affections of the viscera, usually attributed to hyperæmia, where the blood is healthy, there is at first no fever, and the fluid contains its normal proportion of fibrine; but the hyperæmia continuing and passing into inflammation, acrimonious particles are absorbed, and an inflammatory commotion of the blood with increase of fibrine, is produced.

On *post mortem* examination, where death has taken place whilst the blood is simply hyperinotic, and before ulterior changes, producing hydræmia, spanæmia, or necræmia, have established themselves, fibrinous coagula are commonly met with in the heart, and in the blood-vessels of every calibre down to the capillaries. These coagula are white, or yellowish white, compact, and frequently enclose serum; they are susceptible of organisation or textural conversion, and are more frequent and more compact in the left heart, and in arterial blood, than in the right heart or venous blood. There is also lividity, great cadaveric rigidity, deep red muscles, tense, dry areolar tissue, and the decomposition of the body is retarded. (*Rokitansky.* "*Simple Fibrine Crasis.*")

Where the purely hyperinotic state of the blood is giving way to other and deeper seated morbid conditions, the fibrine becomes affected. The coagula are then opaque, yellow, or of a greenish yellow colour, and contain fat; they are less disposed to become organised, and more readily liquefy; they lose their globe-like structure and fibrillation, contain an abundance of nuclei and cell formations in different degrees of completeness, and more or less assimilating to the pus-cell, and in the most marked cases they pass rapidly into puriform liquefaction. The blood in the most marked of these cases is fluid or loosely clotted, often tenacious from loss of serum, of a dark cherry-red tint, forming dirty red hypostases in the viscera; the liver is dark coloured, the muscles lax, dark patches are rapidly and extensively developed, rigor mortis is delayed and slight, the parenchyma is collapsed, flabby, lacerable, and moist, and where there is no hypostasis it is pallid. (*Croupous Crasis of Rokitansky.*)

Treatment.—The treatment of hyperinosis in the practice of surgery merges into that of inflammations, hyperæmias, wounds, and local diseases generally, and we must refer to those diseases which involve this condition of the blood for a full statement of the principles adopted, confining ourselves to such remedies as appear to be indicated by the blood disease itself. We have to bear in mind that a very short time indeed is necessary to complete organic processes in the blood, and that a change in its condition may take place very rapidly. When this point is duly considered there are two circumstances to be deplored; 1. The bent of the public mind to act upon its own rather than on medical judgment, in the earliest stages of disease; 2. The prevailing "homœopathic" dalliance with this and allied conditions. Bleeding is the most important remedy in the early stage of a well-marked attack. The experience of the best observers and the most judicious practitioners of every age has sanctioned it, apart from all theoretical views. A full bleeding arrests at once the molecular activity of the blood, diminishes its temperature, promotes its dilution, calms the action of the heart and lungs, and either prevents the hyperæmia of organs, or relieves the stasis of blood which leads to local inflammation. The question of bleeding, its amount, and the propriety of its repetition, turn upon the period of the disease and the actual state of the blood. The surgeons of former times were guided mainly by experience, and among the most judicious, that experience generally led them right. Errors have no doubt been committed up to our own day, and the cultivation of pathological science has, in a great measure, led to an explanation and appreciation of those errors. It is the great rapidity with which changes occur in the blood during its increased molecular activity which has been too frequently overlooked. In the early stage the withdrawal of a portion of the circulating current arrests those destructive processes which deprive it of its red corpuscles. To adopt such a measure after the blood has lost a large portion of its most important morphological element, is to deprive it of its vital powers, and to promote hyperæmias, stases, effusions, and inflammations. Neither, although an inflammation of the blood may have been produced by an acrimony or poison developed in the economy, or introduced from without, is bleeding resorted to for the purpose of evacuating that poison. When an inflammatory commotion of the blood supervenes upon an opposite condition, a state of hypinosis, which often occurs when poisons and acrimonies are absorbed in low states of the system, or in chronic constitutional affections attended with a low state of vitality of the blood and a diminished amount of fibrine, as in the paroxysm of gout or of mania, the amount of fibrine will be relatively increased, and the buffy coat may form, but bleeding is contraindicated or must be resorted to with caution. When, on the other hand, the blood becomes inflamed in subjects otherwise healthy, bleeding is indicated to check a morbid process and to prevent ulterior changes; more particularly, to prevent or arrest hyperæmias, exudations, and coagulation during life; to prevent arrest of blood in the heart and other viscera, and thereby to maintain its uninterrupted circulation throughout the most extreme parts; and to prevent the blood itself running into a hydræmic, or spanæmic, or pyæmic condition; in other words, to prevent local inflammations, dropsies, purulent deposits, typhoid diseases, or rapid sinking from coagulation in the heart or vessels.

With or without bleeding, abstinence from animal food and all stimulating substances, with plentiful dilution, is indicated for the purpose of moderating the vital activity of the blood and increasing the secretions, and where the inflammation depends on an acrimony or poison, for the purpose of promoting the evacuation of such poison from the system. Saline medicines are administered with the same intent, many of these determining to particular secreting organs. Antidotes, and medicines possessed of special elective affinities, are also frequently indicated. The laws which regulate the action of foreign substances received into the blood, are however treated of under another head. (See art. Blood, Coagulation, of, during Life; Hyperæmia; Inflammation; Plethora; Toxæmia.)]

Henry Ancell.

HYPERPLASIA, see Hypertrophy.

HYPERTROPHY (ὑπὲρ, and τροφὴ, signifying an excess of nutrition). This term ought to be restricted to cases, in which a part, though increased in bulk, retains its natural organisation and structure. It is one of the most common effects of increased activity in the nutrition of textures and organs; and likewise one, which may give rise to the most diversified functional disturbance. It cannot always, however, be regarded as a disease. The mere increase of size of a part, unattended with change of structure, or the interruption or disorder of any function by such hypertrophy, cannot be considered as a morbid affection. Thus, hypertrophy in a muscle of animal life is not a disease; but, in the heart, it becomes one of the most serious. (See *Andral*, *Anat. Pathol.* t. i. p. 166.) It can hardly come under the denomination of a disease, until it interferes with the regular and complete accomplishment of a function. As one of the most distinguished modern pathologists observes, "That the increased anormal development of an organ, or tissue, denominated hypertrophy, depends essentially on an excess of the nutritive function, appears to be sufficiently demonstrated by the presence, on the one hand, of an increase of bulk, and the absence, on the other, of any adventitious solid, or fluid substance. The organisation and structure remaining unaltered, is also further evidence, that the increase of bulk is owing to a superabundant deposition of the natural solid constituents of the affected organ from an excess of the nutritive function." (See *R. Carswell's Illustrations of the Elementary Forms of Disease*, fasciculus ix.)

1. Many hypertrophies seem to arise altogether from augmentation in the habitual activity of the functions of organs. "The prodigious development and power of the muscles of the superior extremities of the blacksmith, and of the inferior extremities of the stage-dancer, are striking examples of hypertrophy occurring under the influence of the frequent and increased exercise of a function, the effect of which is a corresponding increase of nutrition and of development of the muscular tissue. The anormal development of the muscles of involuntary motion, as those of the heart, bladder, and intestines, is likewise often precisely of a similar nature, an increased exercise of the muscular power of these organs having been excited and kept up to overcome a mechanical obstacle to the free passage of their respective contents." (*Carswell, Ib.*)

2. Some hypertrophies take place as the unequivocal result of what Andral calls active *hyperæmia*, either acute or chronic, or, in other words, of a great determination, or of a copious afflux of blood to parts, for a greater or lesser time.

3. Others proceed from some physiological or pathological stimulus, some irritation of the nutritive function, creating an excess of it. (See *Andral, Précis d'Anat. Pathol.* t. i. p. 182.)

[According to Mr. Paget the conditions which give rise to hypertrophy are chiefly three. "1. The increased exercise of a part in its healthy functions. 2. An increased accumulation in the blood of the particular materials which a part appropriates to its nutrition or in secretion. 3. An increased afflux of healthy blood." With respect to the hypertrophy of muscle he alludes to Hunter's opinion that the muscles of organic life are more prone to hypertrophy than those of animal life. He also adopts Harting's statement that in the increased growth of striped muscles, there is not a numerical increase of the *fibres* but an enlargement of them with an additional number of the *fibrillæ*.

In speaking of hypertrophy of the bones of the skull, he uses the term eccentric growth to denote their expansion in cases of hydrocephalus, and of concentric growth to designate their increase in thickness. He relates a remarkable instance of concentric growth in the cranium of a lady of weak intellect, in whom the external layer of the bones retained its normal symmetry and dimensions while the internal was adapted to an imperfectly developed brain, the intermediate diploe being increased in some parts to the extent of half an inch in thickness.

In the long bones he draws attention to the increase in length as well as in thickness, which occasionally takes place, and to the interesting fact that, in the division of a limb in which there are two bones, if the hypertrophy affects only one, the healthy bone retaining its normal length compels the elongated bone to assume a curved form. With regard to the effect of pressure in producing thickening or hypertrophy, he notices Hunter's remark, that pressure from within usually produces absorption, while pressure from without is followed by deposition. He admits the facts as stated by Hunter, but would explain the result differently: he observes, "Constant extra-pressure on a part always appears to produce atrophy and absorption, occasional pressure may, and usually does, produce hypertrophy." (*Paget, Lectures on Surgical Pathology*, p. 74—92.)

Virchow admits two kinds of increased growth: 1. Simple hypertrophy, in which the individual elements are enlarged; 2. Numerical hypertrophy (hyperplasia), in which an increased number of elements are added. He adduces as instances of simple hypertrophy the increased thickness of all the primitive fibres of a muscle or nerve, the enlargement of each individual hepatic cell, or of every single fat cell, while hyperplasia of the liver gives rise to new hepatic cells; of nerve, to new nerve substance; of skin, to a fresh production of the elements of skin; of fat, to an additional number of fat cells. (See *Cellular Pathology, by Rudolf. Virchow, translated by F. Chance*, 1860.)]

[HYPINOSIS (from ὑπὸ and ἶς, *ἰνὸς*, the fibre of flesh). A diseased condition of the blood, in which the fibrine is diminished in quantity, absolutely, and also in proportion to the red corpuscles. In extreme cases a trace only remains. Its vital properties are also deteriorated.

Hypinosis, in a vast majority of instances, constitutes but one element of a complicated morbid condition of the blood. Nevertheless, it is in itself so important an element of disease, or the degree in which it exists is so accurate a measure of the intensity and import of complicated blood affections, that it demands especial attention.

In hypinotic blood, the albumen, the salts of the liquor sanguinis, and the red corpuscles may be in the normal proportions, or even in excess, hence designated by Wedl "albuminosis." It is less oxygenated, of diminished temperature, and its metamorphoses take place more slowly. The red corpuscles do not run together in rouleaux, but are irregularly scattered, and their preponderance arises, probably, partly from their diminished consumption, and partly, often, from a smaller proportion of water. According to J. F. Simon, the blood is always alkaline, and Richardson refers the defective fibrillation to excess of ammonia; but Rokitansky affirms that such blood is sometimes acid. The clot is of a dark red colour, very frequently but not necessarily large; it is soft, diffluent or loose; feebly contractile; sometimes failing to separate itself from the serum; and sometimes no clot is formed. The serum is often of a dark yellow tint or reddish from the breaking up or suspension of red corpuscles. A buffy coat is seldom seen, and when it does occur is thin and soft, or forms a gelatinous party-coloured coating.

Blood of this character acts as a diminished stimulus to the heart, and this organ partially loses its power; hence its contractions succeed each other with increased rapidity, but the blood is propelled with diminished force, and the pulse, although quickened, is weak and often wiry, and the current of the blood is comparatively slow.

Hypinosis is so direct an effect of many poisons, miasms, and contagions, that it has been regarded as a primary blood disease. It may be produced by the inhalation or ingestion of poisons artificially (*Richardson*, lib. cit. p. 90), and is the condition, so far as discovery has at present developed, which most constantly attends simple fever. In its minor degrees it is not well marked, nor easily detected, either by physical observation or chemical research. Fibrine was found to be deficient constantly, by Andral, in the premonitory stage of fever; being sometimes reduced as low as 1·6, and recovery having taken place after its reduction to 0·9 in 1000 parts of blood. During the period of excitement or reaction, however, there is always a tendency to hyperinosis, hence, it would appear, that while the materies morborum, in such cases, lead to the dissolution or deterioration of the fibrine, they, at the same time, excite the molecular actions upon which the reproduction of this vital proximate constituent depends. In typhoid fevers, for instance, the period of increased temperature is marked by a great increase of the urea excreted, and the increase of the urea being in proportion to the temperature, to the progress of the emaciation, and to the rapidity of the pulse. (*Dr. Warncke*, lib. cit.) It is important, also, to bear in mind that the inflammation or "commotion" of the blood, which often obtains at the commencement of fevers, has a direct tendency to deteriorate and exhaust the blood, first of its red corpuscles, and ultimately of the fibrine; hyperinosis, in proportion to its intensity, the more certainly and rapidly passing into a state of hypinosis. (See art. Hyperinosis.)

Hypinosis occurs in its extreme degree in the hæmorrhagic diathesis, and in typhus and typhoid fevers, and occasionally in the exanthemata. The fibrine decreases in proportion, as the worst forms of malignant diseases progress. It occurs consecutively to numerous affections of the solid parts, as organic diseases of the heart, apoplexy, and diseases of the nervous centres, and diseases of the lungs, liver, spleen, and kidneys. It has been shown by Dr. Hood, that there exists a marked state of hypinosis in acute mania during the period of excitement, and a correction of this state during convalescence; analysis shows that there are other radical disturbances in the composition of the blood in mania, but that a deficiency of fibrine is the most constant. (*Med. Chir. Trans.* 1860, p. 159.) This is the habitual state of the blood in gout, and has been observed also in chronic rheumatism; rickets; mollities ossium; cancer; tetanus; chronic mental aberration; hypochondriasis; hydrophobia; chronic metallic poisoning, especially with lead; narcotism; exhaustion from excessive fatigue; starvation; atrophy from acute diseases; Asiatic cholera; and suffocative death seizures. Hypinotic blood is liable to various complications. It may be rendered relatively and temporarily hyperinotic by inflammatory attacks in gouty subjects during the paroxysm, in the different stages of many of the above affections, and during the complications which arise; considerable changes taking place in the condition of the blood, so that it can no longer be considered simply as hypinotic. In many cases, hydræmia constitutes one of the most important complications of qualities, the proportion of water increasing, and the albumen becoming deficient, a condition which is often promoted by extensive exudation; or, if the water of the blood is at the same time profusely effused, a tar-like inspissation may occur, with anæmia, as in cholera or profuse diarrhœa; or the salts, carbonic acid, corpuscles, and solid constituents may decrease to such a degree, as to produce an extreme state of poverty or dissolution of the blood. Hypinosis may also result from an acrimony, or a poison in the blood, and is also often associated with an oily condition and fatty degeneration of the tissues. These conditions are treated of under their respective heads. (Vide Blood-anhydrous; Heterochymeusis; Hydræmia; Necræmia; Olæmia; Spanæmia; Toxæmia.)

Thus, a deficiency and degeneracy of the fibrine accompanies some of the most severe and complicated blood affections. It constitutes one of the most fatal qualities of the blood in such cases. It has accordingly a very marked influence over many surgical diseases. As already intimated, the fibrinous defect of the liquor sanguinis predominating, it is, perhaps, in all cases accompanied by other more or less obvious pathological blood-changes; but the defect in the power of fibrillation of itself appears to diminish the solidifying qualities of the blood, and the natural control over hæmorrhage. Wounds, in this state of blood, are apt to heal without inflammation, the lymph organising rapidly, and in this respect contrasting with inflammatory blood. The newly organised parts are very weak, and apt to give way, and to degenerate. The perfect adhesion of incised wounds is prevented, for although a common cut surface will often adhere without any inflammation, it will as speedily give way, and is then followed by suppuration, ulceration, and hæmorrhage. Exudations are distinguished by an excess of albumen, diminished coagulability and an indisposition to become organised; but they rapidly corpusculate and form pus in purulent fluids. Where fibrine occurs as a pathological exudation, it coagulates into a "yellowish, opaque, soft, succulent, or almost creamy clot;" or it may be a fluid containing disintegrated fibrine, in the form of films or molecular fragments; in serous membrane, it appears as an aplastic lymph; the clots found in the heart and blood-vessels after death exhibit the same character. (*Gulliver*, *Med.-Chir. Trans.* vol. xxii. p. 136.)

This state of the blood, in a moderate degree, particularly when accompanied by increased secretions, is favourable to the degeneration, liquefaction, and absorption of coagulable lymph, and of fibrinous exudations; thus the absorption of the exudations in iritis and orchitis, is promoted by a tendency to hypinosis being superinduced by mercury and bleeding.

Hypinosis in a severe degree can last only for a short period; the blood must soon either begin to recover its diminished vitality and return to its normal conditions, or its vital properties become still further deteriorated, and it assumes those characters which belong to the most malignant forms of spanæmia. When, in fever, symptoms of convalescence set in, the fibrine increases, and this occurs before any improvement of the diet to account for it, and continues during the progress of the convalescence. Where the red corpuscles have been in excess, they simultaneously decrease in proportion.]

Henry Ancell.

HYPOPIUM, or HYPOPYON, (from ὑπὸ under; and πὺον, pus.) An accumulation of a glutinous, yellowish fluid, like pus, in the anterior chamber of the aqueous humour, and frequently also in the posterior one. This viscid matter of hypopium, though commonly called pus, is found to be coagulating lymph, or fibrine, secreted either by the iris or the ciliary processes. (See *Mackenzie*, *On Dis. of the Eye*, p. 572, ed. 2.) The symptoms portending such an extravasation in the eye, or an hypopium, are the same as those which occur in the highest stage of acute ophthalmia: viz. prodigious tumefaction of the eyelids; the same redness and swelling of the conjunctiva as in chemosis; burning heat and pain in the eye; pains in the eyebrow and nape of the neck; fever, restlessness, aversion to the faintest light, and a contracted state of the pupil.

As soon as the hypopium begins to form, says Scarpa, a yellowish semilunar streak makes its appearance at the bottom of the anterior chamber, and, regularly, as the glutinous fluid is secreted from the inflamed internal membrānes of the eye, so as to pass through the pupil, and fall into the aqueous humour, it increases in all dimensions, and gradually obscures the iris; first at its inferior part, next where it forms the pupil, and lastly, the whole circumference of this membrane. So long as the inflammatory stage of violent ophthalmia lasts, the hypopium never fails to enlarge; but, immediately this stage ceases, and the ophthalmia enters its second period, or that dependent on local weakness, the quantity of coagulating lymph, forming the hypopium, leaves off increasing, and, from that moment, is disposed to diminish.

Scarpa states, that persons, little versed in the treatment of diseases of the eyes, would fancy that the most expeditious and efficacious mode of curing an hypopium, after it has become stationary in the second stage of acute ophthalmia, would be that of opening the cornea at its most depending part, in order to procure a speedy exit for the matter collected in the chambers of the aqueous humour; especially as this was once the common doctrine. But experience shows, that dividing the cornea, in such circumstances, is seldom successful; and most frequently gives rise to evils worse than the hypopium itself, notwithstanding the modifications suggested by Richter (*Obs. Chir.* fasc. i. chap. 12) not to evacuate the whole of the matter at once, nor to promote its discharge by repeated pressure and injections, but to allow it to flow slowly out of itself. The wound made at the lower part of the cornea for evacuating the matter of the hypopium, small as the incision may be, most commonly reproduces severe inflammation, and a greater effusion of coagulating lymph in the chamber of the aqueous humour. It might even convert the hypopium into an ulcer of the cornea, attended with prolapsus of the iris, and occasionally of the lens itself.

There seems to Scarpa to be only one case, in which dividing the cornea is, not only useful, but indispensable; this is, when there is such an immense quantity of coagulating lymph extravasated in the eye, that the excessive distension which it produces of all the coats of this organ occasions symptoms so vehement, as not only threaten the entire destruction of the eye, but even endanger the life of the patient.

The dispersion of hypopium, by means of absorption, forms the primary indication at which the surgeon should aim. In order to stop its progress the most efficacious method is to subdue the first violence of the inflammation, and to shorten its acute stage by the free employment of antiphlogistic treatment, and the use of emollient topical applications. In conjunction with these means mercury should be exhibited, so as to affect the mouth; a practice which was found many years ago, at the London Ophthalmic Infirmary, to be the most powerful means of checking effusion of lymph in the eye. (See *Saunders's Work on the Eye*, ed. 2; and *A Synopsis of the Diseases of the Eye, by B. Travers*, p. 135.) I observe, that in Hufeland and Himley's Journal for October 1809, p. 93, there is an account of the treatment of an hypopium, or case of effused lymph in the chambers of the eye, by exhibiting from 12 to 18 grains of the chloride of mercury, in the space of 12 hours, and then giving bark; while as an external application, the tinct. opii crocat. was employed. Thus we see, that the efficacy of mercury in checking the effusion of lymph in the eye, and promoting its absorption, has been known many years in Germany. The efficacy of this practice, combined with the external use of belladonna to make the pupil expand, will be hereafter noticed. (See OPHTHALMIA.) The acute stage having been checked, a seton, or a blister on the nape of the neck, as recommended by Scarpa, should be applied.

[It is, however, only in the acute and inflammatory stage, that advantage can be expected from mercurial treatment; when suppuration has taken place, tonics will be more appropriate, and in many cases, the tonic and mercurial treatment may be advantageously combined.]

Mr. Lawrence strongly disapproves of the practice of puncturing the cornea in hypopium. "I lay it down (says he) as an invariable rule, not to puncture the cornea in hypopyon. Inflammation must be arrested by suitable means, and the effusion will be rapidly absorbed." (*On Dis. of the Eye*, p. 279.) The only exception made is, the case of general suppuration of the globe, where the eyesight is already lost, and relief of suffering may be obtained by giving exit to the matter. Mr. Middlemore takes a similar view, believing, that the treatment of hypopium should be directed against the inflammation, which is the cause of it. On the other hand, Dr. Mackenzie is partly in favour of the practice, which, in the hands of Dr. Monteith, was even repeated from time to time with advantage.

In bad cases, hypopium may lead to ulceration, opacity, and bursting of the cornea. The ulceration takes place with great celerity, and as soon as an aperture has been formed, an abundance of coagulating lymph begins to escape, and a degree of relief is experienced. But, this is not of long continuance; for, scarcely is the glutinous fluid evacuated, that distended the whole eye, and especially the cornea, when it is followed by a portion of the iris, which glides through the ulcerated aperture, and protrudes externally. (See IRIS, PROLAPSUS OF.) But if in such an emergency, the cornea, already ulcerated, opaque, and greatly deranged in its organisation, should not immediately burst, the surgeon is then constrained by the violence of the symptoms, depending on the prodigious distension of the eyeball, to make an opening in this membrane.

Were there the least chance of restoring, in any degree, the transparency of the cornea, and the functions of the organ of vision, after opening the cornea, Scarpa acknowledges, that it would be more prudent to make the opening at the lower part of this membrane. But, in the case now considered, in which the cornea is universally menaced with ulceration and opacity, and seems ready to slough, there can be no hope of its resuming its transparency at any point, and he therefore deems it the best and most expeditious method of relief, to divide its centre with a small bistoury, to the extent of a line and a half; and then to raise the little flap with a pair of forceps, and cut it away all round with one stroke of the scissors, so as to let the humours escape without any pressure. The eye is to be covered with a bread and milk poultice, which is to be renewed every two hours; such general remedies as are calculated to check the progress of acute inflammation, and to quiet the nervous system, not being omitted. In proportion as the interior of the eye suppurates, the eyeball gradually diminishes, shrinks into the orbit, and at length cicatrises, leaving things in a favourable state for the application of an artificial eye.

When Scarpa delivers his opinion, that in the above aggravated form of hypopium, there can be no chance of the cornea resuming its transparency at any point, I think his assertion rather imprudent. Nor, admitting its general truth, does it follow, as a matter of course, that it is necessary and right to cut away a piece of the centre of the cornea, and absolutely destroy whatever little chance may yet be left of saving the eye. In support of this remark, let me contrast what Mr. Travers has said, with the advice of Scarpa :— "When the hypopium is so large as to rise towards the pupil, and the ulceration of the cornea is extending, I think its discharge *by section near the margin* advisable. If not too long delayed, the ulcerative process is checked by it, which would otherwise run into sloughing, and *the cornea recover with only partial opacity and disfigurement.*" *Synopsis of the Diseases of the Eye*, p. 280.) *C. Bader.*

Mauchart, De Hypopyo; Tubingæ, 1742. *C. P. Leporin*, De Hypopyo; 4to. Goët. 1778. *Goeldlin*, Diss. de Hypopyo; Erlang. 1810. *Walther*, Merkwürdige, Heilung eines Eiterauges, &c. 8vo. Landshut, 1819. *A. Scarpa*, Saggio di Osservazioni e d'Esperienze, sulle Principali Malattie degli Occhi; Venezia, 1802. *Richter*, Anfangsgründe der Wundarzneykunst, b. iii. 1795. *J. Wardrop*, Essays on the Morbid Anatomy of the Human Eye, chap. vi. Edinb. 1808. *W. Lawrence*, On Dis. of the Eye, p. 279. 8vo. Lond. 1833. *R. Middlemore*, On Dis. of the Eye, vol. i. p. 606. 8vo. Lond. 1835. *W. Mackenzie*, On Dis. of the Eye, p. 572. 8vo. Lond. 1835. See also articles, IRIS, and CORNEA.

HYPOSPADIAS (from ὑπὸ, under, and σπαω, to draw). The congenital imperfection in which the urethra terminates at the under part of the penis, and does not extend sufficiently far forwards to reach the right situation of its orifice in the glans. Sometimes there is a vestige of this orifice, sometimes none: half an inch or more of the urethra may be deficient. In a case of hypospadias in a young child, in which I was consulted, I cut a new passage through the glans, and, having established a communication between it and the urethra, introduced a silver tube. This tube, which was furnished with a rim and apertures by which it could be conveniently fixed, was worn for some time, and the little opening having been touched with caustic, a complete cure was brought about. Mr. Liston sometimes succeeded in completing the passage by turning back a portion of the prepuce, and uniting it without any twist, *i. e.* with its cutaneous surface directed inwards or towards the urethra. (*Practical Surgery*, p. 476.)

[At an early stage in the development of the fœtus, all that is found of the urethra is a groove on the under surface of the penis. The sides of the groove subsequently coalesce to form a canal, and the union takes place from behind forwards. If the union is arrested before the whole canal is closed in, a hypospadias is the result. In many instances of hypospadias, the development of the floor of the urethra terminates opposite the base of the glans, and from this point a groove is continued forwards along the under surface of the glans to its anterior extremity. If this condition of the parts is unattended with further deformity, it does not interfere with the urinary, and probably not in any material degree with the sexual, functions of the organ; but in other instances the anterior extremity of the penis is curved downwards, and is incapable of perfect erection or of emission of the seminal secretion in the proper direction. The lower part of the prepuce is usually deficient in a corresponding degree to the deficiency of the urethra; but it is developed to the normal extent superiorly, and falls over the curved extremity of the glans so that the term "monkshood prepuce" has been applied to the appearance which it presents.

In other cases, the meatus urinarius is found in its normal situation, and the anterior part of the urethra is not deficient, but terminates in a cul de sac in front of the unnatural opening; or the urethra may be pervious in front of the hypospadiac aperture, and form a cul de sac in the opposite direction, in consequence of the closure of the meatus.

In those cases in which the anterior part of the canal is entirely deficient, surgical interference is not likely to be attended with much benefit; it would be necessary to perforate the glans with a trocar and canula, and thus entirely to reconstruct the anterior portion of the urethra. A passage thus made is not likely to remain permanently open, unless constant attention is paid to it to keep it from contracting. It would be more probably a source of permanent annoyance than of satisfaction to the patient.

In those cases, however, where the anterior portion of the canal terminates in a cul de sac, and is not deficient, much good may be expected from the perforation of the cul de sac, and the establishment of a communication between the two portions of the canal, after which the sides of the abnormal orifice may be made to unite by the application of caustic; or, should that fail, by a plastic operation similar to that recommended for fistulous openings into the urethra. Possibly in some cases a turning back of the skin, as practised by Mr. Liston, may be found to answer the purpose.]

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The Sciences of Anatomy and Physiology comprehend no less wide a range than all the known facts and laws, of all organised structures—animal and vegetable; from those of the primary simple cell, to those of the highest and most complex of beings, Man;—not less extended is the scope of this work. So vast a district of the realm of science cannot, it is obvious, be efficiently cultivated by any one individual, be his intellectual power never so great. By the co-operation of many labourers, each exploring his own favourite region, much that has heretofore been unknown is brought to light, much that has hitherto been obscure is made clear; fresh additions are continually accruing to our stock of knowledge, fresh discoveries constantly elucidating or modifying the theories of science. Favoured by such a division of labour, the editor has been enabled to bring successfully to a termination his long and difficult undertaking. In its execution the editor and his fellow-labourers are sensible that they have achieved a work which concerns not only one profession, but which must affect the pursuits of all students of organisation—and which shall be of service to all lovers of nature.

Within the period that has elapsed since this work was commenced, every animal and vegetable tissue has been scrutinised by the microscopist and the chemist; so great, indeed, are the additions that have been made to our stock of knowledge, that minute or microscopic anatomy, or Histology, may be said to have been originated. So rapid have been the advances which physical science has made within the last quarter of a century, that most, if not all, the formerly received doctrines of physiology have required revision, while its "established" facts have demanded re-investigation by original experiment. The result has been that through the medium thus afforded for publication, a series of monographs by contributors of the highest eminence is presented to the public.

It is not too much to claim for this publication the formation of an epoch in the history of physiological science—by having brought to an exact point the latest advances of physiology, it has founded archives in which are deposited documents by which future inquirers may be guided.

A brief statement of the general scheme of this work will suffice to show its comprehensive character. It includes the descriptive anatomy of man, a sketch of every individual member and organ of the human body; the topographical or surgical anatomy of man, denoting the parts, boundaries, and relations of those regions of the human body which most frequently become, through accident or disease, the seat of surgical operations: the department of anatomy termed "general" or "physiological," in which are examined the particular tissues by which individual members and organs are built up. It is in this department of anatomy that the greatest changes have been made through the comparatively modern use of the microscope, and through the investigations of chemists. Not restricted, however, to the anatomy of man, this work embraces also descriptions of the structure of the various classes of the animal kingdom; of the several systems of organs traced throughout these classes, from the lowest to the highest, through all their modifications—constituting the science of "Comparative Anatomy." Under the title of "Physiology" this work offers a series of elaborate essays on the functions which distinguish organisation, both in the animal and vegetable kingdoms—in which, moreover, are taught the modes by which we live, and move, and have our being. Lastly, an account of the chemical composition of animal and vegetable structures, together with the properties and attributes of their varied constituents.

As a guarantee of the accuracy and care with which each article has been prepared, as well as for its intrinsic value, it may be added that the list of contributors to this Cyclopædia includes the names of nearly all the most distinguished cultivators of physiological science in the present age.

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Light
Darkness
Heat
Cold
Electricity
Magnetism
Food
Exercise
Climate
Modes of ascertaining the Effects of Medicine
Active Forces of Medicine
Changes effected in Medicines by the Organism
Physiological Effects of Medicines
Therapeutical Effects of Medicines
Parts to which Medicines are applied
Classification of Medicines
Remedies acting on the Organs of Respiration
Remedies acting on the Nervous System
Remedies acting on the Digestive Organs
Remedies acting on the Perspiratory Organs
Remedies acting on the Sexual Organs
Water
Distilled Waters
Sea Water
Mineral Waters
Plumbago
Carbonic Acid
Borax
Phosphorus
Sulphur
Sulphuric Acid
Chlorine
Iodine
Bromine
Nitrogen, and its Compounds with Oxygen and Hydrogen
Ammonia
Potash
Soda
Soap
Rosin
Lime
Magnesia
Alumen
Chromic Acid
Manganese
Arsenic
Antimony
Bismuth
Zinc
Tin
Lead
Iron and its Compounds
Copper
Mercury
Silver
Gold
Platinum
Irish Moss
Corsican Moss
Wall Lichen
Yeast or Barm
Mushroom
Champignon
Maidenhair
Rice
Oats
Darnel
Wheat
Bread
Rye
Ergot of Rye
Sugar
Sugar-cane
Sago
Areca-nut
Saffron
Hellebore
Aloes
Indian Aloes
Squill
Garlic
Saffron Crocus
Arrow-root
Ginger
Turmeric
Vanilla
Sarsaparilla
Turpentine
Oil of Turpentine
Tar
Savin
Willow
Gall or Dyer's Oak
Cork
Hemp
Hop
Black Pepper
White Pepper
Cubeb Pepper
Croton Oil
Castor Oil
Snake-root
Cinnamon
Laurel
Nutmeg
Rhubarb
Peppermint
Horehound
Foxglove
Deadly Nightshade
Thornapple
Tobacco (Virginian)
Potato
Tea
Coffee
Cocoa
Chocolate

Scammony
Jalap
Gentian
Nux Vomica, or Strychnia
Olive
Manna
Storax
Benzoic Acid
Gutta Percha

Indian Tobacco
Elecampane
Dandelion
Chicory
Valerian
Ipecacuanha
Dover's Powder
Bark (Cinchona)
Elder
Carraway
Coriander
Assafœtida
Ammonia
Galbanum
Hemlock
Colocynth
Wild Cucumber
Clove
Pomegranate
Almond
Prussic Acid
Almond Milk
Wild Cherry
Red Rose
Bean
Balsam
Vetch
Acacia
Logwood
Senna
Copaiva
Poison Oak
Myrrh
Rue
Angustura Bark
Oxalic Acid
Tartaric Acid
Gin
Brandy
Spirits of Wine
Ethyle
Ether
Methylated Spirits
Acetic Acid
Chloroform
Gamboge
Lemon-tree and Fruit
Orange-tree and Fruit
Mallow
Flax
Violet
Horse Raddish
Poppy
Opium
Laudanum
Morphia
Cocculus Indicus
Black Hellebore
Monkshood
Geranium
Creasote

Sponge
Oyster
Leeches
Spanish Fly
Cochineal
Honey
Isinglass
Cod Liver Oil
Musk Animal
Stag
Ox
Beaver
Badger

Tabular View of the History and Literature of Materia Medica.

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